With the Compliments of the Author.

COMPOSITE PORTRAITURE

ADAPTED TO THE

REDUCTION OF METEOROLOGICAL

AND OTHER SIMILAR

OBSERVATIONS.

BY

G. M. WHIPPLE, B.Sc., F.R.Met.Soc., F.R.A.S.,
Superintendent of the Kew Observatory, Richmond.

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[*From the* Quarterly Journal of the Meteorological Society, Vol. IX. No. 48.]

It has often been remarked that one of the main, if not the chief, of the difficulties the meteorologist has to contend with, is the enormous amount of preliminary labour which has to be expended in the not very pleasing task of forming the observations he may wish to discuss into tables, casting the columns of figures so obtained, and then computing the means. Should, as in many cases now-a-days, his original material be in the shape of curves, *e.g.* barograms, thermograms or anemograms, he has first to reduce these to figures by tabulation, before he can attempt any step towards their reduction.

The deterrent nature of these preliminary operations not unfrequently forms a complete bar to the entering upon most interesting investigations with the view to the advancement of the science, in the case of persons unable to devote sufficient time to such labour, which may almost be termed drudgery. To cite examples, a glance at the recently published papers in the Proceedings of the Royal Society, by Professor Balfour Stewart and by Mr. C. Chambers, in which they endeavour to trace a possible intimate connection between solar and terrestrial phenomena, will show the immense amount of calculation they had to perform in order to arrive at their results—how, for instance, preliminary means had to be taken of three days' observations and the result assumed to be a corrected value of the middle day of the three, then after the whole series had been so treated, a second or even a third set of three-day averages computed. The author has also a lively recollection of the excessively tedious calculations required to eliminate in a somewhat similar manner the effect of disturbances in the discussion of the Kew magnetic results for the late Sir E. Sabine. With the view of arriving at results by a shorter cut, the author has been led to consider the possibility of employing a method suggested by an examination of the highly ingenious system of composite portraiture invented by Mr. Francis Galton, F.R.S., and utilised in his anthropological studies.

Mr. Galton's method of experiment is based upon the fact that certain groups of people possess certain physiognomical features in common. This agreement of feature is usually characterised by the term "family likeness." In order, therefore, to select this particular element from the others, and to obtain a picture in which it is most strongly defined; or, in other words, to form a characteristic portrait of the group of individuals, Mr. Galton employs a series of photographs. These, representing a large number of men or women, are first reduced to the same scale, and then projected successively upon a sensitised photographic plate, having been previously so arranged that the eyes or other salient feature shall always fall on the same portion of the plate.

In this manner a negative is eventually obtained which gives a print depicting a countenance which, although resembling but partially any one of the component portraits, gives a fair typical picture of the group of individuals. Among other results Mr. Galton has detected the likeness existing in various classes of criminals, and also in patients suffering from the same disease, as well as the more marked features transmitted through the different members of a family.

Since in meteorological investigations the desire is to select and to identify the one particular variable running through a group of phenomena, it has appeared to the author, arguing by analogy, feasible to perform this operation by a method somewhat resembling that just described. Supposing, for example, it is desired to determine the true curve of diurnal variation of the wind velocity at any given station. In the case of proceeding by the ordinary routine of hourly sums and means, it will be found that the occurrence of a high wind or gale on a single day will vitiate the results for a considerable period of time.

If, on the other hand, instead of doing this, a drawing or photograph be made on one sheet of the daily curves for a few weeks, it will be found that the traces for the days free from storms will lie so fairly close together or upon one another, that little difficulty will be found in selecting or drawing through them a curve representing the general run of the group. Several sets of curves having been so treated, the typical curves must be in turn themselves superimposed, and through them another curve drawn, which will be still less affected by abnormal movements; so eventually the true curve of diurnal variation would be arrived at.

In the case of subjecting photographic traces, *e.g.* barograms, thermograms, electrograms, magnetograms, &c. to this treatment, it would be advisable to employ negatives instead of the original curves, in order that the composite produced might consist of dark lines on a white background; not the reverse, which would be comparatively useless for the purpose.

For the reduction of anemograms, rain, and sunshine curves, by this method, it will be necessary to make drawings or tracings first from the curves, giving the hourly values separated, as is done in the diagrams published in the *Quarterly Weather Reports* of the Meteorological Office and in the Kew *Times* curves.

Another application of the method of composite drawing will serve to facilitate the acquisition of a knowledge of the general distribution of weather systems over large tracts of the Earth's surface. To do this a series of weather charts should be taken, and selecting certain prominent features, such as the centres of cyclonic and anticyclonic disturbances, day by day their positions should be marked off upon one chart. This being done in a sufficient number of cases and combined, a repetition of the process would enable a determination to be made of the average distribution of these systems for a given season.

The author has attempted to illustrate his proposed applications of the method of composite portraiture by three examples. The data treated in every case were chosen at random, and may therefore be considered as indicating the applicability of the process to meteorological work in general.

In the first example the mean diurnal variation in the wind velocity at the Kew Observatory, Richmond, was determined for three months—August to October, 1879. Taking the hourly values of the rate at which the wind was blowing, from the Meteorological Office publications, curves were plotted down on a conveniently open scale, a fortnight on a sheet. Through the fourteen curves drawn in pencil a mean curve was traced in red. This roughly represented the average daily movement for a fortnight.

The pair of fourteen-day curves being superimposed on a third sheet, a third trace drawn between them was assumed to be the mean trace for the month, and finally combining the three so derived months' traces, it was easy to draw a final curve showing the mean diurnal variation of wind velocity during the quarter in question.[1]

The second experiment was an attempt to obtain a monthly mean of the barometer directly by the graphic method. Taking advantage of a self-registering aneroid being on trial, its traces were utilised for the month, January 8th to February 7th, 1883. These were copied off on a sheet of tracing paper, ruled so as to comprise one day's curve only. The tracing paper was then folded vertically, so as to compress the curves, and the mean positions of the traces were drawn on the folds. After four foldings a point was fixed upon as the mean of the month, and the value of this point referred to the scale of the instrument. The resulting value for the mean barometric pressure of

[1] It must be remarked that a due proportion should be preserved between the scales of the ordinates and abscissæ, for unless this is done the combined traces may appear merely as a mass of confused lines. Such was the case in one experiment made by the author, when he attempted to derive the curves directly from the zinc templates engraved at the Meteorological Office, and kindly placed at his disposal by Mr. Scott.

the month very satisfactorily agreed with the value determined by calculation from the barometer readings taken daily at the Observatory.

The third series of illustrations represented the positions of the centres and the contours of the areas of maximum and minimum barometric pressure over the Atlantic during January, February, and March, 1881. A number of blank charts were worked off by the chromograph, on tracing paper, to the scale of the International Synchronous Charts. Tracings were made on one sheet in blue pencil of the cyclonic centre for each day of the month, and a similar set of tracings in red of the anticyclonic centres. Having from these drawn the mean positions and areas of the systems for the month, it was easy to draw another chart with the general distribution for the quarter. These diagrams were seen on comparison to differ materially from those drawn for the monthly means of the observations. In suggesting the composite method of treatment of meteorological data, the author is fully aware that a somewhat similar process has been already applied in the determination of the radiant points of shooting stars, and would also desire to state that the process is not by him considered as equalling or even approximating in accuracy that of employing the Harmonic Analyser in computing the periodical variations of the elements. As, however, that instrument is not at the command of many investigators, he is of opinion that the labour of reduction may in many cases be saved by making use of the graphic or composite, instead of the purely numerical method.

Identity Demonstrated, &c.

"EACH BEING DIFFERS FROM EVERY OTHER BEING."—*Lavater.*

THE great diversity that prevails in the contour and expression of the human FACE, asks for no other proof than that afforded by the sense of sight.

The careful nomenclature of Ethnology and the more fanciful jargon of Physiognomy both of them evidence the extent to which this diversity of the features of the countenance has claimed the attention of the studious. Its details have been elevated into topics of learned investigation and have afforded unfailing themes of literary comment.

Yet, to the eye of ordinary observers and the general body of superficial people, so closely does one face in those of a multitude resemble another, that the statement will probably be regarded by many with incredulity, that in a case of disputed personal identity conclusive evidence may from such a source be obtained.

Individuals of an order thus incompetent and unlettered may with advantage be reminded that so note-worthy and exhaustless are nature's modes of producing variety, that a phrase may be said to have been coined for the very purpose of giving expression to the idea: "There are not two blades of grass that are exactly alike."

A practical and in its way an amusing illustration of the diversity which presents itself, even in the unpromising countenances of sheep, may also here be referred to. An unobservant person perceives in a flock of those animals only expressionless similarity, multiplied to an indefinite extent. Yet in such a case the experienced shepherd discerns facial discrepancies which enable him to distinguish between every separate member of an extensive flock, and even to detect in their midst the presence of a stranger.

Upon what data does such an identification proceed, if not upon the *ever-varying re-arrangement* of the

Lines and Curves—

the furrows and protruberances of the frontal surface? And why should not the adapted formularies of geometry be found competent to deal with those lineal data and to subject them to analysis?

But the remarks in these pages have regard only to the differences observable between the faces of *members of the human family;* and even of such, only those who have arrived at mature years. And, certainly, in

The Countenances of Men,

not only do the differing proportions of each separate feature operate as *the factors of an endless diversity*, but every pervading sentiment—every predominating habit of life, adds its quota to the permanent result. And thus the characteristic speciality of each individual becomes distinctly stereotyped upon the tissues of the face, and the data of identification are multiplied.

From Chili to Piccadilly
WITH SIR ROGER TICHBORNE.

The Santiago Daguerreotypes and the London Photographs Compared.

IDENTITY
DEMONSTRATED
GEOMETRICALLY.

With Photo-type Illustrations.

BY

WILLIAM MATHEWS,

EDITOR, LATE OF *Weston-super-Mare Gazette*, &c., &c.

BRISTOL:
J. WRIGHT & Co., 10 & 11, STEPHEN STREET.
LONDON:
63, FLEET STREET, AND ALL BOOKSELLERS.

1876.

"All countenances, all forms, all created beings, are not only different from each other in their classes, races, and kinds, but are also individually distinct. Each being differs from every other being of its species. However intimate the analogy and similarity of the innumerable forms of men, no two men can be found, who, brought together, and accurately compared, will not appear to be very remarkably different."—*Lavater.*

[*Copies of this pamphlet, at 6d. each, may be obtained of W. Mathews, The Royal Fort, Bristol.*]

USES OF PHOTOGRAPHY.

Under such circumstances, and in view of the abundant uses for which the

Microscopical Accuracy of Photography

has rendered it valuable, strange would it be if science could devise no means of obtaining evidence—conclusive and irrefutable, in a case wherein personal identity is the specific issue.

Certainly, the indispensable preliminaries of a function so judicial are an accepted

Scale of Admeasurement

and an adapted nomenclature. *A scale of inches* and of its sub-divisions *will not serve* the required purpose. Obviously, the scale must be of such a nature as will operate independently of the ever-varying magnitudes of the portraits to be examined—it must remain unaffected by the differing powers of the lenses employed in the production of such pictures.

And how may such a *desideratum* be arrived at? And what must be the specially adapted constituent of such a scale? The answer is this:

The "Unit" of an Admeasurement

of this nature must be a fractional part—a well-defined fractional part—of the given whole. It must be a fractional part which shall *exist under identical conditions* in each face submitted to the test: the first and most obvious consequence being that such fraction will *vary always in equal ratio with the varying magnitude of the whole picture.*

It will be obvious to the meanest understanding that upon a careful sub-division of any *two photographs produced from the self-same negative,* and divided by the *self-same fractional part,* that they must always minutely correspond. So, it necessarily follows, must also a larger or smaller copy of the same portrait, when the selected "unit" of the sub-division has varied *in the same ratio as the whole picture.*

And this granted, what remains but that, *cæteris paribus,* the incidence of the lines of subdivision must equally correspond in ANY TWO PORTRAITS OF THE SAME PERSON TAKEN AT EVEN WIDELY DISTANT INTERVALS.

The author of these pages submits that the carefully-obtained

Diameter of the Iris of the Eye,

at its exterior rim, provides *the requisite fraction,* and affords the sufficient and undeviating unit of a crucial admeasurement.

The whole inquiry in such case converges upon the question of the abiding

Permanency of the Diameter

of the iris. And this is a question open to instant solution by reference to photographic portraiture and the data possessed by physiologists and opticians. Not to multiply opinions upon a point so readily authenticated, the author here inserts only the remark of

An Eminent Anatomist

to whom an inquiry was addressed touching this exact issue. He replied: "I beg to say, that the extreme diameter of the iris, as well as the proportions of the other parts of the eyeball have always appeared to me much the same in the youth as in the grown-up person."

AUTHENTIC PORTRAITS.

Possibly it will be thought incumbent upon the author to assure the reader of the perfect *authenticity of the Portrait* of Mr. Roger Tichborne inserted in these pages. It has been reproduced by photographic process,* from the well-known *carte* published by the London Stereoscopic Company. It is in evidence that two daguerreotypes were taken on January 10th, 1854. Mr. Tichborne was at that time 25 years of age; the date of his birth being January 5th, 1829.

The daguerreotype plates, the production of Mr. Helsby, an English artist, residing at Santiago, in Chili, were sent to England by Moore, the personal attendant of Mr Tichborne. One of them was forwarded, at the immediate date of the sitting, to Lady Doughty, and the other ultimately came into the possession of the Dowager Lady Tichborne.

THE PHOTOGRAPHS IN THE WITNESS BOX.

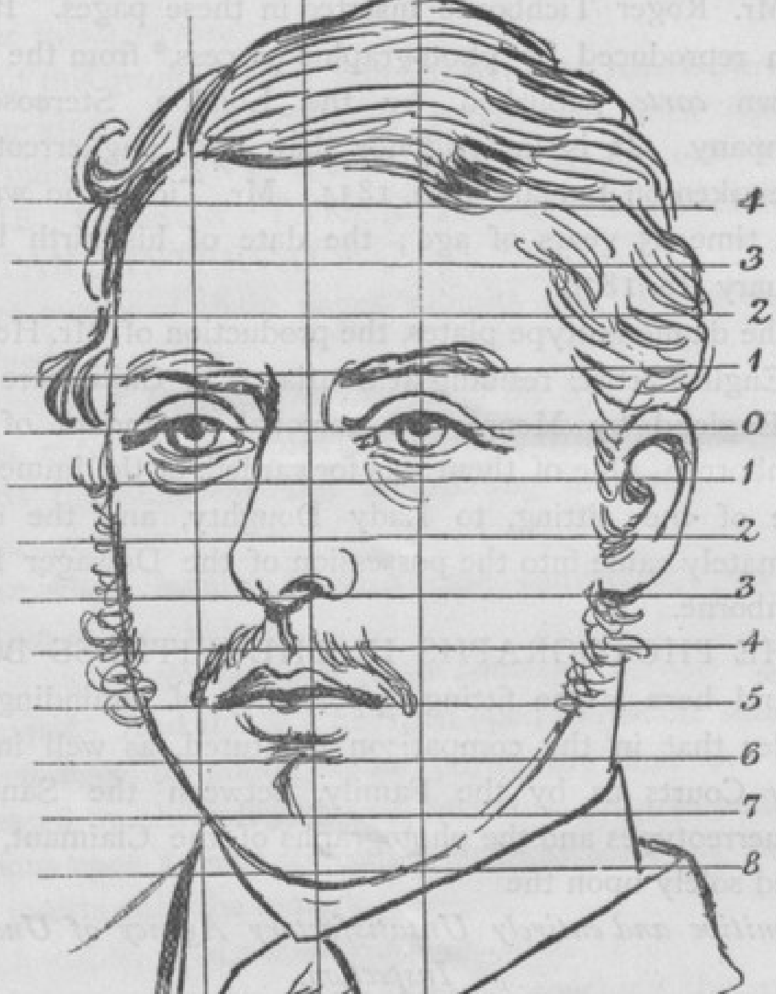
And here is the fitting opportunity of reminding the reader that in the comparison instituted, as well in the Law Courts as by the Family, between the Santiago daguerreotypes and the photographs of the Claimant, they relied solely upon the

Primitive and entirely Unsatisfactory Agency of Unaided Inspection.

No method of test was employed that could by possibility rise superior to the effects of fourteen years' residence under Australian skies—a period which, commencing with scarcely-attained manhood, extended into middle life.

The disproportion between the fully-developed countenance of the Claimant and the attenuated features pourtrayed in the daguerreotypes was thus allowed to operate with unabated force. The Court, the Jury, and

* "Leitch's process."



H.R.H. PRINCE LEOPOLD.

the Witnesses were alike unconscious of the unquestionable fact that, despite the seeming discrepancies, it might to a mathematical nicety be shown that

The Eyes are at the same exact Distance from each other. Perfectly oblivious were they that fat and muscular tissue, protrude however they might upon the Claimant's face and person, added not the minutest fraction to the

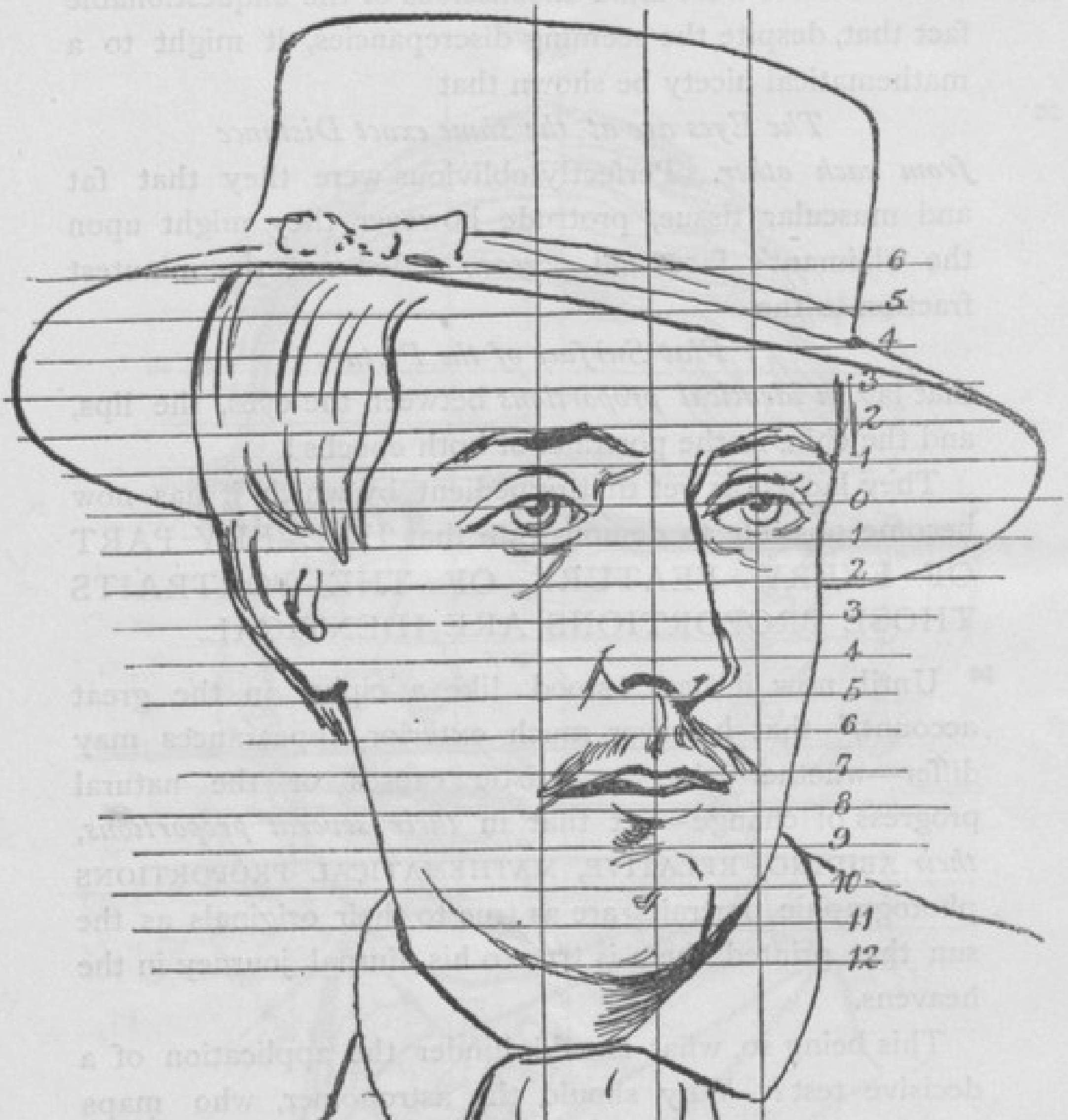
Flat Surface of the Picture

that lay *in identical proportions* between the eyes, the lips, and the chin, in the portraits of both epochs!

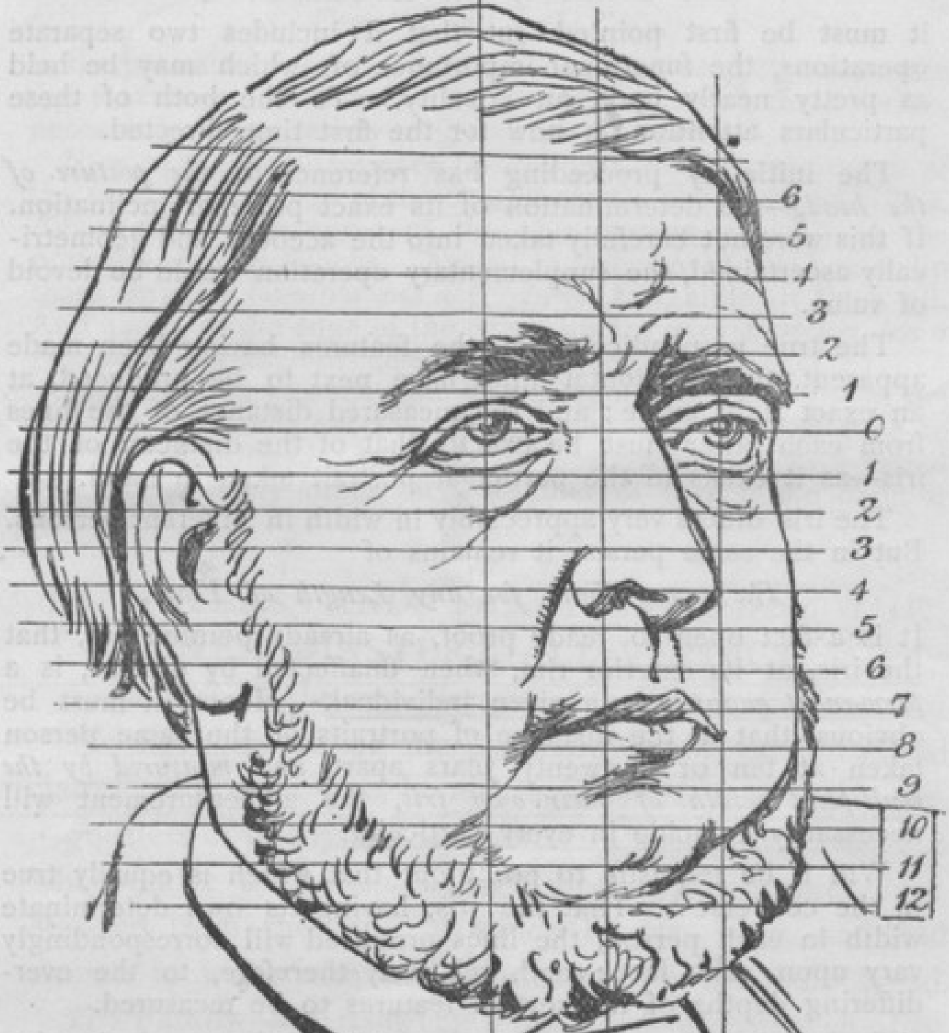
They lacked as yet that expedient by which it has now become possible to demonstrate that IN EVERY PART OF EVERY FEATURE OF THE PORTRAITS THOSE PROPORTIONS ARE IDENTICAL.

Until now it has "stood like a cipher in the great account," that however much exterior appearances may differ—whether due to artistic causes or the natural progress of change—yet that in *their several proportions, their* ABIDING, RELATIVE, MATHEMATICAL PROPORTIONS photographic portraits are as true to their originals as the sun that printed them is true to his diurnal journey in the heavens.

This being so, what should hinder the application of a decisive test? Why should the astronomer, who maps out the paths of the planets and traces their courses among the stars, be better assured of *his* conclusions, than he, who by the aid and teaching of the same science of geometry proposes to determine—and as incontestably, the identity of a given face, that with *microscopic accuracy of admeasurement has been imprinted upon a photograph?*



TICHBORNE, 1853.



TICHBORNE, 1873.

THE ADMEASUREMENT.

Coming now to

The Process of the Admeasurement,

it must be first pointed out that it includes two separate operations, the functional importance of which may be held as pretty nearly upon an equality. To the both of these particulars attention is now for the first time directed.

The initiatory proceeding has reference to *the posture of the head,*—the determination of its exact poise or inclination. If this were not carefully taken into the account and geometrically ascertained, the supplementary operation would be devoid of value.

The true perpendicular of the features having been made apparent, the horizontal lines have next to be produced, at an exact right angle; and the measured distance of the lines from each other must be exactly that of the diameter of the iris—as it exists in the particular portrait taken in hand.

The iris differs very appreciably in width in different persons. But in the same person it remains of

The same Width for any Length of Years.

It is a fact open to ready proof, as already pointed out, that the iris, at its exterior rim, when unaffected by disease, is a *permanent quantity* in a given individual. Hence, it must be obvious, that in the instance of portraits of the same person taken at ten or at twenty years apart, and *measured by the multiplied width of their own iris,* the admeasurement will necessarily coincide in every particular.

Will it be requisite to point out that which is equally true in the converse? That the iris, having its own determinate width in each person, the lines produced will correspondingly vary upon each face; and, relatively therefore, to the ever-differing depths of the several features to be measured.

Such being the conditions, the logical inference is irresistable: namely, that the lines upon no two portraits, being those of two separate persons, will ever be found traversing, at all points, an identical series of those manifold minutiæ that are so variously presented by the human countenance.

Thus, then, we arrive at the conclusion, that whereas the entire series of Tichborne Photographs—from the Santiago portraits of 1854 to the latest photographs of 1874, have every line in identically the same place upon every part of every feature—we say that, incontestably and by geometric process, they prove our case, and mathematically demonstrate the Claimant's identity as

Sir Roger Tichborne.

And what are the observable results? Be it understood that whilst in the photographs of some persons, six or eight diameters of the iris suffice to reach

From "Zero" to the Chin,

in the portraits of others, fourteen or more scarcely constitute the *maximum*. And between the two extremes there exists, necessarily, every variety of fractional diversity.

Now, in the whole series of Tichborne faces, (from the centre of the pupils to the verge of the chin) there are just *twelve* diameters. Again; the upper curve of the chin agrees minutely in the portraits of both epochs. Again; to the edge of the lower lip there are *eight diameters and a fractional part*, alike in them all. And again, to the edge of the upper lip are *seven diameters less a fractional part* alike in them all.

Thus may we proceed from spot to spot over the whole of the features, and point out that they agree absolutely and even to minutest fractions. And this in presence of the ever-varied diversity of every other face, whether of parent and child or twin-brothers.

DIAMETERS AND FRACTIONS *versus* THE WESTMINSTER HALL VERDICT.

Here, then, is the summing-up of the whole matter.

We have before us the photographs of an individual claiming to be the true, honest, legitimate heir of Tichborne, —guiltless of felony and unstained by perjury or fraud; but who—under conditions by no means without precedent, stooped from the rank in which he was born, and had chosen to work with his own hands for his daily bread.

His Family—the relatives of his blood—deny his identity, and obtain his prosecution as an impostor.

After an inquiry of unexampled duration, the chief judge—reviewing the enormous mass of evidence then before him, is compelled to confess, at the latest moment of the investigation, "*It would be extremely difficult to say that there was not great doubt hanging over the case.*"

And now, reader, mark what happens. Many months after that trial is over, and when the unhappy defendant —to whom the "great doubt" was of no avail, as it should have been, before a jury of Englishmen—had been conveyed, a manacled prisoner, to linger out a living death amid the fogs of Dartmoor: at that *eleventh* hour, the science of geometry was brought to bear upon his sun-printed pictures, and, lo, every doubt—*every alleged doubt*—was dispelled utterly. For as face answers to face in a glass, so did those faces answer to each other—with perfect, with palpable, with microscopic accuracy of admeasurement!

What say you to that, impartial reader? Will you not accept the evidence of your own senses? Will you not listen to the stern logic of mathematical fact? Or will you, on the contrary, permit your better judgment still to be submerged in that fathomless abyss—denoted by the presiding judge, with unaccustomed significance—"the *Conflict of Testimony?*"

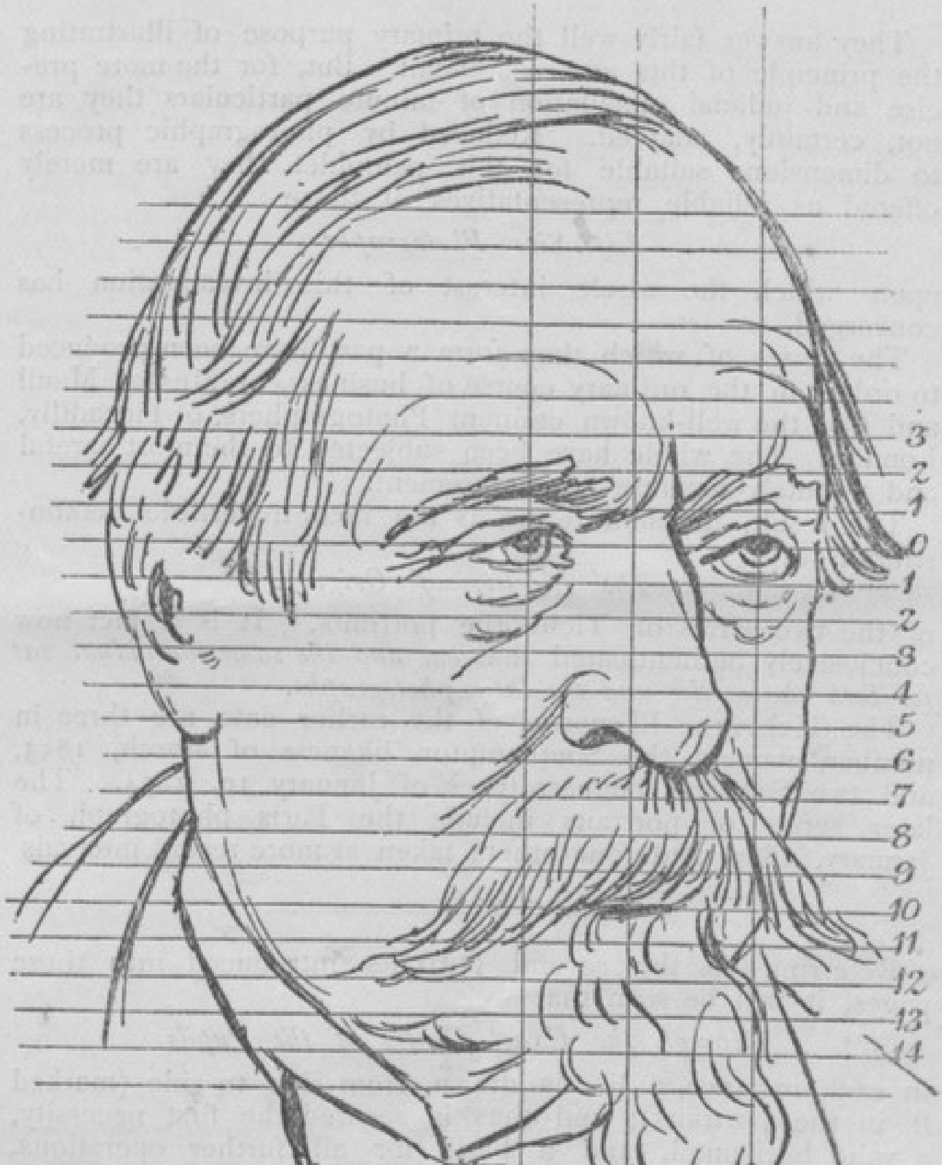
Can any power on earth stay the recognition of a scientific fact? Possessing on the one hand, daguerreotypes of matchless excellence—of microscopic accuracy of detail; and upon the other hand, a whole series of photographs by artists of the first repute, what else does the mathematician need, to solve the problem of

The Identity of Tichborne?

Rest assured that an affirmative decision is in *the immediate future,* now that the question has been relegated to the arena of Science.

A derelict of the Law Courts and of Parliament, the "Case of the Claimant" has been transferred from their heated atmospheres, to the more sequestered cloisters of the physiologist and the mathematician. And, if Science once pronounce *these* portraits to be identical in their origin with *those,* think you that the Judgments of Westminster Hall or the Vetoes of St. Stephen's will have power to annul the decision?

J. Wright & Co., "The Bristol Steam Press," 10 & 11, Stephen Street.



NAPOLEON III.

THE ILLUSTRATIONS.

The power of transmuting a photographic portrait directly into a metallic block, and of placing it side by side with ordinary types, for the purpose of being printed from, has not yet been attained. The nearest available approach to such a process has been sought out, however, in order that the portraits inserted in these pages might be placed above the suspicion of

Intentional Falsification.

They answer fairly well the primary purpose of illustrating the principle of this admeasurement. But, for the more precise and judicial elucidation of minute particulars they are not, certainly, adapted. Reduced by photographic process to dimensions suitable for this pamphlet, they are merely offered as reliable representatives of those

Life-Size Photographs

upon which the whole interest of this investigation has converged.

The series of which they form a part have been produced to order, in the ordinary course of business, by Messrs. Maull and Co., the well-known eminent Photographers, of Piccadilly, London. The whole have been subjected to the most careful and minutely-accurate admeasurement.

The result, in plain terms, is the incontrovertible demonstration of

The Identity of Origin

of the two series of Tichborne portraits. It is a fact now conclusively authenticated that *one and the same individual sat for both the earlier and the later photographs.*

The Tichborne likenesses of the earlier date are three in number, namely, the Southampton likeness of March, 1853, and two Santiago daguerrotypes of January 10, 1854. The later series of portraits include the Paris photograph of January, 1867, and four others taken at more recent intervals

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Referring to the several portraits introduced into these pages, it will be seen that

Through the Exact Centre of the Pupils

in each instance, a line is drawn, from side to side (marked 0 in the portraits); and thus is secured the first necessity, a valid horizontal, and a basis for all further operations. Bringing the exact distance between the centres of the pupils to our aid, we next strike intersecting arcs above and below the horizontal; upon these arcs being connected by a line passing through the points of their intersection, we arrive at *the indispensable requisite*, the true perpendicular and natural poise of the head, as it variously exists in each portrait.*

That feature of the operation having been carefully effected, we proceed with equal care to mark off the lines representing the diameter of the iris, upward and downward — starting always from the centre of the pupils.

* The bisection of sufficiently large portraits, identical in focus—by dividing them with a penknife, carefully, down the perpendicular lines, and then transferring one or the other section from one to another portrait—will afford an *ocular demonstration* of the *perfect correspondence* of the Tichborne portraits of the two epochs.

Composites p. 109

THE

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OF

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NORMAL AND PATHOLOGICAL.

CONDUCTED BY

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Journal of Anatomy and Physiology.

ON THE HISTOLOGY OF THE VITREOUS HUMOUR.

By Arthur C. Younan, M.B., C.M., *Vans Dunlop Scholar, University of Edinburgh.* (Plates I. and II.)

Few subjects in histology have been the occasion of so much difference of opinion as the structure of the vitreous humour of the eye. The tissue is so transparent, its structural element so delicate and difficult to observe under the microscope, that so much variance in opinion is scarcely surprising. The great diversity of views entertained by different authors is also, in part, explicable on the ground that they resorted to artificial hardening, which in great part alters both the macroscopic and microscopic appearances of the vitreous.

It is admitted by all that the vitreous consists of a solid and a fluid part. The nature of both has been disputed, but especially that of the solid part, and also its arrangement. Pappenheim (1842, quoted in *Op.* 1, p. 348) found that, on hardening the vitreous with carbonate of potash, the stroma appeared to be composed of laminæ running parallel with the surface, each lamina consisting of fine fibres and a homogeneous matrix. Brücke (1843, *Op.* 2, p. 346) removed the sclerotic, choroid, and retina from the eye of a sheep as far forward as the ora serrata, and placed the exposed vitreous in a concentrated solution of diacetate of lead. After some hours he made sections of the vitreous thus hardened, and observed concentric white lines parallel with the general surface, and presenting on section the appearance of finely striped agate. He found that the vitreous so prepared tore easily in the direction of the layers, which appeared to him to consist of milky transparent membranes with intervening clear spaces filled by an apparently ing of the membranes, his description of which is likewise very inadequate. R. Virchow, Kölliker, and others have regarded the vitreous as consisting of mucous connective tissue, viz., branching connective tissue corpuscles forming a network with an intervening fluid containing mucin. Ciaccio (*Op.* 8, vol. vii. p. 376) is of opinion that delicate fibres and cells are its only solid constituents. Iwanoff (*Op.* 1, p. 345) and Schwalbe (*Op.* 5, p. 139, and *Op.* 6, p. 524) express a similar opinion. Iwanoff states that the cells of the vitreous are all amœboid, and are found only in its outer part. The fibres are wavy fasciculi bearing some resemblance to the fibres of connective tissue, and are found only in the peripheral part of the vitreous. Most are found anteriorly; in the posterior part there are only a few scattered fine fibrils; there are also a considerable number of fibres like elastic fibres commencing at the equator of the eye in the form of extremely fine looped fibres, first seen in large numbers at the ora serrata, where they form the commencement of the zonule of Zinn.

My observations on the vitreous, made on the eyes of the ox, sheep, rabbit, cat, rat, and cod, have led me to the belief that the fully developed vitreous is certainly an organised structure, altogether differing from mucous connective tissue. Its solid part consists of thin membranes, cells, and fibres, and I propose to give an account of the appearance and arrangement of these. I have not investigated the chemical nature of the fluid between the membranes, but this has been done by Lohmeyer, quoted by Schwalbe (*Op.* 5, p. 137 and *Op.* 6, p. 523) and Hans Virchow (*Op.* 7, p. 10), who finds that in ruminants and carnivora the fluid contains salts, extractives, and albumin, but no mucin. Schwalbe, however, finds a trace of mucin in the sheep, and also gives the composition of the fluid in the human vitreous and in that of the fish as differing from the fluid in the vitreous of the ox and dog, in containing mucin (*Op.* 6, p. 523).

Cells of the Vitreous Humour.—In the vitreous of the adult, the cells are, as stated by most authors, found mostly near the surface. They present two different types. (1) *Amœboid cells* of various shapes and sizes: oval, circular, flask-shaped, or quite irregular, the protoplasm being protruded as buds; these have large nuclei, and a varying amount of coarsely granular protoplasm. Some cells contain two or three nuclei, but those internal to the limiting hyaloid membrane have generally a single nucleus. In some cases no protoplasm is visible, the nuclei being large and distinct. Lieberkühn and Schwalbe suppose these cells to be leucocytes derived from the retinal vessels in the region of the papilla optici, and also from the vessels of the ciliary body, and so account for their being found in greater numbers in the anterior and posterior regions of the vitreous. Pagenstecher (*Op.* 6, p. 555), observed them in the vitreous of the young rabbit on a hot stage under the microscope, and followed the different changes in form that they undergo. These cells are seen to lie on the inner surface of the limiting hyaloid membrane, as also on the inner surface of the other membranes in the cortex of the vitreous. Some of them may appear under the microscope to be folded round creases of the membranes, and they have then an appearance so like clasping cells, as to have led to the folds being mistaken, by some, for fibres developed from the cells. The character of the amœboid cells is well seen in Plate I. fig. 1. (2) Besides the above, there are large and small *branching cells* with distinct nuclei; these also vary greatly in shape, and may be uni-, bi-, or multipolar. The processes are clear, and may be straight, curved, or twisted in various directions, and with straight or irregular outlines, the irregularity being due to a beading or varicosity along the course of the processes, which sometimes end in a distinctly beaded manner. I have seen some of these branching cells arranged so as to come in relation to a network, both in the adult and young animal. This network has been chiefly observed in the equator of the eye, in which region some of the fibres which run towards the zonule appear to lose themselves in the network. I have also seen bright elastic-looking fibres arising apparently as processes of cells in the region of the zonule, and adding themselves to the fibres of that ligamentous membrane. The character of the branching cells is shown in Plate I. figs. 2 and 3. Fig. 4 shows what at first appeared to be a network of branching cells in the region of the zonule, the fibres of the network corresponding in some of their microscopic characters with the elastic-looking fibres of the zonule, some of which fibres can be traced to the network; the nature of this network will be considered later.

Vacuolated cells have been described by Iwanoff (*Op.* 1, p. 352) as a distinct type. It seems, however, unnecessary to classify them separately, inasmuch as they are merely derivatives of the first two types. Schwalbe (*Op.* 6, p. 536) attributes the formation of the vacuoles to inhibition, in consequence of their being found in adult life, when the vitreous is rich in water, and not generally in the embryo, where the vitreous is more consistent. Each cell may present one or more vacuoles, which at times attain a large size, quite displacing the nucleus, or they may be found in the processes of the branched cells where they give rise to dilatations. Schwalbe (*Op. cit.*) is of opinion that all the cells above described have a common origin, viz., are derived from white blood corpuscles which have undergone changes in configuration, in some cases to a marvellous extent. In support of this view he describes an experiment in which he placed, at different periods, the human vitreous and also that of the sheep and pig in the dorsal lymphatic sac of the frog, at the same time injecting a fluid containing fine coloured granules in suspension into the lymph spaces of the frog. The pigment granules were taken up by the lymph cells, and so carried eventually into the vitreous enclosed in the lymph sac. On examining portions of the vitreous removed after eighteen hours from the sac, he found that the lymph corpuscles which had emigrated into the vitreous had assumed various shapes, which corresponded in a marked manner to the different forms presented by the cells of the vitreous body. I am not at all prepared to admit that all the branching cells are mere modifications of lymph corpuscles; some may fall into that category, *e.g.*, the cells with beaded or irregular processes as shown in Plate I. fig. 3, but there are other branching cells with bright sharply-defined processes, some of which are of great length, which seem to be of a different nature, and others again fusiform or irregular in shape which I have frequently seen in relation to a network of clear fibres, which, though represented in Plate I. fig. 4 as forming the network by union of their processes, may be of the nature of connective tissue corpuscles in close relation to the fibres. These will again be considered in alluding to the fibres of the vitreous. In passing, I might say there are other cells among the zonular fibres which are distinctly clasping cells giving origin to the fibres. These are seen in Plate II. fig. 10.

Membranes.—The membranes of the vitreous constitute by far the most important structural constituents of the tissue. They can be seen on examining with the microscope portions of the fresh or hardened vitreous snipped off with a pair of scissors from *any part* of the organ, or by making complete antero-posterior or vertical sections through the vitreous shrivelled by placing it in a strong solution of gum or glycerine. The most external membrane, or so-called hyaloid membrane, can however be separated by the action of hardening agents, as Kleinenberg's picric acid solution,[1] or ammonium chromate solution (5 per cent.); it forms a sort of capsule for the vitreous. Each membrane presents a homogeneous appearance when it is spread out, but the surface may be readily thrown into innumerable folds and crimples, the latter giving in some places the impression of fibres, more especially where a cell is folded round it. The resemblance is so striking, that I had much hesitation at first in pronouncing as to their nature, but, judging from the optical characters of the crimples, and their similar appearance in other parts where no cells can be made out, as is the case near the centre of the organ in the adult, I consider them to be folds or creases and not fibres. The general character of the membranes, folds, and crimples is well brought out by staining agents, *e.g.*, carmine (Plate I. fig. 5), logwood, chloride of gold (Plate I. fig. 6), &c., when the general surface presents a uniform tint, with darker straight, curved, or twisted lines, or bands corresponding to the folding or crimpling. The crimples or creases assume very peculiar shapes in some cases, which may present here and there a corkscrew-like arrangement. The external membrane, or so-called hyaloid membrane has been considered as a special structure; according to my observations, however, it does not differ from the internal membranes except in being thicker, and therefore I think it is unnecessary, and indeed misleading, to distinguish this membrane by the special name of hyaloid

[1] To 100 c.c. saturated solution of picric acid add 2 c.c. sulphuric acid; filter, and add 300 c.c. distilled water.

membrane, inasmuch as all the membranes are hyaloid. It may, however, with propriety, be termed the limiting hyaloid membrane (membrana limitans hyaloidea) as Henle has proposed. Iwanoff (*Op.* 1, p. 346) regards it as identical with the inner limiting membrane of the retina, but in this I differ from him entirely. Plate I. figs. 5 and 6 show the characters of the external and of one of the internal membranes respectively. These clear, homogeneous, hyaloid membranes are so arranged as to give rise to a concentric lamination, the laminæ extending to the canal of Stilling, which courses through the centre of the vitreous, from the posterior pole of the organ, where there is a distinct depression opposite the papilla optici of the retina, marking its origin, to near the posterior surface of the crystalline lens, where it ends in a blind extremity. The arrangement of the membranes in the region of the canal of Stilling can be explained by the membranes being invaginated by the entrance of the hyaloid artery which occupies the canal in the fœtus. With regard to the portion of vitreous immediately posterior to the lens, it is likewise composed of concentric membranes continuous with those at the sides. The limiting hyaloid membrane is continued forwards internal to the zonule of Zinn, becoming more delicate as it passes behind the lens, and, similarly, the the other membranes are continued forwards within it. The presence of these membranes behind the lens may be demonstrated by examining even fresh portions of the vitreous after removal of the lens, or of the great mass of the vitreous from behind.

Plate II. fig. 7 shows a clear membrane in relation to the capsule of the lens; a part of the membrane is torn and folded over, exposing the capsule behind it. Schwalbe denies this concentric arrangement of membranes, on the ground that if the vitreous be pricked externally, all the fluid from its interior passes off, leaving a shrivelled mass, which, he argues, would not be the case if the fluid was enclosed in *different compartments* constituted by membranous partitions. He, however, does not take into consideration the fact that in the fœtus the vitreous is full of vessels which communicate freely in all parts of the organ; in the adult no vessels are found, but there is no reason why the fluids in the different compartments of the vitreous should not communicate by means of tracts left in the adult by the fœtal vessels, just as the canal of Stilling represents in the adult the situation of the hyaloid artery of the fœtus. Klein is of opinion that the canal of Stilling has nothing to do with the course of the hyaloid artery; I have, however, seen in the eye of the ox a conical projection from the centre of the papilla optici exactly opposite the depressed commencement of the canal, and in fact fitting into the depression. This projection can be injected through the distal end of the central artery of the retina, and is very probably the remains of the hyaloid artery.

The Canal of Stilling, or central canal of the vitreous, can be easily demonstrated by the injection of a coloured fluid through the distal end of the central artery of the retina, after section of the optic nerve. On injecting a solution of soluble Prussian blue, the course of the canal could be readily distinguished, but there were no indications of any smaller canals or slits communicating with it as Stilling describes (*Op.* 6, p. 526). The walls of this canal appear to be smooth, and composed of clear membranes of the same nature as above described.

The Zonule of Zinn, or suspensory ligament of the lens, has been the subject of much dispute among authors. Schwalbe, Klein, and others consider it to be a modified continuation of the hyaloid membrane; according to Henle, it is the middle division of the membrana limitans interna of the retina, while in the opinion of Iwanoff it arises in the substance of the vitreous in the form of delicate fibrils which arise within the vitreous, in great part behind the ora serrata, pass up towards the ora, become applied to the membrana limitans interna of the retina (thus accounting for the close connection between the retina and vitreous in this region), and finally pierce the vitreous at the ora to form the zonule. Some fibres also arise from the vitreous in front of the plane of the ora serrata, and, passing out, are added to the fibres of the zonule (*Op.* 1, p. 354). My observations are quite in accordance with those of Iwanoff in regard to the origin of the fibres of the zonule of Zinn. I cannot believe that the zonule is merely a modification of the hyaloid membrane, inasmuch as it is composed of fibres running in so many different directions. Plate II. figs. 8 and 9 show two and three layers of fibres respectively running in different directions, and I have seen other layers of fibres pursuing a still more varied course, which for the sake of simplicity have been omitted in fig. 9. It is in some cases easy to see the fibres curving at their extremities and dipping into the vitreous either individually or in strands, in the latter case giving rise to distinct ridges and furrows on the surface of the preparation which mark the lines of curving and penetration respectively. It is quite true that the outer membrane presents a distinctly fibrillated appearance at and near the zonule; this, however, is easily explained by the fact that, as Iwanoff has described, the fibres run along the inner surface of this membrane for some distance near the region of the ora serrata before piercing it. As the membrane is pierced along several lines between the ora serrata and the margin of the crystalline lens, it is evident the fibrous thickening of the membrane is carried beyond the ora towards the lens. The latter fibres, on piercing the membrane, add themselves to those which have already passed out, so that the zonule is constantly receiving additions in its course to the lens. The outer membrane of the vitreous, as before stated, passes inside the zonule to cover the surface of the vitreous behind the lens, and in so doing leaves a space between it and the zonule, which during the life of the animal is filled with a fluid; it is, in fact, the lymph space or canal of Petit, bounded anteriorly by the zonule of Zinn, and posteriorly by the vitreous covered by its proper membrane.

The anterior boundary, or zonule of Zinn, though forming a continuous membrane, does not completely shut out the canal of Petit from the posterior chamber of the eye, as there are some apertures of communication between these two lymph spaces, which are probably situated near the lens margin, seeing that a solution of soluble Prussian blue is found to penetrate the zonule near the margin of the lens when injected into the anterior chamber of the eye.

The nature of the fibres of the zonule of Zinn has been much disputed, and in fact is yet far from determined. They present a stiff highly refractile appearance, are seen to branch and stain with picric acid and to some extent with magenta and eosine. Some of them may become swollen by absorption of water, still however retaining their peculiar characters. Besides these there are distinct white fibres in the zonule, as some of them are seen in process of development in young animals. Plate II. fig. 10 shows two of these fibres as observed in the young rabbit. On following the zonular fibres forwards towards the lens, they split up in the form of a brush to be attached to the anterior and posterior parts of the capsule of the lens. Those attached to the anterior part of the capsule can be traced for some distance along its surface, serving to strengthen it and at the same time making its attachment more secure. This accounts for the anterior part of the capsule of the lens being thicker than the posterior. Tracing the fibres of the zonule back to their origin, they are seen to be formed by the union of delicate fibrils which can be followed into the vitreous. Here the elastic-looking fibrils form an open network, which very closely resembles a network of elastic fibres, and here and there cells are seen closely applied to the fibres. This is well seen in Plate II. fig. 9, where a fibre can be distinctly traced from the elastic-looking network, and is then seen to divide and mingle with the fibres of the zonule, which it exactly resembles. In Plate I. fig. 4, which was previously alluded to when describing the cells, we have a similar network, in the young rabbit, in the region of the zonule. Here the fibres are represented as though they were processes of cells, and I am obliged to admit such was my opinion when the figure was drawn. I am now of opinion, however, that the cells are here, as in fig. 9, closely applied to the fibres. Two clear fibres are seen passing from this network, and are not recognisable from the zonular fibres.

Fibres of the Vitreous—Besides the elastic-looking fibres found in the equator of the eye and in the region of the ora, there are others of the same nature in the substance of the vitreous behind the lens, where they can be seen to form a network as well. In the posterior pole and in the centre of the vitreous, however, the fibres are few in number, and scattered here and there in the preparations; they present nevertheless the same clear appearance and sharp borders as the fibres above described. Lieberkühn describes fibres which are the remains of the embryonal vessels in the vitreous. I have been unable to distinguish these in my preparations, though I have seen certain swollen fibres in the anterior pole of the vitreous which look much like white fibres; these I am inclined to believe belong to the region of the zonule as white fibres have been seen to develop there (see Plate II. fig. 10). From the above description it is evident that most of the fibres just described bear a close resemblance to the fibres of the zonule of Zinn. This is especially true of the elastic-looking networks with which some of the zonular fibres have been shown to be continuous.

The importance of the anatomical fact that the zonule of Zinn arises in the substance of the vitreous, as above described, will be evident, if we consider for a moment the relations of the zonule, and its bearings on the mechanism of accommodation. The anterior part of the choroid, at, and anterior to, the ora serrata, and especially the ciliary processes are adherent to the zonula. Here also the retina is more closely related to the vitreous; therefore, when the ciliary muscle is put in action, it draws not only the ciliary processes and choroid forwards, but also to some extent the zonule of Zinn. Were the zonule of Zinn continuous with the inner limiting membrane of the retina or with the so-called hyaloid membrane, positive accommodation would be attended by a drawing forward of the retina against the vitreous, on the one hand, or by a bulging posteriorly of the vitreous on the other; in either case the retina would be rendered anæmic by pressure, and consequently less sensitive to the image focussed on it. As accommodation occurs so very frequently, a constant emptying of the retinal vessels would lead to injury of its delicate structure and interference with sight. Such, however, is fortunately not the case, for the zonule arising in the vitreous and being connected with a network peripherally, at, and anterior to the equator of the eye, every pull on it is distributed to the fibres in the anterior part of the vitreous, and hence the force being so spent, no bulging of the vitreous posteriorly can occur, as would be the case if the zonule were a modification of the outermost or so-called hyaloid membrane. Before leaving the consideration of the fibres of the vitreous I have still to allude to a delicate network of fibrils, the description of which has been deferred on account of its perplexing nature. It can be demonstrated in all parts of the vitreous, but is especially well marked in the cortical portion.

I first noticed this network in the vitreous of the young rabbit, injected during the life of the animal (while fully under the influence of an anæsthetic) with a ½ per cent. solution of gold chloride, the eye being subsequently exposed to light for about twenty-four hours. On examining portions of the vitreous so treated, the membranes were found to be stained with the gold, which also stained a delicate network of fibres lying on the surface of the membranes in some parts of the preparation. The network as observed is represented in Plate II. fig. 11. Not being able at first to determine the nature of the network, I repeated the experiment on the eye of the young rabbit soon after death, and likewise on the fresh vitreous of the ox, with the same result. The network stood out prominently, and appeared to consist of large and small bundles of fibrils forming fibres, from which the fibrils were every here and there given off as branches, passed in various directions and united with one another to form a very delicate network. This at first sight seemed to be produced by a precipitation of fine coloured granules on the surface of delicate fibres. On careful focussing, each fibril was seen to consist of a row of bright globules enclosed in a *distinct sheath*, while in some places there were varicosities in the course of the fibrils. I was at first under the impression that we had here to deal with a network of delicate elastic fibres, and hence considered it as analagous to the network above described as being in relation to the zonule. On investigating the subject still further, I observed that it was possible to demonstrate the network in the fresh vitreous of animals, by tinting with carmine, or by the ordinary silvering process for tissues. In all cases I obtained the same appearances, and was much struck by the marked resemblance of the network to the arrangement of nerve fibrils as seen in the cornea, mesentery, &c. The appearance of the network and its close correspondence to that of delicate nerve fibrils is seen in Plate II. fig. 12. The larger bundles of fibrils, with indications of fibrillation, the delicate fibrils themselves beaded in some places and at times very regularly so, and finally their staining with gold, carmine, and nitrate of silver, were all extremely suggestive of their nervous nature. I advance this view, however, with some reserve, considering that the presence of nerves in the vitreous has never even been hinted at by previous observers. The vitreous, however, being a fully organised, tissue, it seems to me not more remarkable that it should contain nerve fibrils than that they should be found in the substance of the cornea, and in other forms of connective tissue.

In conclusion, I have to acknowledge my indebtedness to Professor Rutherford for his kindness in suggesting the above to me as a subject for research, for the use of his laboratory, and for the encourgement and assistance he has been ever ready to render me in my investigation of this difficult and often perplexing subject. I have finally to thank him for his supervision of this paper, to which I have much pleasure in giving publicity, hoping that thereby the subject will once more engage the attention of eminent observers.

LIST OF WORKS REFERRED TO.

1. Stricker's *Histology*. 1878, vol. iii.
2. Müller's *Archiv*.
3. *Lectures on the Eye*, by Bowman. 1849.
4. Kölliker's *Microscopic Anatomy*. 1860.
5. Schwalbe's *Lehrbuch der Anatomie der Sinnes Organe*. 1883.
6. Schwalbe, *Anatomie de Corp Vitre dans Traite Complet d'Ophthalmologie*, par. L. de Wecker et Landolt, Tome ii. fascicule ii. 1884.
7. Hans Virchow, *Beiträge zur vergleichenden Anatomie des Auges*. Berlin, 1882.
8. *Jahresbericht der Anatomie und Physiologie*, Hofmann und Schwalbe.

For a complete list of the Bibliography relating to the structure of the vitreous, see Schwalbe's article in Landolt and Wecker's *Traité d'Ophthalmologie*.

EXPLANATION OF PLATES I. AND II.

Fig. 1. shows large amœboid cells taken from the posterior pole of the vitreous of the ox, internal to the limiting hyaloid membrane. Stained with picro-carmine. The nuclei are very distinct, and usually contain nucleoli; some cells are vacuolated. *a*, vacuole; *b*, cell breaking down. × 700.

Fig. 2. Branching cells as seen in the vitreous of the ox near the equator of the eye. Two are vacuolated, *a*. The processes are of various shapes, some straight and clear as at *b*. × 500.

Fig. 3. Branching cells from near the equator of the eye with nuclei and vacuoles. Processes with irregular outlines due to beading along its course, some end in a beaded manner. *a*, vacuole; *b*, beaded extremity. × 700.

Fig. 4. Network of clear fibres from anterior portion of vitreous of young rabbit. Cells are seen in close relation to the network as at *a*; *b*, a fibre following a somewhat curved course; *c.c*, two straight clear fibres resembling the zonular fibres. × 700.

Fig. 5. Portion of limiting hyaloid membrane of ox much crimpled and creased, stained with carmine. × 375.

Fig. 6. Portion of internal membrane of ox folded and creased. *a*, a fold; *b*, a crease; *c*, homogeneous surface of membrane. × 375.

Fig. 7. Portion of membrane behind lens capusle; also a network on darkly stained portion, taken from eye of young rabbit injected with gold chloride. *a*, capsule of lens; *b*, clear membrane; *c*, darkly stained membrane with a network of fibrils; *b′*, portion of clear membrane torn off and folded over, exposing lens capsule. × 375.

Fig. 8. Portion of zonule of Zinn with pigment cells of two ciliary processes lying on it. *a*, pigment cells of ciliary processes; *b*, hexagonal cells of pars ciliaris retinæ; *c*, ridge of zonular fibres between adjacent processes; *d*, superficial plane of clear elastic-looking fibres; *e*, deeper plane of fibres running nearly at right angles to *d*. × 375.

Fig. 9. Portion of zonule of Zinn of cod, showing three layers of fibres *a*, *b*, *c*; on *c* is seen a network of elastic-looking fibres *d*, from which a fibre passes up, divides and becomes lost among the other fibres of the layer; *e* and *f* two cells in close relation to the fibre which runs upwards; *g* and *h* are the divisions of the fibre. × 375.

Fig. 10. Two developing fibres of white fibrous tissue from the region of the zonule of Zinn.

Fig. 11. Network of fibrils as seen in the eye of the rabbit injected with gold, it is left uncoloured in drawing. *a* and *b*, membranes darkly and faintly stained; *c*, network of fibrils. × 375.

Fig. 12. Network of fibrils lying on the surface of a membrane, stained with gold chloride; there are large and small bundles, and also delicate fibrils. The appearance is much like nerve fibrils, which, however, are irregularly beaded, except here and there, where varicosities are clearly seen. Two fibres project beyond the membrane. *a*, membrane; *b*, fibre; *c*, fibril; *d*, fibril with distinct varicosities × 700.

ON THE COMPARATIVE VARIABILITY OF BONES AND MUSCLES, WITH REMARKS ON UNITY OF TYPE IN VARIATIONS OF THE ORIGIN AND INSERTION OF CERTAIN MUSCLES IN SPECIES UNCONNECTED BY UNITY OF DESCENT.[1] By G. E. Dobson, M.A., F.R.S.

So many papers have been written on the variability of muscles that several biologists, who have not specially studied the subject, have formed the opinion that nothing in the structure of an animal is half as variable as a muscle, and that, consequently, little value attaches to any deductions one may be led to make from the closest study of these parts. They forget, however, that, in the first place, these published notes have been almost wholly confined to the muscles of man, the very type of a domestic animal, and therefore, as Darwin points out, a most unsuitable subject for studying fixity of type in; and secondly, that the few variations recorded represent the exceptions to the rule in thousands of normally formed bodies. It is on this very principle that exceptions are few, that writers of works on human anatomy have been able to lay down with exactitude, in few words, the limits of the origins and insertions of the muscles, and the student rarely, indeed, finds that his book fails to describe sufficiently accurate the relations of the muscular structures he is examining.

From study of the muscular structure of mammals killed in the feral state, I have formed the opinion that muscular variability in the same species is a matter of extreme rarity—so rare as to form a very unimportant factor, indeed, in affecting general deductions which may be based on the study of few examples of given species.

An anatomist has remarked that it appears unquestionable that the arrangement of the muscular system is intimately connected with and altogether subordinate to that of the bony

[1] Read before the Biological Section of the British Association for the Advancement of Science, at the Montreal Meeting, 2nd September 1884.

framework.[1] This, which at first sight appears to be an axiomatic statement, although undoubtedly true to a great extent, yet is not absolutely so, for I shall presently show that, not only many most important changes in the form and arrangement of the muscles have taken place quite independent of the osseous structures they are attached to, but also many muscles are much more permanent than the bones of the limbs to which they belong, and by their permanence afford important indications of the extensive changes that have befallen the skeleton.

Of all the different parts of the osseous framework of the animal body, none are so liable to modification as the bones of the extremities; and here we may therefore study with best effect the subject under consideration.

To pass at once to an instance of extreme modification of the bones of the fore-limbs, we have only to consider their condition in the bats, where the shaft of the ulna is reduced to a mere thread-like bony spicule anchylosed with the radius, whilst the head scarcely enters into the formation of the elbow-joint. Nevertheless, all the usual muscles, with the exception of the *pronator quadratus*, are present, and, as Professor Humphry has shown in *Pteropus*, the only differences from the dorsal muscles of the human fore-arm and hand are to be found in the insertion of the supinator and in the extensors of the pollex. Even in the horse, where the ulna is represented only by the olecranon and upper part of the shaft, and the digits are reduced to one, most of the forearm muscles of the five-toed mammals are represented, the *extensor minimi digiti* even surviving, although both its insertion and special function have long been completely altered.

In the hind-limb, however, the relative modification of bones and muscles are even better exemplified, for there the changes displayed throughout the mammalian series are more diversified and intense.

The hind-limb of most bats affords an instance of intense modification not less remarkable than that of the fore-arm, for (except in the sub-family *Molossinæ*) the fibula is either very slender, or cartilaginous and ligamentous in its upper third, or

[1] George, "Monographie du genre Damen," *Ann. des Sci. Nat.* vi^me Sér., t. 1^er, p. 123.

reduced to a small bony process above the heel, or altogether absent, as in *Nycteris*.[1] Nevertheless, the *flexor digitorum fibularis* (*flexor hallucis longus*), which in all other mammals arises almost altogether from the fibula, is present, having shifted its origin inwards to the outer side of the tibia, as in many bats, or upwards to the outer condyle of the femur,[2] as in *Nycteris* and some other species, which in this respect resemble birds. Professor Humphry has pointed out that, although the upper part of the fibula is altogether absent in *Pteropus*, the *peroneus longus* is present, having simply shifted its origin to the tibia.[3]

The independent character of the changes which affect bones and muscles, is nowhere better illustrated than when we compare the several modifications of the long flexor muscles of the feet of mammals and the concomitant condition of the bones of the legs and feet to which they are attached.

In a paper published in a preceding volume of this *Journal*[4] I demonstrated the fact that two types of arrangement of these muscles—the *flexor digitorum fibularis* (*flexor hallucis longus*) and *flexor digitorum tibialis* (*flexor digitorum longus*)—were recognisable, namely, a united condition of their tendons in the sole of the foot, present in most placental mammals, and a disunited, caused by separation of the tendon of the *flexor digitorum tibialis*, as seen in certain families of placental mammals, and in nearly all the implacental. Now it is worthy of special notice that the united or disunited condition of the tendons of these flexors

[1] In a specimen of *Nycteris hispida* I find a small cartilaginous process attached by ligament to the outer side of the head of the tibia, giving origin to some fibres of the *flexor fibularis*. This may be a rudiment of the head of the fibula.

[2] The muscular fibres are therefore continued from the femur across the knee-joint, as in the undifferentiated condition still represented by the *ambiens* muscle of crocodiles and many birds. See Gadow, "Observations in Comparative Myology," *Journ. Anat. Phys.*, vol. xvi. pp. 502–3.

[3] The peculiar course of the *rectus abdominis et sternalis* muscle in the golden moles (*Chrysochloris*), affords an interesting example of the capability of muscles to accommodate themselves to altered conditions of the skeleton. In these animals, the usual course of this muscle being interfered with by alterations in the form of the thorax, it has assumed a position altogether different from that of any other known mammal, lying superficial to, instead of under cover of, the pectoral muscles. See the writer's notes on this condition of the muscle, at pp. 84–85, vol. xvii. of this *Journal*.

[4] Vol. xvii. pp. 142–179, plates iv.–vi.

appears to have no relation whatever to the united or disunited state of the leg-bones. Thus, although the fibula is well developed in all the implacental mammals, in the sciuromorphic rodents, and in the American species of Edentata, the *flexor digitorum tibialis* is nearly always separate, or the muscle is altogether absent; while, on the other hand, in all Chiroptera and Ungulata, in which this bone is generally rudimentary or fused with the tibia, the tendon of that muscle is united in the foot with that of the *flexor digitorum fibularis*, as it is in the Carnivora and Primates, where both bones are well developed.

Just as in the marsupial, *Hypsiprymnus gaimardi*, where the animal walks on a single toe and the long flexor muscles are reduced to one[1] (the fibular flexor), so, in the one-toed horse, one, who was acquainted with the anatomy of the former species only, would expect to find similarly a single flexor; but his expectations would not be realised, for the horse has both flexors, with well-developed tendons united in the foot, as in the greater number of five-toed mammals, a sure indication of his five-toed ancestry.[2]

The migration of the tibial flexor (which normally arises, as we find it in *Centetes*, from the head of the fibula, the interosseous membrane, and the adjacent margin of the upper part of the shaft of the tibia) from the fibular to the tibial side of the popliteus muscle generally occurs (in placental mammals) as a prelude to the separation of its tendon from that of the fibular flexor, and is evidently due, not to changes in the bones of the

[1] *Journ. Anat. Phys.*, *loc. cit.*, plate v. fig. 9.

[2] In my paper already referred to I have shown how, in *Centetes ecaudatus* (which in many respects presents a better example of an undifferentiated Eutherian than even *Gymnura rafflesii*), the evidently original mode of distribution of the tendons of these muscles in the ancestral forms from which existing mammals have sprung may still be traced; for in this species their connections, as they overlie one another, are not so close as to prevent their exact discrimination; and it may at once be seen (*Journ. Anat. Phys.*, *loc. cit.*, plate iv. fig. 1) that, while the tendons of the *flexor digitorum fibularis* supply the three middle toes, those of the *flexor digitorum tibialis* are distributed to the outer and inner toes respectively. All connected conditions of these tendons in other mammals are evidently but modifications of such an original arrangement, and the presence of the tendon of the tibial flexor in the foot of any mammal, however modified, indubitably points to a pre-existing five-toed state; so that, in the case of the horse, if no other evidence were attainable of his five-toed ancestors, the presence of the two deep flexors we find in his pes would sufficiently indicate them.

limbs (for we find it in the horse on the fibular side), but to increase in the size of the body of the fibular flexor, which occupies its attachment, and gradually forces it towards the internal margin of the tibia.

Intermediate conditions are beautifully shown in the marsupial flying squirrel (*Belideus flaviventer*), in *Solenodon cubanus*, in the Pyrenean water-mole (*Myogale pyrenaica*), in the American jumping mouse (*Zapus hudsonius*), in the great rodent mole (*Bathyergus maritimus*), and in the common hedgehog. In *Belideus* (*Journ. Anat. Phys., loc. cit.*, plate v. fig. 8) the tibial flexor has partially migrated to the tibial side of the popliteus muscle, retaining still its connection by a few fibres with the fibula, while its tendon has separated in the foot from that of the fibular flexor, and become attached to the base of the first metatarsal bone, these changes, it may be noticed, having taken place quite independent of any alteration in the fibula. In *Zapus* (*loc. cit.*, plate vi. figs. 4, 4*a*) the greatly-increased size of the fibular flexor, evidently consequent on the weight when leaping being thrown on the three middle toes, has forced the tibial flexor away from its fibular and interosseous attachment altogether, so that it occupies the shaft of the tibia immediately below the insertion of the popliteus, while its tendon has thrown out a second slip, apparently preparatory to separation from the fibular flexor. In *Solenodon* (*loc. cit.*, plate iv. fig. 2), where the three middle toes are so much larger than the others, probably for digging, we find a similar but more advanced stage; for the fibular flexor (which, as shown in *Centetes*, specially supplies these toes) has so increased in size and attachment as to occupy not only the whole space on the fibular side of the popliteus, but also part of the shaft of the tibia below the insertion of that muscle, so that the tibial flexor has been obliged to seek a new attachment on the tibial side of the popliteus. In the Pyrenean water-mole (*loc. cit.*, plate iv. fig. 5), where the digits are so much lengthened, this enlargement of the body of the fibular flexor has attained the greatest possible extent; for it occupies the whole posterior surface of the shafts of the fibula and tibia, and the greater part of their heads, while the tibial flexor is reduced to the state of a mere rudimentary muscle, attached on the tibial side of the popliteus to the upper margin of the head of the tibia. In the true moles (*Talpa*) the relations of these muscles are similar, but the tibial flexor is larger. The great rodent mole (*Bathyergus maritimus*) presents an instance of similar changes in the muscular structures, induced by similar habits in an animal otherwise widely separated from the true moles. Here the large fibular flexor, as in *Myogale*, has forced the tibial flexor inwards, so that the latter is attached to the head of the tibia internal to the attachment of the popliteus; and its tendon having separated in the foot from that of the fibular flexor, is attached, precisely as in the true insectivorous moles, to the tibial margin of the basal phalanx of the hallux, developing, as it crosses the ento-cuneiform articulation, a broad sesamoid ossicle.

A review of these facts suggests two interesting questions:—

1. What were the causes which led to final separation of the tendon of the *flexor digitorum tibialis* from that of the *flexor digitorum fibularis*.

2. How happens it that, in certain widely separated species, in no way connected by descent from a common ancestor having similar peculiarities, separation of this tendon from that of the fibular flexor and attachment to a different part of the foot has occurred in a perfectly similar manner.

I have already partly indicated what I believe to be the solution of the first question, namely, that, seeing that the three middle toes are supplied by the fibular flexor, whatever cause might lead to greater work being thrown on these digits would necessarily lead also to increased size in the body of the muscle, and, consequently, to a more extended origin for its fibres; and that this increased origin, if carried sufficiently far, must occupy the whole fibular side of the tibia, and so force the less used tibial flexor to the internal side of the bone. In such a position it is evident (*loc. cit.*, plate iv. fig. 2) that its tendon, being united at a considerable angle with the side of the tendon of the fibular flexor, has a constant tendency to separate from the side of that tendon. If now, previous to separation, it has, by the formation of a second tendon, attached itself to any other part of the pes, as in *Solenodon cubanus* (*loc. cit.*, plate iv. fig. 2), such connection will be maintained or, perhaps, extended after separation, as we find in some species, such as in *Erinaceus europæus* (*loc. cit.*, plate iv.

fig. 3), *Crocidura cærulescens* (*loc. cit.*, fig. 4), *Myogale pyrenaica* (*loc. cit.*, fig. 5), *Bathyergus maritimus* (*loc. cit.*, plate iv. fig. 6), and in many species of Rodentia, Edentata, and Marsupialia, where it is connected with the first metatarsal bone, or with the first halluceal phalanx. If, on the other hand, it has not formed such connections, it may attach itself, after separation from the fibular flexor tendon, to the superficial fascia and integument of the sole of the foot, as we find it in some species of *Erinaceus*, *Myoxus*, &c., or it may disappear altogether, as we notice in others.

Now there are two conditions, namely, fossorial and climbing actions, which tend to throw most work on the three middle toes, and so lead to the development of the fibular flexor, and separation from it of the tibial tendon, as we find it in all the species of true moles (*Talpidæ*), hedgehogs (*Erinaceidæ*), and shrews (*Soricidæ*),—which are all so closely allied that they may well have been derived from a common ancestor,—also in most of the fossorial Rodentia and Edentata, and in Echidna and Ornithorhynchus, the fossorial habits of which are so well known; also among arboreal mammals[1] (or those descended from ancestors having arboreal habits), as in the squirrels and dormice, the arboreal Edentata (*Brachypodidæ*, *Myrmecophagidæ*) and their descendants, and in nearly all the marsupials.

It is especially interesting that the arrangement of the long flexors in the pes of the marsupials has led me to form an opinion similar to that deduced by Professor Huxley[2] from the prehensile character of the pes, namely, "that the primitive forms whence the existing Marsupialia have been derived were arboreal animals."[3]

[1] Two different modifications of the pes for climbing are observable, one in which the three middle toes and their claws are especially elongated, and climbing is effected by the claws, as in the squirrels and other arboreal non-quadrumanous animals, the other, in which the four outer toes are nearly equally elongated, have flat nails, and the hallux is more or less opposable, climbing being effected by the grasping action of the digits, as in the Quadrumana and Lemuroidea; in the former we find, as by my theory we should expect, the tibial flexor separated, and, in the latter, still united with the fibular flexor.

[2] "On the application of the laws of evolution to the arrangement of the Vertebrata, and more particularly of the Mammalia," by T. H. Huxley, F.R.S., *Proc. Zool. Soc.*, 1880, pp. 655, 656.

[3] The Dasyuridæ alone are probably an exception to this rule. In *Thylacinus* neither the form of the pes nor the arrangement of the long flexor muscles indicate descent from arboreal ancestors, and, although, in the arboreal species of the

Solution of the second question is attended with much greater difficulties. We see, as I have shown, how in two very different animals, such as the common mole, and the great rodent mole, which resemble one another only in living under ground, and in similarly using their hind feet, precisely similar modifications of the deep flexor muscles have been brought about. The similar separation of the muscles in the progenitors of both animals is easily understood, as above explained, but not so the peculiar mode of attachment of the separated tendon of the fibular flexor, so perfectly similar in both. Such unity of type unexplained by unity of descent seems capable of being understood only under the assumption that the special modification arrived at, is, in both cases, the best possible, and that it has been reached in both animals independently by natural selection.

family separation of the tendons of these muscles has taken place, yet it appears probable that they and *Thylacinus* are the descendants of some terrestrial form provided with five unmodified digits.

Beside the separation of the tibial flexor in the pes, there are other characters in the feet of all marsupials, except *Dasyuridæ* and *Didelphidæ*, which, whether the hallux be rudimentary, or, as in most species of *Macropodidæ* and *Peramelidæ*, absent altogether, affords absolute proof of its pre-existence and opposable condition in the ancestral forms from which all the species of these families were derived. I refer to the united and more or less rudimentary state of the second and third digits, the cause of which has long puzzled zoologists. How this has been brought about by the development of an opposable hallux in the pes of animals in which separation of the tibial flexor had previously taken place, I purpose demonstrating in a future communication.

CONGENITAL MALFORMATION OF THE TRACHEA OF A HORSE. By F. Smith, *Veterinary Surgeon, 12th Royal Lancers.*

Malformations of the trachea of the horse are by no means common, and I can find no account on record of the peculiar condition which I am about to describe. An aged Australian horse was under my professional care for lameness. I noticed a strange appearance of the front of the neck over the trachea, the part being flattened, with a large depression in its centre running some distance down the neck. On examining this, I found the trachea large, flattened, and unyielding, with a space 3 inches wide in the centre, which could be traced from just below the larynx into the chest. The borders of this space were formed by the trachea, its edges being rounded and unyielding. The space was soft and compressible, and the finger could easily be pressed into the channel of the trachea. My first impression was that there was a rupture of the tracheal rings, for I need hardly say that normally there is no incomplete condition of the cartilaginous rings at the anterior part. Further examination showed that this could not be the case on account of the extent of the lesion. I could only infer that the posterior part of the trachea (that part nearest the vertebra, where the rings are normally incomplete, and their two sides connected together by muscular and fibrous tissue) was twisted round, so that the posterior part became anteriorly placed. The patient when trotted "roared" badly.

He was destroyed for incurable lameness, and I thus had an opportunity of examining the trachea.

The larynx was not distorted, but there was atrophy and fatty degeneration of the muscles on its left side. From below the larynx the trachea twisted round so that the posterior part became anteriorly placed. The rings were wide and flattened, towards the centre of the neck they were very rigid, and at the lower part they became angular, and had bony protuberances on them. All the rings ended by a flattened square edge on one side, and on the other they were thick and abrupt as if cut with a knife. Connecting these two edges of the trachea was a thin, fibrous, shiny, tough membrane, which on the cut-like edge formed bands, but not so on the other; lower down the bands disappeared, but the connecting membrane was more tense. The width of this connecting membrane (and consequently the distance between the two edges of the trachea) was, superiorly, immediately behind the cricoid cartilage, 1 inch; centrally, opposite the third and fourth cervical vertebræ, 3 inches; and inferiorly, above the bronchi, 2 inches. It was this membrane I had felt during life, and resting on it was the œsophagus, which thus ran near the central line of the neck instead of down the left side. Just before the trachea broke up into the bronchi, a piece of narrow thin cartilage, 4 inches in length, was found lying in and attached to the connecting membrane of the edges of the trachea; it ended abruptly at the bronchi by overlapping three or four other large plates of cartilage which were coming from the bronchi. This condition was most singular. The circumference of the trachea was, superiorly, $8\frac{1}{2}$ inches; centrally, $9\frac{1}{2}$ inches; inferiorly, $9\frac{1}{2}$ inches; just in front of the bronchi, $7\frac{3}{8}$ inches. The number of rings in the trachea was fifty-six.

Transverse sections of the trachea were made at regular intervals throughout its length in order to show the calibre, and these proved most interesting. The first section, 4 or 5 inches below the larynx, showed that the tube was oval, the opening being 3 inches in its transverse diameter, and $\frac{7}{8}$ inches in its antero-posterior diameter; second section showed the lumen much narrower, the ring at one part being flat, the measurements were $2\frac{5}{8}$ inches in its transverse, and $\frac{3}{8}$ inch in its antero-posterior diameter; third section, this was very singular, here the space for the air to pass through was reduced to a most insignificant size, it was $2\frac{7}{8}$ inches in its transverse and $\frac{3}{8}$ inch in its antero-posterior diameter; fourth section showed the channel considerably enlarged, it was 3 inches in its transverse and $1\frac{1}{8}$ inch in its antero-posterior diameter; the fifth section was again larger, it was $2\frac{5}{8}$ inches in its transverse and $1\frac{3}{16}$ inch in antero-posterior diameter; in the sixth section the rings of the trachea were singular, and the passage was $2\frac{5}{8}$ inches in transverse and 1 inch in antero-posterior diameter.

Distortions of the trachea of the horse have been known to occur from the abuse of the "bearing rein," but these are of a surgical rather than anatomical interest. The malformation I have described was congenital, and such a condition as the trachea being twisted and flattened is, I think, of sufficient interest to the anatomist to warrant me in placing the case on record.

ON THE NATURE OF LIGAMENTS. (PART II.) By J. B. SUTTON, F.R.C.S., *Lecturer on Comparative Anatomy, Middlesex Hospital Medical School.* (PLATE III.)

SECTION I.

IN a previous number of this *Journal*[1] I ventured to advance some views respecting certain ligaments of the human body. Since that essay was published abundant good material has come to hand enabling me to extend the investigation. In the present paper particular attention will first be devoted to the ligaments connected with the clavicle, scapula, and humerus, in order to show the relation they bear to muscles, and to strengthen the theory previously enunciated, that "many ligaments are the *tendons of muscles* which were originally in relation with the joint, but the parent muscle has either formed new attachments or become obsolete, whilst the tendon remains as a passive element in the articulation," the above statement being really the text of the present communiction.

Before entering into details concerning individual ligaments the subject of *metamorphosis of muscles* must of necessity be inquired into.

Metamorphosis of Muscle.—Any one working for the first time at the myology of Amphibia or Reptilia must be impressed with the small amount of tendon entering into the structure of the muscles. This becomes more marked when the muscular system of an Amphibian is compared with one of the higher mammals. It would be needless to particularise any muscle or group of muscles in this respect; the fact must be obvious to any one who has devoted any attention to comparative myology.

Histologists have too long regarded muscle and tendon as distinct structures. More than one anatomist has noted how the arrangement of the fibres in tendons strongly recalls those of the fasciculi of the belly of a muscle, and it is very difficult, in examining the termination of muscle in tendon, to say how the two structures are joined, or by what means the union is brought about. Even the most expert histologists fail to find a septum

[1] Vol. xviii. Part iii.

between the carneous and ligamentous portions of a muscle, the two parts becoming so insensibly blended.

The position of tendons has an important bearing on this question:—As a rule they are situated at the extremities of muscles where contractile tissue has little opportunity of exerting itself advantageously, *e.g.*, the long tendon of the biceps at the shoulder, the elongated tendons of the long flexors and extensors of the fingers and toes. If a tendon develops in the centre of a muscle, as in the digastricus of man, it is usually in a situation where muscular tissue would be of little avail. Again, when a muscle is so circumstanced that its contractile power can be brought into play throughout its whole length, it may remain muscular in structure from origin to termination, as in the case of the intrinsic and extrinsic muscles of the tongue. If either or both extremities of a muscle fail to act to the full advantage, the very reason for the existence of such a tissue fades, and the ends degenerate into tendons to play an important part nevertheless as passive agents. Physiologists agree that the tissue of voluntary muscle is to be regarded as one of the master-tissues of the animal body. To maintain these highly specialised structures in good condition the frequent exercise of their function is necessary. Parts frequently used are, as a rule, abundantly supplied with blood, for healthy performance of function depends on the organ being adequately nourished. If these premises be correct then the conclusions which must necessarily follow are these:—The ends of certain muscles are badly situated to exert their full contractile power, or on account of modification in the creature's habits, portions of, and in some cases whole muscles become rarely used or rended inoperative. Loss of function leads to diminished blood supply, decrease in the amount of nutrition ends in degradation of tissue. The converse of this leads to hypertrophy. The ends of muscles, when compared with the central portions, are passive; they need little blood supply, and become, in consequence, *metamorphosed into tendons.* The active central parts are often called into play, are well nourished and increase in size and quality. A very good illustration of this presents itself in the biceps flexor cubiti.

If the muscle to which the tendon belongs is one frequently exercised, as in the case of the gastrocnemius and soleus, the attached tendon contains a very large amount of elastic tissue. If, on the other hand, the muscle degenerates from disuse, in the morphological sense of that word, the amount of elastic tissue is diminished and the parts take on the character of fibrous ligaments.

The Six-banded Armadillo (*Dasypus sexcinctus*) posseses in its hind-foot some admirable examples of these changes.

The arrangement of the muscles of the foot in this creature has attracted the attention of two writers, in particular, Mr J. C. Galton and Professor D. J. Cunningham. The last named anatomist has entered minutely into the question in his valuable research into the " Anatomy of the Mammalian Foot" contained in *The Challenger Reports*, part xvi. "Marsupialia." With regard to the foot of the Six-banded Armadillo the pith of the matter runs thus:—" The foot of this animal is of peculiar interest, from the fact that, except in the case of the hallux and minimus, the intermediate flexors and dorsal abductors have undergone regression, and are converted into fibrous tissue, so that the flexor breves and dorsal interossei muscles are represented by fibrous bands, the reason of the transformation of these muscles being due no doubt to the manner in which the digits are bound together, limiting the power of independent movement."

The Professor also refers to Macalister's observations no *Dasypus*, regarding the first and fourth dorsal interossei muscles. In Professor Cunningham's specimen these muscles were represented by fibrous bands, in Professor Macalister's specimen they were muscular in structure as usual. It is a point of great interest, therefore, to find that the transformed muscles in some cases assume their original condition.

The *Linn. Soc. Trans.*, vol. xxvi., 1868, contains two papers by Mr J. C. Galton, one "On the Six-banded Armadillo" the other " On *Orycteropus capensis*." Both communications deal with the myology of the fore and hind limbs of these creatures. In the memoir on *Orycteropus*, certain fibrous bands are described in the sole of the foot, and are well represented in the figure accompanying Galton's paper. These fibrous bands Cunningham considers as the representatives of certain flexor muscles missing in the sole of the foot of this animal.

These facts, of which the briefest outline has been given, were of the greatest value and interest to me; and, possessing a Six-banded Armadillo in store, I proceeded to verify these observations. In the specimen examined, the flexor brevis digitorum, the inner portion of the flexor brevis hallucis and the dorsal interossei were definitely represented by fibrous bands. But the most significant fact in connection with the foot remains to be told; in the armadillo the plantaris muscle, instead of being, as in man and many animals, chiefly represented by a long, thin, and straggling tendon, is larger than the gastrocnemius. The muscle arises as usual from the back part of the external condyle of the femur (Mr Galton says internal condyle, but this is surely an oversight), it then expands into a large fleshy belly extending the whole length of the calf; at the heel it forms a tendon which glides in a well-formed groove on the back of the os calcis, and spreads out as the plantar fascia, slips of which pass to the hallux, second, and third toes, extending even to the terminal phalanges. By this remarkable arrangement the function of the flexor brevis digitorum is abrogated by the plantaris, and it degenerates into fibrous tissue. Professor Cunningham overlooks this fact in connection with the flexors, simply explaining the metamorphosis on the ground of limited movement enjoyed by the digits. This no doubt accounts for the regression of the dorsal abductors satisfactorily enough, but the dwindling of the flexor brevis needs some such explanation as is suggested above.

Guided by these facts, we must regard the glistening fibrous bands which extend ventrally and dorsally on the manus of the porpoise, as degenerate representatives of the flexors and extensors of the digits in other mammals.

Mr D'Arcy Thompson, in vol. xviii. of this *Journal*, draws attention to the fact, that in the fore-arms of the Mole the flexor sublimis muscle is metamorphosed into a powerful ligament which is made to flex the digits, in virtue of the peculiar rotatory motion given to the humerus by the teres major and pectoralis major muscles. Dr Dobson, in his admirable work on the Insectivora, gives a careful and detailed account, with figures of this metamorphosed muscle in *Myogale*.

The development of the auriculo-ventricular valves of the heart bears testimony to the view here advocated, for they first appear as muscular outgrowths from the ventricular walls, which by degrees become replaced by fibrous and connective tissue.

It is needless to multiply examples. Sufficient facts have now been adduced from independent sources to show that tendinous and fibrous degeneration of voluntary muscles is by no means uncommon.

Dr Gadow very concisely sums up changes in muscles, such as those described above, thus:—

"Any muscle may become superfluous, either because it may be put out of action by a given position of the limbs becoming permanent, or because the work hitherto done by the muscle can be better done by neighbouring muscles, or because its special activity is not required any longer. In all these cases the muscle will become aborted, and will either form an accessory supporting part to another muscle, or it may become converted into an aponeurosis, and finally disappear without leaving any trace of its former existence."—*Journal of Anatomy and Physiology*, xvi. 509.

Let me now address myself to the task of showing that many of the ligaments about the shoulder arise from muscles.

If the demonstration be commenced by discussing those points which are plain and self-evident, proceeding thence to consider those which are more intricate, the inferences will not be so likely to appear as though overdrawn or far-fetched, for what is true in the simple instance will appeal with almost equal force to that which is complex.

The Coraco-Brachialis.

This muscle presents itself as an excellent example whereby to illustrate the question. Thanks to the labours of Professor Wood, the history and constitution of this muscle have been expounded in an able and very satisfactory manner in the *Journal of Anatomy*, vol. i., 1867, where it is conclusively shown that the muscle in mammals has for the most part a triple constitution. Ordinarily the muscle arises from the tip of the coracoid process of the scapula in company with the short head of the biceps, with which it is joined for some distance. The muscle is inserted into the inner border of the humerus near its middle, between the origins of the triceps and brachialis anticus muscles. Some of the higher fibres are attached to a fibrous band which forms an arch over the tendons of the latissimus dorsi and teres major muscles, the fibrous loop extending from the coracoid process to the lesser tuberosity of the humerus. Viewed in the light afforded by a study of the variations this muscle is subject to in the human body, and information gained from comparative myology, the coraco-brachialis presents three parts.

1. The portion represented by the fibrous loop may develop as a distinct muscle attached to a lesser tuberosity of the humerus and known as the *rotator humeri.*
2. The middle portion is the *coraco-brachialis* of ordinary human anatomy.
3. The third piece may exist as a muscular belly extending from the common tendon to the internal condyle of the humerus. It is rare to find this piece fully developed, its situation being marked out by the fibrous band which commonly extends from the lower part of the muscle to the elbow, and is familiar as the *internal brachial ligament* of Struthers.

Here, then, is as good an example of regression of muscle as is afforded by the Armadillo, the fibrous bands now and then declaring their ancestry by persisting as muscles either wholly or in part.

The ligaments at the shoulder-joint will now be considered, commencing with the

Gleno-Humeral Band.

Anatomists have long been aware that the Frog possesses in its shoulder-joint a ligament very much resembling the ligamentum teres in the hip-joint. This structure is often represented in the shoulder-joint of man by an accessory band, as some writers regard it, known as the gleno-humeral ligament, having the following attachments :—Above it springs from the edge of the glenoid fossa at the root of the coracoid process, and passes downwards to the lesser tuberosity of the humerus. It runs parallel with the long tendon of the biceps, and forms, in the usual condition of the parts, a distinct bulging into the joint, separated from the synovial cavity by the thin serous membrane only. Occasionally the ligament is complètely surrounded by the synovial membrane, and forms as prominent a structure in the joint as does the biceps tendon; indeed, it then becomes a veritable *ligamentum teres.* This condition seems, according to my own dissections, far more frequent in the fœtus than in the adult I have also met with it in the condition of a ligamentum teres in the shoulder-joint of the common Wombat (*Phascolomys wombat*), in the Galago (*Galago maholi*), the Opossum (*Didelphys philander*), in the Hedgehog (*Erinaceus europea*), and in *Chlamydophorus truncatus*

Facts will now be adduced to show that in all probability this gleno-humeral ligament is the *tendon of insertion of the subclavius muscle.* The interesting amphibian, *Menobranchus lateralis,* presents about the shoulder a very distinct muscle, having the following attachments:—It arises from the ventral surface of the long precoracoid cartilage, and passes backward, to be inserted into the head of the humerus, between the deltoid, pectoralis major, and supraspinatus muscles, as shown in fig. 1. Mr Mivart, in his paper on the myology of this creature, identifies this muscle as the *subclavius.* Whether it deserves this name, or that of *epicoraco-humeral*, is a matter of little moment, but its situation and points of attachment are, for the purposes of this paper, of great importance. It seems to me that this muscle is the ancestor of the subclavius of mammalian myology. If any one objects to the propriety of descending so low in the scale of vertebrate life as that occupied by menobranchus, to draw conclusions regarding muscles in man, let me refer him to a statement of Professor Humphry, in vol. vi. of this *Journal*, where, in writing on the myology of *Cryptobranchus japonica*, he draws attention to the probability of the remarkable tendinous inscription in the semimembranosus of man being homologous with a similar inscription in the great flexor and adductor muscle of the leg of that creature, which corresponds with the gracilis, semitendinosus, and semimembranosus of mammals (page 19).

Let the shoulder-joint of a pigeon or some such bird be next dissected.

Arising from the dorsal portion of the keel and median portions of the body of the sternum is a broad, flat sheet of muscle, which passes forward as a strong tendon through the bony foramen formed by the union of the scapula, coracoid, and clavicle; emerging from this osseous ring it is inserted into the dorsal surface of the head of the humerus in the immediate neighbourhood of the attachment of the pectoralis major; the tendon, after traversing the foramen triosseum, *lies within the capsule of the joint.* The muscle corresponding to this description enjoys a variety of names, as *pectoralis secundus, levator humeri,* and *subclavius.* Its attachment, appearance, and relations are shown in fig. 2. The *Linn. Trans.* for 1868, vol. xxvi., is enriched by a paper from Prof. Rolleston, "On the Homologies of Certain Muscles connected with the Shoulder-joint," in which it is most conclusively shown that the muscle, whose main function it is to raise the wing, is homologous with the subclavius and not with the pectoralis minor muscle.

Turning now to man we find a muscle arising from the costal cartilage of the first rib, passing thence beneath the costo-coracoid membrane, but above the coracoid process of the scapula, to be finally inserted in the ordinary course into the under surface of the clavicle near the acromial end, in contact with the attachment of some strong fibrous bands known as the coraco-clavicular ligaments; this muscle is the subclavius.

The point of insertion occasionally varies, the muscle ending in the coracoid process near its base, instead of going to the clavicle, the variation being one recognised in human anatomy. This unusual arrangement affords the key, as these variations often do, whereby the morphologist may receive direction and guidance in his interpretations. The explanation runs thus:—The coraco-clavicular ligaments (conoid and trapezoid) are degenerate fibres of the subclavius, and they form the bridge or connecting link by which the subclavius muscle and the gleno-humeral ligament become continuous. A little dissection, especially in fœtuses, often shows that this gleno-humeral band is continuous with the coraco-clavicular ligaments, and as the muscle is in intimate relation with these bonds, the inference is clear that *the gleno-humeral ligament is the divorced tendon of the subclavius muscle.* Fig. 3 shows the muscles and ligaments in the relation they bear to each other normally.

In the shoulder-joint of two young crocodilians (*Crocodilus acutus* and *Alligator missisipiensis*) I found a well-marked ligamentum teres lying inside the capsule. It arose from the scapula anterior to the glenoid fossa, and was attached to the head of the bone near the anterior tuberosity. This band was strong and unconnected with any muscle. Its existence is noteworthy in an animal lacking a clavicle and any representative of a precoracoid.

Before closing the evidence bearing on the relation of the subclavius to the gleno-humeral ligament, it is absolutely necessary to dispose of another band lying in relation with the capsule of the shoulder-joint known as the coraco-humeral ligament. This presents little difficulty.

The coraco-humeral band springs from the coracoid, having an attachment from the base to near the tip of that process; passing thence *over* the capsule, it is inserted into the outer tuberosity of the humerus.

The pectoralis minor muscle, as a rule, finds an attachment to the upper border of the coracoid process, but now and then it glides as a tendon over this bony prominence to blend with the capsule of the joint, or ends in a tendon to be attached to the great tuberosity of the humerus.

Fig. 4 represents this condition as seen in the Capuchin (*Cebus albifrons*). In very many of other monkeys it is the normal conditions. Professor Macalister, in an interesting paper in this *Journal*, vol. i., 1867, entitled "Notes on an Instance of Irregularity of the Muscles around the Shoulder-joint," reviews several recorded instances of this abnormal arrangement of the pectoralis minor, and hints that the gleno-humeral ligament belongs to this muscle; but this view of the matter is invalidated on two points. Firstly, the pectoralis tendon when it takes this unusual course lies outside the capsule, whereas the gleno-humeral ligament lies within it. Secondly, it cannot be the homologue of the tendon of the levator humeri of birds, as Professor Macalister makes out, for Rolleston has shown so satisfactorily that the pectoralis minor of man is not the homologue of the avian levator humeri, that a recent text-book of Zootomy calls the muscle that raises the bird's humerus, subclavius. The relations of the pectoralis minor to the capsule in man and in monkeys lead me to believe that the coraco-humeral ligament is the tendon of that muscle metamorphosed into a fibrous band.

The Rhomboid Ligament.

Having disposed of the outer end of the subclavius muscle, some attention must now be devoted to the inner portion in order to study the relation it bears to the band of fibrous tissue which unites the first costal cartilage to the clavicle, called, on account of its shape, the rhomboid ligament. It is in the opossums that the key-note is struck whereby we may seek to unravel the history or pedigree of this apparently wayside structure.

Whilst dissecting the muscles about the shoulder of the Opossum (*Didelphys philander*), it was observed that the usual situation of the rhomboid ligament was replaced by a muscle, which arose from the costal cartilage of the first rib, and was inserted into the under surface of the clavicle.

The relations of clavicle and sternum in *Didelphys* are somewhat complicated, but are full of interest, as they probably explain the degenerated condition of this muscle in the higher mammals.

Fig. 5 is intended to represent the upper part of the sternum, and the costal cartilages in relation with it and the clavicles, which, instead of abutting on the sternum through the intervention of an interarticular fibro-cartilage, are connected therewith by two ossicles which replace the discs in question, these ossicles in their turn are attached to the top of the sternum by ligaments, synovial cavities being developed between each of these bones and the top of the sternum, also between these bones and the inner end of the clavicle. Briefly it amounts to this, the interarticular fibro-cartilages of man's sterno-clavicular joint are represented in this animal by bones, the number of synovial cavities remaining the same.

The clavicle in the opossum by this arrangement is able to move freely on this intercalated ossicle (omosternum, Parker), aided by the subclavius and the muscle described above, which I propose to term the *costo-clavicular*, in reference to its points of attachments.

Passing upwards to man, the office of the costo-clavicular muscle becomes abolished, and its fibres become represented as a ligament. In many animals where this composite condition of the clavicle does not exist, the subclavius arises from the side of the sternum and fills up the space between the costal cartilage and the clavicle, and it is on this ground that the costo-clavicular muscle is to be regarded as a segment of the subclavius, therefore the rhomboid ligament has the same origin, and is to be regarded as a segment of the inner end of the same muscle. If some anatomists should consider that the costo-clavicular muscle is rather a representative of the upper segment of a *rectus sternalis*, which in the opossum is well developed, but ends definitely at the lower border of the first rib, it will be well to remember that Professor Rolleston was well aware that the subclavius does in some cases borrow elements from that muscle, so that if the ligament in question arises from regression of the upper end of a rectus sternalis, it will invalidate but little the argument here set forth.

Viewed in the full bearings of this speculation, the history of the subclavius is as instructive as a muscle could well be. It is advisable, therefore, briefly to summarise the conditions. Commencing with the menobranchus, we see it as a muscle arising from the precoracoid, and at its insertion enveloping the outer aspect of the head of the humerus, being of muscular structure throughout.

Next we see it luxuriating in fullest perfection in flying birds, its distal end metamorphosed into tendon, the muscle performing the laborious and important function of raising the wing.

Lastly, in man it becomes reduced to almost insignificant proportions, lying as a small second-rate muscle under the clavicle, and representing in its retirement the middle portion only of the bird's *levator humeri*, its proximal end degenerated into a uniting bond to connect the clavicle with the first costal cartilage, whilst its outer end is represented by the coraco-clavicular ligaments, and the small insignificant band, so far as function is concerned, known as the gleno-humeral ligament.

The Coraco-Acromial Ligament.

Arising from the outer border of the coracoid process of man's scapula, and passing over the head of the humerus to be attached to the under surface of the tip of the acromion, is a strong band of ligamentous fibres one-fourth of an inch broad on an average.

This band is commonly known as the coraco-acromial ligament, and the office usually ascribed to it is, that it limits undue movement of the head of the humerus upwards, thereby preventing dislocation of that bone.

Whether this be so or no, I do not intend to argue, but Mr St Geo. Mivart, in his work on *Elementary Comparative Anatomy*, draws attention to the fact that this band of fibrous tissue is the representative in man and many animals of the curious hoop-like prolongation of the acromion which arches downwards to join with the coracoid process of the scapula in the Two-toed Sloth. Therefore it seems to be of greater morphological significance than of functional value.

The Transverse Ligament.

The ligament which converts the small suprascapular notch into a foramen for the transmission of the nerve of that name is of interest, for it probably arises in two different ways.

1. It may be regarded as some of the fibres of the supraspinatus muscle, which have become converted into fibrous tissue. This view of its nature is supported by the condition of the parts in the porpoise.

2. It is well known that in the sloths the foramen is completely surrounded by bone, as sometimes occurs in man.

In a young Ant-eater (*Myrmecophaga jubata*) I had an opportunity of examining, the foramen was composed in part by the body of the scapula and completed by the coracoid process, thus affording an interesting example in the limbs of a passage of a nerve between two centres of ossification, a condition almost constant in the skull. Therefore I am disposed to the view that the transverse ligament is the fibrous representative of this bony bridge constant in sloths, and that the occasional occurrence of a complete osseous foramen in this situation is not to be regarded as an ossification of the transverse ligament, but as a reversion to a former condition.

This view receives some support from the supracondyloid foramen in the humerus of many animals. In the lion, at birth the foramen is formed in its upper part by a bony outgrowth from the humeral shaft, the lower half is completed by an osseous projection from the lower end of the humerus below the epiphysial line, the two projecting arms forming by their union the foramen in question (fig. 6). In man, the most frequent condition of this foramen, when it exists, is to have the upper part of the ring formed of an osseous outgrowth of the shaft of the humerus, and known as the supracondyloid process, the lower part of the ring being completed by a band of fibrous tissue extending to the internal condyle, and often affording attachment to the pronator radii teres muscle (fig. 7). This foramen, and that at the upper border of the scapula, seem to be, so far as their mode of formation is concerned, exactly parallel, the ring sometimes existing as bone, at other times part of the osseous material being replaced by ligament.

It is by no means a novel suggestion, that osseous parts in one animal may be represented by fibrous tissue in another. Professor Humphry, writing on the "Myology of the Limbs of Unau, the Ai, the Two-toed Ant-eater and the Pangolin," in this *Journal*, vol. iv., 1870, writes :—"The gradations of the clavicle in the four creatures are curious. In manis it is absent; in ai it is a mere scale attached to the inner edge of the coracoid, which is large, and projects forwards to the inner end of the acromion. A *long ligament* the *remnant* of the structures of which its proximal end was originally composed, connects its inner end with the sternum. In Unau the clavicle is articulated externally with the acromion, which remains continuous with the coracoid, and is much longer; still it does not quite reach the sternum, a strong *ligament* the *degenerated* omosternum of Parker connecting it with the sternum."

These examples afford conclusive evidence of bony parts being represented by ligament; other cases readily suggest themselves to the mind of the comparative anatomist.

Briefly, the antecedents of the ligaments about or near the shoulder-joint may be summarised thus:—

1. The *lower* portion of the coraco-brachialis muscle is responsible for the *internal brachial ligament* of Struthers.

2. The *fibrous loop* passing from the coracoid to lesser tuberosity of the humerus, arching over the tendons of the latissimus dorsi and teres major muscle, represents Wood's *rotator humeri.*

3. The *gleno-humeral ligament* is the divorced *tendon* of the *subclavius* muscle.

4. The *coraco-humeral band* represents the original *insertion* of the pectoralis minor muscle.

4. The *rhomboid, conoid, and trapezoid* ligaments arise by regression of the *muscular fibres* of the *subclavius.*

6. The *transverse ligament* of the scapula is formed either by metamorphosis of fasciculi of the *supraspinatus* muscle, or represents the *bony bridge* constant in sloths, and occurring as a variation in man.

7. The *coraco-acromial band* represents the *bony loop* which connects the two processes in the Two-toed Sloth (Mivart).

8. The *interclavicular ligament,* the *interarticular fibro-cartilages* at the sternal and acromial ends of the clavicle represent *aborted bony segments* belonging to the pectoral girdle (see Parker's *Shoulder-Girdle and Sternum*).

9. The *ligamentous band* extending from the tip of the coracoid process to the costal cartilage of the first rib, occupying the free edge of the costo-coracoid membrane, is the fibrous representative of the long *coracoid* of birds and monotremes (Gegenbaur and Rolleston) (fig. 3).

10. The fibrous loop running from the tip of the supracondyloid process of the humerus (when present), represents the lower bony part of the foramen as it exists in many other animals.

SECTION II.

The Migration of Muscles and its Relation to Ligaments.

The term "migration of muscles" may be defined as:—The changing of the situation of a muscle by alteration of its origin or insertion.

Dr Hans Gadow, in an interesting paper on "Comparative Myology," in vol. xvi., 1882, of this *Journal*, gives some examples of the process, and states that as a rule the origin is more subject to variation than the insertion of a muscle. My own observations lead me to concur with this statement.

Dr Gadow chooses for illustration the ambiens muscle. In alligators this muscle arises from the anterior superior spine of the ilium, but in Hatteria (sphenodon) and in Testudo, from the *processus lateralis pubis.* In Monitor, Lacerta, and others, from the inner and ventral aspect of the preacetabular part of the ilium, close to the acetabulum. While in other Saurians, as Iguana and Chameleon, its origin has passed over to the acetabular part of the os pubis.

But by far the most important contribution to our knowledge in this respect is afforded by Dr Ruge of Heidelberg in an admirable paper entitled "Untersuchung über die Extensorengruppe am Unterschenkel und Füsse der Saügethiere" published in the *Morph. Jahrbuch* for 1878.

Here Dr Ruge satisfactorily traces out the history and ancestry of the extensor brevis digitorum muscle. He shows that in the Monotremata this muscle belongs to the peroneal group, and arises entirely from the fibula. Ascending the scale of mammalian forms we find the muscle passing down tendon by tendon until it reaches the condition presented in the foot of man.

Having recently enjoyed the opportunity of dissecting a Koala (*Phascolarctos cinereus*), in which animal the muscle in question presents an intermediate condition of this interesting process; it will be well to describe it by way of illustration. Reference to fig. 8 will show the extensor longus digitorum arising from the external tuberosity of the tibia and the head of the fibula to be inserted as usual into the four outer digits. The extensor brevis digitorum is seen as a tiny muscular slip arising from the outer aspect of the os calcis, then dividing into two tendons to be attached to the long extensors destined for the syndactyle second and third digits. The remaining portions of the short extensor arise as separate muscles from the head and outer surface of the shaft of the fibula, being limited to the upper third. They degenerate into delicate tendons to pass with the peronei muscles behind the external malleolus, to be distributed to the fourth and fifth digits. These two muscles are usually referred to as *peroneus quarti metatarsi* and *peroneus quinti metatarsi*. It seems to me that one of the great points in Ruge's investigation is that it shows clearly that the fourth and fifth peronei muscles, thought to be absent in man, have really descended from the fibula, and help to make up his extensor brevis digitorum. Man's peroneus tertius is a muscle almost, if not exclusively, human, and is to be regarded as that portion of the extensor brevis which belongs to the fifth toe, but, contrary to its companions, has not descended on to the dorsum of the foot. Its origin from the anterior surface of the fibula does not negative this conclusion, for Ruge points out that the peronei in Monotremata arise from the anterior surface of the fibula, but in the opossums they have wandered to the outer side.

Dr Cunningham has discussed these relations very fully in his *Report on the Marsupialia*, and substantiates them by his own dissections so far as relates to Thylacinus and to Cuscus. In the first-named animal the extensor brevis digitorum arises from the fibula; in the cuscus the part belonging to the medius and index has reached the dorsum of the foot, whilst that portion belonging to the two outer digits still shows a fibular origin, thus repeating the condition seen in the koala.

Whilst engaged dissecting a Koala and an Armadillo (*Dasypus sexcinctus*), in order to verify some of these arrangements for my own satisfaction, I was led to observe an additional example of migration.

In both these animals the tibialis posticus muscle is described as being double. Wood, Cunningham, and Galton found the same thing in the example of *D. sexcinctus* dissected by each of them. Young describes the duplicity of this muscle in the Koalas he dissected. In my specimens two muscles arose from the posterior surface of the shaft of the tibia, and partly from the fibula. The inner one, much the larger, was attached to the upper two-thirds of the tibia, and partly to the head of the fibula, then becoming tendinous passed behind the internal malleolus to be attached to the inner side of the base of the first phalanx of the hallux, having a very large sesamoid bone developed in the tendon where it passed along the inner side of the scaphoid bone (fig. 9).

The second muscle, much smaller, arose from the posterior surface of the tibia and fibula near their heads, formed a thin tendon which passed in a groove behind the internal malleolus, external to the foregoing muscle, and finally was inserted into the scaphoid bone.

The only difference in the two animals was this: in the Koala the sesamoid was very much larger than in the Armadillo. The two animals agree in this respect, that neither possessed an *abductor hallucis muscle.*

In Galton's specimen the abductor hallucis was not clearly or distinctly defined, and the muscle figured by Cunningham is not only a small and insignificant structure as compared with mammals generally, but does not quite agree with the abductor hallucis in its mode of origin.

It seems to me that this so-called double tibialis posticus either represents by its inner portion an abductor hallucis arising from the tibia, or else it abrogates the function of the short muscle usually bearing that name.

It is noteworthy in this respect, that in my Koala there was no short abductor to the hallux, and in Professor Cunningham's figures the muscle is represented as arising from the large ossicle on the inner side of the scaphoid. Certainly this does not correspond with the abductor hallucis as it is usually seen! Hence it would be more in accord with these facts, aided by the light of Ruge's observations on the short extensor, to consider that the abductor hallucis in these animals arises from the posterior surface of the shaft of the tibia, winds behind the internal malleolus, then develops a sesamoid bone in its tendon, where it plays over the scaphoid, and is inserted into the first phalanx of the hallux, the sesamoid bone often affording attachment to a slip of the flexor brevis hallucis, which thus *simulates a short abductor hallucis.*

There are yet other reasons for believing that the abductor hallucis is an "emigrant" muscle, as it exists in the sole of the foot of man. In the hand it is the normal condition for the abductor pollicis to arise from the ridge on the trapezium, and the annular ligament passing thence to be inserted into the radial side of the base of the first phalanx of the pollex. Often the muscle in question deviates from this arrangement by taking origin in part from some one tendon or other about the wrist. Frequently it is connected with the extensor ossis metacarpi pollicis, occasionally with the palmaris longus, and it has even been seen arising from the styloid process of the radius. Dr Dobson points out that in the Mole the palmaris longus sends a slip to the pollex. When the muscle contracts the pollex is abducted by virtue of this arrangement. In this aspect it seems to be fairly obvious that this muscle has, at some time or other, wandered from an original attachment to the bones of the forearm to its present position on the carpus.

There is little doubt that the abductor pollicis and abductor hallucis are homologous, and it is interesting to find both muscles offering evidence of a change of origin from a proximal to a distal segment of the limb. If this way of regarding these muscles be correct, the radial head of the flexor brevis pollicis and the tibial portion of the flexor brevis hallucis must be looked upon as the abductores in the intrinsic mechanism of manus and pes respectively.

Before leaving the Koala there is just one point more in the anatomy of its hind-limb which has a very important bearing. Wedged in between the lower end of the fibula and the astragalus is a fibro-cartilaginous disc, one end of which, becoming gradually thinner, merges into the lower end of the peroneo-tibial muscle, which in this animal replaces the interosseus membrane, and forms a well-developed muscle, exceeding in this respect the corresponding muscle in the Wombat (fig. 8).

In several animals I have had the opportunity of dissecting, notably the Great Ant-eater (*Myrmecophaga jubata*), the popliteus muscle is continuous with, by means of its tendon, the external semilunar fibro-cartilage of the knee-joint, and in the bull frog the semi-membranosus muscle is, in the same way, in direct continuity with the internal disc. For a long time the opinion was in my own mind, that these discs had some other significance, but by the indications afforded by the disc in the ankle-joint of the koala, it will probably turn out that they have a muscular origin also. Among other examples of "migrations" of muscles, the peroneus longus, tibialis anticus, and extensor longus digitorum must be cited as clear and indisputable cases.

In my previous paper it was pointed out that the external lateral ligament of the knee-joint is formed by the peroneus longus muscle acquiring a new attachment to the fibula, its original point of fixation being the femur, and subsequent observations support that view strongly. The tibialis anticus muscle in man and the majority of animals arises from the tibia, but in the horse among mammals, and the ostrich among birds, this large and important muscle springs by a strong and powerful tendon from the external condyle of the femur (fig. 10). The extensor longus digitorum in very many animals, even in some of the anthropoid apes, such as the Orang, arises from the femur instead of limiting itself to the bones below the knee, as in man. In the Ostrich and other birds it arises from the femur (fig 10).

Not to multiply instances, these three muscles illustrate in a positive manner that muscles are exceedingly prone to migrate particularly with regard to their origin. This interesting process of the shifting of muscles from one attachment to another affords evidence of an additional mode by which muscles, or parts of muscles, may become converted into ligaments. In this way it seems to me that the ligaments about the ankle-joint have been formed, that many, certainly the more important, muscles about the sole of the foot, have had, at some time or other, an origin from the bones of the leg, and that in the progress of "slipping down," a part of their tissue has been utilised to form ligamentous bands, which later become developed as independent structures, and in the clear light afforded by comparative anatomy we can read the history of the formation of some of these ligaments as distinctly as any process written in the "book of nature."

With regard to some structures in the lower limbs of a more or less ligamentous nature, their ancestry may be arranged thus:—

1. The *plantar fascia* results from the modification of the distal and of the *plantaris muscle.*

2. The *palmar fascia* represents tendons of the *palmaris longus* which used to go to the digits. (This example is placed here for comparison.)

3. The *posterior ligament* of the superior tibio-fibular articulation results from the regression of the *rotator fibulæ muscle.*

4. The *transverse ligament* of the inferior tibio-fibular articulation represents the lower end of the *peroneo-tibial* muscle. The *posterior fasciculus of the external lateral ligament* of the ankle-joint probably has a similar origin.

5. The *anterior* and *middle fasciculi* of the *external lateral ligament* of the ankle-joint are probably derived from the *extensor brevis digitorum* as it slipped from the fibula on to the dorsum of the foot.

6. The *internal lateral ligament* of the ankle-joint in all probability has its origin from some of the short flexor muscles of the sole of the foot, such as the *abductor hallucis* or *flexor brevis digitorum* muscles when they migrated from the leg to their later situation in the plantar region.

The Inferior Calcaneo-Scaphoid or Spring Ligament.

In the hind-limb of a Frog most of us are aware that the astragalus and os calcis present the anomalous condition of long bones, and, lying side by side, recall in a marked degree the relations of the radius and ulna to one another as seen in man. Fig. 11 represents the os calcis, astragalus, the remaining portion of the tarsus with the five metatarsals, and the additional ossicles found on the inner side of the foot of the Frog. The specimen from which the drawing was made was a Bull-frog, and the parts are represented of natural size.

Arising from the under surface of the os calcis and astragalus is a well-developed muscle. It ends in a strong tendon, which passes over the tarsus to be inserted chiefly into the bases of the first and second metatarsal bones. This muscle I shall term *calcaneo-metatarsal*. More than once I refused to allow myself to believe that this muscle was the "ancestor" of the *spring ligament*, and possibly also of the *calcaneo-astragaloid ligament* in the foot of man. Morphologists, as a rule, consider the wonderfully rich muscular system of the Frog too specialised for enabling conclusions to be drawn respecting man. Let us consider awhile. In the group of lemurs are placed two curious forms, Tarsius and Galago, whose tarsal bones present a condition somewhat resembling the Frog. I have had an opportunity of dissecting Galago, and shall confine my remarks to that animal. The os calcis and scaphoid are very elongated, but the astragalus is fairly normal in shape, as seen in fig. 12. In the place of the calcaneo-metatarsal muscle is a broad ligament containing an abundance of yellow elastic fibres; it represents in a ligamentous form the large muscle of the Frog's foot. The inferior calcaneo-scaphoid ligament of the human foot arises from the anterior and inner extremity of the os calcis, and is attached anteriorly to the under surface of the scaphoid bone. In this it agrees with the condition of the ligament as seen in the Galago, except that in this lemur it is a much broader structure relatively.

Comparing the Galago's foot with that of the Frog we shall see that the calcaneo-metatarsal muscle of the batrachian's foot has the same relations posteriorly as does the ligament in the lemur. Anteriorly it differs, inasmuch as it gains an attachment to the metatarsus, whilst its strong tendon supports that portion of the tarsus lying immediately behind the metatarsus. All this difference may depend on the diversity or arrangement of the tarsal bones in the two forms described, yet it seems legitimate in this case, as in the other examples of metamorphosed muscles discussed, to consider that in all probability the Frog's calcaneo-metatarsal muscle is the ancestor of the *inferior calcaneo-scaphoid ligament* in the foot of man. After reviewing these facts it may not appear presumptuous or untimely to generalise in the following manner:—

Muscles, particularly those of the limbs, and more especially those of the distal segments, are prone to conduct themselves in three diverse ways.

1st. Their extremities, or the greater part of their structure, may become metamorphosed into tendon.

2nd. The points of origin may shift from their original situation. This affects the proximal end far more frequently than the distal one.

3rd. Whole muscles may have their function abrogated, and their structure becomes converted into fibrous tissue.

The three processes may be termed, for the sake of convenience, "metamorphosis," "migration" and "regression." Any one of these three processes may result in transforming an inactive muscle, wholly or in part, into a passive ligament, to act as a means of union between any two parts of the skeleton.

Whilst working out these metamorphoses the truth of the following statement, usually accredited to Müller, seemed to appeal with great force:—"Comparative Anatomy in its complete form leads to such necessary consequences, that expressions may be found for organisations which are like the expressions of an equation. If these expressions are found, the unknown quantities may, in a given case, be reckoned from the known."

All points in the anatomy of animals mentioned in this paper, with the exception of Thylacinus and the Monotremes, I have directly verified by my own dissections, so as to be responsible as far as possible for the statements made.

In the Bibliography is appended a list of the more important works and memoirs which have been to me of the very greatest assistance in working out the history and ancestry of some of the ligaments of the human frame; the help and guidance these writings have afforded me in my dissections I cannot too gratefully acknowledge.

Prof. Humphry, Numerous papers on Comparative Myology scattered through this *Journal*.

Prof. Rolleston, *Linn. Soc. Trans.*, vol. xxvi., 1868, "On the Homologies of certain Muscles connected with the Shoulder-Joint."

Prof. Wood, *Journal of Anatomy and Phys.*, vol. i., 1867, "On Human Muscular Variations, and their relation to Comparative Anatomy."

Dr Ruge, *Morph. Jahrbuch*, 1868, "Untersuchungen ueber die Extensorengruppe am Unterschenkel und Füsse der Saügethiere."

Prof. Cunningham, *Zool. Chall. Exp.*, part xvi., 1881, vol. v. "Marsupialia,"

Prof. Gegenbaur, "On the Episternal Portions of the Skeleton as they appear in Mammalia and in Man," *Nat. Hist. Review*, vol. v., 1865 (a Translation).

St Geo. Mivart, *Proc. Zool. Soc.*, 1869, "Myology of Menobranchus."

J. C. Galton, *Linn. Soc. Trans.*, vol. xxvi., 1868, "Myology of the Limbs of the Six-banded Armadillo and *Orycteropus capensis.*"

Prof. Macalister, *Journal of Anatomy and Phys.*, vol. i. Paper dealing with variations.

Dr Gadow, *Journal of Anatomy and Phys.*, 1882, "Comparative Myology."

Dr Young, *Journal of Anatomy and Phys.*, vol. xiv., 1882, "Muscular Anatomy of the Koala, (*Phascolomys cinereus*)."

Mr D'Arcy Thompson, *Journal of Anatomy and Phys.*, vol. xviii., 1884, "On the Nature and Action of certain Ligaments."

To my friend Mr Wynter is due all credit for the drawings which illustrate this paper, and I must heartily thank him for the care and pains he so willingly bestowed upon them.

EXPLANATION OF PLATE III.

Fig. 1. The left scapula and upper limb of *Menobranchus lateralis*, showing the subclavius muscle arising from the præcoracoid cartilage. × 2.

Fig. 2. The coracoid, with part of the clavicle and head of the humerus of *Rufous tinamou*, showing the subclavius muscle and the tendon traversing the "foramen triosseum."

Fig. 3. The upper part of the thorax and pectoral girdle, with the heads of the humeri of a human fœtus at birth. On the left side the rhomboid ligament R, the subclavius muscle, the coraco-clavicular ligaments, and the gleno-humeral band are shown. On the right side the long coracoid ligament LCL is represented.

Fig. 4. The left scapula with the head of the humerus of a monkey (*Cebus*) designed to show the pectoralis minor muscle PM being attached in part to the coracoid process, and in part to the head of the humerus.

Fig. 5. The top of the sternum and clavicle of an opossum (*Didelphys philander*), to show the relation of the costo-clavicular muscle to the subclavius.

Fig. 6. The humerus of a still-born lion (*Felis leo*), to show that the upper part of the supracondyloid foramen is formed from the

diaphysis, and the lower part is completed by the epiphysis in the adult, but in this young specimen it is cartilaginous.

Fig. 7. The lower end of a humerus from a man, to show that the lower part of the bony supracondyloid foramen of the Carnivora and other animals may be represented in man by ligaments.

Fig. 8. Front view of the leg of koala (*Phascolarctos cinereus*), designed to show a part of the extensor brevis digitorum on the dorsum of the foot, and two of its tendons still attached high up on the fibula. The peroneo-tibial muscle and the interarticular fibro-cartilage at the ankle-joint are shown.

Fig. 9. A view of the inner side of the leg of koala, showing the abductor hallucis arising from the fibula, passing behind the inner malleolus, having a large sesamoid developed in the tendon where it plays on the side of the scaphoid, then sending a slip on to the base of the first phalanx of the hallux. The tibialis posticus is inserted as usual into the scaphoid bone.

Fig. 10. The left knee-joint of an ostrich (*Struthio camelus*), showing the extensor longus digitorum and tibialis anticus muscles arising from the femur.

Fig. 11. The tarsus of a bull frog, to show the calcaneo-metatarsal muscle (CM) and its attachments.

Fig. 12. The astragalus, calcaneum, and scaphoid of *Galago maholi*, to show the calcaneo-scaphoid ligament.

OSTEOLOGY OF *NUMENIUS LONGIROSTRIS*, WITH NOTES UPON THE SKELETONS OF OTHER AMERICAN LIMICOLÆ. By R. W. SHUFELDT, *Captain Med. Corps, U.S. Army; Memb. American Ornithologists' Union; Memb. Society of Naturalists, E.U.S.; Memb. Entomological Society of Washington, &c.* (PLATES IV. and V.)

MY first acquaintance with the long-billed curlew occurred nearly twenty years ago, yet the introduction made such a vivid and pleasant impression upon my mind, that I venture to say the picture will probably never be effaced from my memory. The ground was sacred ground, too, to all ornithologists, for, if my recollection serves me right, Audubon had once paced over the same spot, and many of the scenes he drew were flashing before me at the time,—the very realities of his work.

I had made a hasty landing—for a storm was brewing—upon the long, low beach, that faces seaward, of Egmont Cay, on the west coast of Florida. The air was cool and the sea quiet, while the great stretch of white sand beach stood out in marked contrast with the lowering sky that formed its background. Leaving the men with the boat, I determined to skirt the shore as rapidly as possible, so as to return to the vessel before the storm broke.

Hardly had I proceeded a hundred yards when my attention was attracted to a scattered flock of birds, some ten or fifteen in number, approaching the beach from the direction of the sea. Their outstretched and almost motionless wings flashed a deep chestnut in the strange light of the storm. They lit some distance ahead on the beach, without giving vent to any note, but at once started to lead me at a rapid pace. It was not until this time that I recognised the members of the company, and I said aloud in my excitement—"They are long-billed curlews, yes, and a few godwits with them!" Without appearing to regard their movements, I hastened along, for the ground admitted of no concealment whatever, in their direction. They were at least two hundred yards in advance; and so intently was I observing their action, that another flock of birds, if anything still more interesting to me, coming from a direction I could hardly tell where, suddenly alighted about half-way between us. This party consisted of two magnificent roseate spoonbills, accompanied by several oyster-catchers. Our surprise was mutual, and I at once saw that these last arrivals on the scene, as soon as they recovered their senses, intended to take flight again; so without any warning, and in shear desperation, I ran as hard as ever I could up the beach towards them. When within about fifty yards, away they flew, followed, I assure you, by the contents of both barrels of my fowling-piece, but all to no avail. They were joined by the curlews as they passed, and I was obliged to return empty-handed.

This was the last occasion of my meeting with the long-billed curlew on our Atlantic coast, and many years passed by before it was again brought to my notice. In June 1877 I formed, as surgeon, one of a party of troops and Indians, scouting through the central portion of Wyoming territory. Having galloped off by myself one day, away from the command, over the undulating but treeless prairie, my ears were suddenly saluted by the cries of one of these birds as it sailed over my head. Its peculiar rattling note soon caused several birds of the same species to appear and sail over me in a like manner. Their flight at these times was very steady, and unaccompanied during a good part of it by any movement of the wings. Dismounting from my horse, I shot at them several times with my carbine, as they passed directly over me in their slow and steady course, and, after a few shots, I had the satisfaction of so crippling the wing of one, as to cause him to fall and become my game.

Their nests or young were evidently in the neighbourhood, but my search for them proved fruitless, and I never saw either during my entire stay in that country or since. Three years later, at Fort Fetterman, Wyoming, while collecting one day in May, just beyond the buildings of the garrison, eight of these birds came by me. They were in close range, and my first shot broke the wing of one, which, after it had recovered itself from its sudden fall, cried out vehemently to its companions for aid. These flew in a most confused manner about me, until I had secured six of their number in all. From these specimens I made three or four good skeletons, and one exceptionally fine skin.

The description of the former will form the subject-matter of this paper, while the latter now stands up as large as life in the ornithological collection of the Smithsonian Institution.

The genus *Numenius* is quite a cosmopolitan one, and some twelve or fifteen species of curlews are found in various parts of the world. In England two very well known forms occur, *N. arquata* and *N. phæopus;* the latter has been recently added to the fauna of this country.

At the present writing, our avifauna has this genus well represented by the five species found in it. These are *N. longirostris, N. hudsonicus, N. borealis,* all of pretty general distribution over the United States, and *N. phæopus* and *N. taïtensis* confined to certain localities—the whimbrel having been taken in Greenland.

Curlews fall into one of the groups of the great order of grallatorial birds. The order Gallatores comprises all those forms usually known to us as waders. They possess one character that applies nearly universally to all its members. This is the nakedness of the suffrago, or that part of the leg just above the heel. The degree of this nakedness varies in the different species; in *Numenius* it is very well marked. Ornithologists have found that the numerous, and in many cases extraordinary, forms, that comprise this order Grallatores, fall more or less naturally into three groups.

The first of these, and the one to which our curlew belongs, is known as the LIMICOLÆ. In it we find all the snipe-like and plover-like birds, together with such forms as *Hæmatopus* and *Recurvirostra.* They are generally designated as the *shore birds,* and possess in common many characters and habits. In the classification of Huxley, these birds comprise the Schizognathæ, having certain cranial characters, which I have elsewhere applied and enunciated in an American form of plover.[1] Sometimes they lack the intrinsic muscles of the lower larynx, and are said never to possess more than one pair of them.

Our second group of grallatorial birds is made up of the HERODIONES, containing, as it does, the herons and forms more or less nearly related to them. Finally, we have the sub-order

[1] "Observations upon the Osteology of *Podasocys Montanus,*" *Jour. Anat. and Phys.,* vol. xviii. pp. 86–102, plate v.

or group, the ALECTORIDES, represented by the cranes, the rails, and other kindred forms. It does not lie within the scope of this monograph to present the characters of these last two groups, so they will be omitted here.

Believing, as I do, that it is always an advantage to present a concise account of the leading external characters of the bird whose skeleton we are about to describe, I find that in the present instance I can do no better than repeat the words of so eminent an ornithologist as Dr Coues. This author says of the *Limicolæ*:—"With a few exceptions the wing is long, thin, flat, and pointed, with narrow, stiff primaries, rapidly graduated from 1st to 10th; secondaries in turn rapidly lengthening from without inward, the posterior border of the wing thus showing two salient points separated by a deep emargination. The tail, never long, is commonly quite short, and has from 12 (the usual number) up to 20 or even 26 feathers (in one remarkable group of snipe). The legs are commonly lengthened, sometimes extremely so; rarely quite short, and are usually slender; they are indifferently scutellate or reticulate, or both. The feathers rarely reach the suffrago. The toes are short (as compared with the case of Herons and Rails of the next group), the anterior usually semipalmate, frequently cleft to the base, only palmate in *Recurvirostra* and only lobate in *Phalaropodidæ*. The hinder toe is always short and elevated, or absent. The length of the phalanges of the anterior toes decreases from the basal to the penultimate. The lower part of the crus never has feathers inserted upon it, though the leg may *appear* feathered to the suffrago, owing to the length of the feathers. The bill varies much in length and contour, but is almost always slender, contracted from the frontal region of the skull, and is as long as, or much longer than, the head, representing the 'pressirostral' (pluvialine) and 'longirostral' (scolopacine) types. Furthermore, it is generally in large part, if not entirely, covered with softish skin, often membranous and sensitive to the very tip, and only rarely hard throughout. The nostril is generally a slit in the membranous part, and probably never feathered."[1]

The special characters as confined to the curlews are—their

[1] *Key to North American Birds;* 2nd edition, by Elliott Coues. Boston, 1884, p. 596.

long, extremely sensitive, downward-curved bill; their tarsi with only very slight scutillations; their toes all present, and showing a slight basal web.

Of the Skull.—It was originally my intention to present the reader with a classified list of the material I have on hand to compare my skeletons of *Numenius* with; but, upon examination, I find there is so much of it, that such a list will be omitted. The collections of the Smithsonian Institution and Army Medical Museum are at my command, and they contain much of value that I will take pleasure in referring to as we proceed, simply calling attention to the specimen, either by footnote or in parenthesis, as convenience may suggest. It gives me pleasure to thank, in addition, however, Mr F. A. Lucas, of the former institution, for the loan of three valuable skulls—one each of *N. arquata*, *N. phæopus*, and *Limosa rufa*, all taken from specimens of these birds collected in France.

Curlews are all the very types of that class of birds which the late Professor A. H. Garrod, F.R.S., designated "Schizorhinæ." In them "the posterior margin of the osseous nares has a distinctly slit-like or triangular form, instead of being simply concave."[1]

This character is seen in my drawing of the superior aspect of the skull of *N. longirostris* (Plate V. fig. 1, B, *n*), and precisely the same condition exists in the skulls of all the other species of this genus that I have examined. Not having in my possession the young of any curlew, it will be impossible to exactly define the limits of the nasal bone. In the adult of the long-billed curlew, as well as the other species, the determinable part of this bone consists in a slender osseous rod with dilated extremities, extending from the fore part of the skull obliquely downwards and forwards to a point where the palatine and maxillary unite. The manner in which this is done may be seen in the figure last referred to. The *premaxillary* is quite broad and subcompressed as it slopes somewhat gently away from the frontal region of the skull, between the nasal bones. It becomes gradually narrower as it proceeds towards the distal tip, but alters but little in form. In an old adult *N. longirostris*, it is nearly six times as long as the remainder of the skull,

[1] "On the Value in Classification of a Peculiarity in the Anterior Margin of the Nasal Bones in certain Birds," *Proc. Zool. Soc.*, 1883, pp. 33–38.

twice as long as the corresponding parts in *N. borealis*. Other forms graduate between these two; in *N. arquata* it is fully four times as long, and is more generally curved throughout.

At the point marked *i* in Plate IV. fig. 3, and in B of Plate V. fig. 1, the nasal meets the maxillary. Beneath, and a little beyond this point, the palatine also merges with these bones. These elements thus unite to form a common rod that contracts immediately after the union to a delicately-fashioned stem that I have given the name of the subnarinal bar. They are seen on either side of the premaxillary, at first beneath the osseous narinal slit, then to pass under this bone, becoming at the same time flatter, more closely applied for the entire length, until they merge into it near the tip at *k* (Plate IV. fig. 3). In *N. longirostris* these bones may be pulled away from the premaxillary, as shown by the dotted lines in Plate V. fig. 1, A, and they spring back to their original position when the hold is released. This is only possible in those curlews that have very long bills. It is not particularly a noticeable feature in the Eskimo curlew, nor the whimbrel. As I am not so fortunate as to have at hand the skeleton of the young of the sickle-bill, it becomes impossible to determine the exact part the nasal, maxillary, and palatine take in forming this subnarinal bar. The sutures are completely obliterated in the adult skull. Much less is it possible to tell the precise limits of the nasal bone at its superior extremity. It may have to do with the median crest of bone found beneath the premaxillary and closely applied to it and to the entire anterior border of the ethmoid, from which it seemingly is developed. Or perhaps the delicate curling crest of bone found just within the nasal bar above, and united with the rounded outer margin of the premaxillary, may have to do with it. This latter seems quite probable, and indistinct sutures seem to point to this latter conclusion.

In *N. hudsonicus* this latter feature is absent, while, on the other hand, it is exaggerated in *N. borealis*, in which bird the entire rhinal chamber seems to be filled with this enlarged, here, a hollow sub-cylinder of thin bone, that meets a similar cylindrical formation of the maxillo-palatine coming from below (compare C and D, Plate V. fig. 2). The median plate, referred to above, is present in all the curlews. We find the *vomer* to be a very well developed bone in *N. longirostris.* The anterior portion, beyond the rostrum, is a thin osseous plate, placed horizontally and shaped like an arrow-head, with the broad part behind. On the under side there is a thin vertical median crest, that in front merges into the free pointed extremity, while posteriorly it is produced backwards by two vertical plates that grasp the rostrum. These at their hinder ends meet the palatines on either side to anchylose with them.

The anterior extremity of the vomer in *N. hudsonicus* and *N. phæopus* is decidedly forked, otherwise the description just rendered will answer very well for the other forms we have under examination. With the exception to what I have already said in regard to the maxillo-palatine for *N. borealis,* this bone has, on either side, a like character in the remaining forms, including *N. arquata.* It is developed as an extremely delicate lamina of bone from the inner margin of each palatine. Anteriorly it merges into the naso-maxillary junction. Externally this plate looks downwards and outwards, and is pierced by at least two, the usual number, large oval foramina. The vomer passes between these plates and never touches them; it may be in contact, however, in *N. borealis.* Upon their inferior aspects, each palatine presents, for the most part, two descending plates, an inner and an outer one, forming a longitudinal concavity between them. Anteriorly, a palatine becomes thicker horizontally compressed, and turns outward to merge into the subnarinal bar, as already described. Posteriorly they support each a pterygoidal head, that is directed outward to articulate with the pterygoid. Their superior surfaces are convex, and each one develops an ascending plate for its inner margin, near the middle, that is carried backwards to its union with the vomer, and forwards to the commencement of the maxillo-palatine lamina. Owing to the comparative greater length of skull in *N. hudsonicus* and *N. phæopus,* these bones are longer in these species. In fact, they are shorter in our long-billed curlew than in any other in proportion to its size. A *lacrymal,* though small, stands out quite prominently at the antero-superior orbital border. It articulates largely with the nasal, and in all curlews sends down a slender bony style that unites with the upper and outer angle of the ethmoidal wing, by which means a large foramen in this locality is encircled. These ethmoidal wings have the same general appearance in all the members of the genus. Each one is a quadrilateral plate, projecting nearly at right angles from the mesethmoid, to form quite an ample partition between the rhinal and orbital cavities.

The interorbital septum is never entire in any of the true curlews, but is pierced in almost identically the same manner in every species. The forms of these interorbital vacuities can best be seen by referring to the several lateral views of the skulls accompanying this paper. But one specimen of the skull of *N. hudsonicus* lies before me, and in that the dividing bar between the two openings is evidently broken out. I have restored it by dotted lines (Plate V. fig. 2, c). The *pterygoids* are comparatively short bones in all the curlews, more particularly so in our present subject. They are twisted and angular in appearance, with sharp longitudinal edges. An elliptical facet occupies the middle of the inner aspect of each, that articulates with the basisphenoid process on either side.

Each *quadrate bone* presents the usual undulatory surface, upon its mandibular head, for articulation with the lower jaw. Just above this, on the inner aspect, is a small semiglobular facet for the cup on the outer end of the pterygoid. The orbital process is a quadrate, lamelliform plate with truncate extremity, while two articulating facets are seen to occupy the dilated end of the mastoid process of this bone. On the outer side we find the usual cotyle for the projection on the quadrato-jugal. The form of the quadrate varies but very little among the other representatives of this genus. Several foramina are seen at the base of the deep sunken cavity, from which the fifth pair of nerves issue. This is the case in all the species, and this elliptical pit on the posterior wall of the orbit, just above the quadrate, is quite a striking feature of the skull. Ossification is so far deficient in the interorbital septum opposite the exit for the optic nerves, that this aperture is here one large circular opening. To its outer side, however, separate and minute circular foramina exist for the third pair. This latter condition seem to be common to all the species. The olfactory nerves, in the anterior part of each orbit, has for its reception a well-marked canal, that leads to a foramen (*N. longirostris*), or a notch (*N. phæopus*), into the rhinal chamber.

A side view of the skull presents for examination, in addition to other points already described, the osseous entrance to the ear, which is here shielded behind by a rather prominent tympanic wing. The sphenotic process in all curlews, except *N. borealis*, is a long, sharp-pointed spine, and even in the exception it may become quite long in old birds.

An upper and lower spine project forward from the squamosal, over the articulation for the quadrate. This feature is more prominent in *N. arquata* of the Continent than any of our American forms, though it is quite a striking character in the lateral aspect of the skull in *N. longirostris*.

In the eye the usual sclerotal plates are found; they are small, comparatively, and about twenty in number. The superior aspect of the skulls of these birds offer some very diverse characters. In all the fronto-maxillary region is concave, and traversed by a longitudinal groove that dies away beyond on the premaxilla. This groove is deepest in *N. arquata*. In *N. longirostris* the superior orbital peripheries are but slightly serrated, and the orbital roof just within them is pierced, but by a very few minute foramina. The "glandular depressions" are shallow. The surface between them is depressed, and a *double* raised line is observed, that in each case is a part of the raised semilunar boundary to the glandular depressions in question. In *N. phæopus* the raised lines have merged into a single median one; the orbital rims are decidedly serrated with small foraminal perforations, and the glandular depressions would hardly attract attention. The raised median line is single and still more prominent in *N. arquata*, causing the depressions to be more concave. In my specimen one large foramen is seen close to the orbital rim on one side, situated rather posteriorly, with a corresponding notch on the opposite side. In *N. hudsonicus* the orbital rims are comparatively smooth; *no* evidences exist of the glandular depression, and the region is barely concave; a minute foramen exists on each side posteriorly. *Numenius borealis* has strongly marked grandular depressions of a semilunar form, situated just within the smooth orbital peripheries. A decided median groove divides them longitudinally, which in this bird is continuous with the groove described in the fronto-maxillary region. The glandular depressions terminate anteriorly in this curlew, in a notch, on either side, just behind the lacrymal bones. The parietal region is smooth and globular, being impressed in most of the species by a longitudinal median groove, most noticeable in *N. arquata*, less so in *N. borealis*, least of all in *N. phæopus*. Among the chief points of interest in the basal view is the form of the foramen magnum. This is nearly circular in *N. longirostris* and *N. arquata*; cordate in *N. phæopus*.

The condyle is small and hemispherical in all the species, and has situated beyond and on either side of it, the usual vascular and nervous foramina seen in this locality in ordinary birds' skulls.

Two large supraoccipital foramina, of elliptical outline, exist in our present subject and in *N. arquata*; these openings are very small in the whimbril, and exist only on one side in *N. borealis*, as a minute perforation.

The surrounding muscular line of the occiput is quite strongly marked in all the species; least of all in the Eskimo curlew.

Within the brain-case we find the tentorial ridges quite prominent, well dividing the various encephalic compartments. The longitudinal one appears to be ungrooved by the sinus.

Foraminal openings occur in the usual localities for the entrance or exit of nerves and vessels. But little diplöie tissue seems to be deposited between the tabular walls of the cranial vault, these latter being quite thin, and composed of firm compact bone.

The curvature of the *mandible* is almost identical with that of the upper bill or premaxillary. When articulated with the skull, it is found to be in all the species a few millemetres shorter than the latter bone. In *N. longirostris* the rami separate and diverge from each other at a point about midway between tip and articular extremity. Beyond this point the mandible is in one piece, rounded beneath and with rounded lateral angles above. A groove deeply marks the bone along its entire course in this portion, in the median line. The rami still remain rounded for some distance backwards after they separate from each other, but, just before they arrive at the long slit-like ramal vacuity, they dilate to become lamelliform plates compressed from side to side. The upper borders of these plates curve inwards towards each other. A second small circular foramen, situated at the base of a larger concavity, on the outer aspect of the ramus, between the vacuity and the hinder end, exists in all the specimens before me, except *N. hudsonicus.* The articular ends are of a form most common to the class; they are produced posteriorly into small vertical plates, that turn outwards, but do not curve upwards to any great extent, as we find them in the *Gallinæ.*

At the inner tip of each we find the usual pneumatic foramen. The sutures designating the limits of the bones that originally entered into the composition of the mandible in any of this genus, have been almost entirely obliterated, the edge of the dentary sometimes being persistent.

With the exception that the cerato-hyals have coalesced with the glosso-hyal, or the posterior part of it, as is usual among birds, all the remaining elements of the *hyobranchial apparatus* of the curlew remain free during life. The first piece of the arch, just referred to, has the form of a long arrow-head, with quite a sizeable fenestra towards its hinder end. The first basi-branchial has a median longitudinal ridge above, connecting the two enlarged articulating extremities; the posterior one has two facets for a cerato-branchial element on each side. These are long and slender, curving upwards. They support the equally delicate epi-branchials, which terminate in filaments of cartilage.

The second basi-branchial is quite short comparatively, it being in turn produced backwards by a slender cartilaginous tip.

Among interesting comparisons to be noted with other American limicoline forms, in so far as the skull is concerned, we find in *Tringoïdes macularius,* that the glandular depressions on the roofs of the orbits are long and narrow, and bound the entire supraorbital periphery. A deep depression occurs in the fronto-maxillary region of this sandpiper, and the vomer is very slender, being pointed anteriorly. The supraoccipital foramina are present, and of some considerable size. Very large vacuities occur in the interorbital septum, and the foramina for the optic, olfactory, and other nerves, have all run together.

Batramia longicauda does not possess the supraoccipital foramina, and the glandular depressions above the orbit are still narrower than we found them in *Tringoïdes.* The wing of the ethmoid on either side has a spur on its outer margin, directed forwards in this tattler. In *Totanus melanoleucus* the glandular depressions are wider again, and the supraoccipital foramina are present. A median notch is found in the upper border of the foramen magnum. In *Totanus flavipes* nearly half the anterior wall of the brain-case is deficient, and the interorbital septum is very large. This latter character does not occur in the willet (*Symphemia semipalmata*). In this interesting bird we find the supraoccipital foramina to be of some size, and of an elliptical outline. The glandular depressions are barely perceptible. Just beyond the fronto-maxillary region, on the culmen, we note the persistence of the premaxillary sutures. This shows to some extent how far the nasals must extend forwards. The vomer is pointed anteriorly, and the interorbital septum is divided by an osseous bar. Upon a basal view, we find that the lower borders of the maxillo-palatine plates appear. They are attached to the palatines anteriorly, being directed backwards as free lamina. Their connection anteriorly with the maxillaries is by their outer angles. In the mandible of *Symphemia* the true ramal vacuity has become a mere slit, filled in with a plate of bone; while the small foramen I described in the curlews is here very large, and almost entirely usurped its place.

This condition likewise exists in *Limosa fœda.* The rims of the orbits in this bird are rounded, differing in this respect from the curlews. In this godwit, too, we note a pointed vomer in front, and the presence of the supraoccipital foramina on the occiput. The glandular depressions above the orbits have disappeared, and the openings in the interorbital septum are three in number, and smaller. A deep, circumscribed, and obliquely-inclined groove is found on the lateral aspect of the skull, back of the ear-entrance. In *Limosa rufa* a deep gutter is seen between the orbits on a superior aspect of the skull. Anteriorly it is bounded by an eminence on the premaxillary. The lacrymal is small in all the godwits, and connects with the alæ-ethmoid, as in the curlews.

Most noticeable in *Tringa* is the absence of the glandular depressions, and the extreme narrowness of the region of skull where they occur in the other forms. *Tringa bonapartii* (No. 1631, Army Med. Mus. Collèction) has the supraoccipital foramen, and the fenestra in the interorbital septum, as in the curlews. There seems to be in the mandible an inclination for the hinder ends to bend downwards.

This character is also observable in *Actodromus minutilla*, and in this sandpiper space between the orbital margins, on the superior aspect of the skull, is reduced to a very narrow isthmus. It is much wider, comparatively, in *Actodromus bairdi;* and this form also faintly shows the glandular depressions. They are quite well marked behind. The mandible shows the posterior bend, and the articular extremities throw off behind lamelliform, upturned processes, that are a prominent feature in this bone. The vomer is pointed in front, and the supraoccipital foramina are present.

Actodromus maculata and *Pelidna alpina americana* possess skulls very much alike in many of their characters—in the arrangement of the maxillo-palatines, the presence in each of the glandular depressions, with a similar form. Both have the supraoccipital foramina, and great deficiency of bone in the anterior wall of the brain-case and interorbital septum. They differ in the form of the ethmoidal wings. *A. maculata* shows a little bony loop, projecting forwards from the outer border of this plate, which is absent in the dunlin. In the pectoral sandpiper this ethmoidal plate is not carried up so far as it is in *Pelidna*, in which bird it absorbs the lacrymal on either side.

The little osseous loop on the ala-ethmoid, referred to as a character in *A. maculata*, is seen also in *Rhyacophilus solitarius*. Here, however, its upper limb comes down from the lacrymal, to throw in its lower limb at a right angle to the ethmoid. This explains the manner in which it is developed, and accounts for its presence. The vomer is pointed anteriorly in the solitary tattler. A deep median pit characterises the fronto-maxillary space in *Ereunetes pusillus*.

As we pass from the genera we have just been considering to the genus *Gallinago*, we are at once confronted by a widely different, though none the less interesting, series of characters in the skull. Indeed, so diverse is the plan upon which these birds' heads are built, that I believe the drawings that I have made to accompany this paper will not come amiss in conveying an idea of their structure. My choice has been the skulls of *Gallinago*, *Philohela*, and *Himantopus*, though many others equally engaging might be added.

The greater part of the brain-case in *Philohela* and *Gallinago wilsoni* occupies a position at the base of the cranium. This brings the foramen magnum into the horizontal plane, and crowds other parts of the skull to the front, as shown in the cut. Although the supraoccipital prominence is but slightly elevated, it shows the usual elliptical foramina noticed in many other species and genera.

A wide median groove is found along the skull on the superior aspect in *Gallinago*, which is shallower in *Philohela*, although in this latter bird the orbital rims are more elevated.

A true septum narium exists in both of these birds, being most complete in the snipe. The large lacrymal sweeps backwards to join with the post-frontal, thus completing the orbital periphery with bone, a very rare condition in birds. In *Gallinago*, and in the woodcock too, the interorbital septum is quite complete, though in the former bird many small deficiencies occur in the bone on the anterior wall of the brain-case. The pterygoids in *Philohela* are exceedingly short and thick, the facet for the basi-sphenoidal process occupying nearly the entire length of the shaft.

In the mandible of the snipe and woodcock the hinder end is bent down almost at a right angle, and the ramal vacuity is unusually large in *Gallinago*.

Himantopus shows an entirely different form of skull, as we may see by its comparison in the figures. Viewed superiorly, we find the median crease very deep between the orbits, and the glandular depressions on either side of it are semilunar in form, strongly stamped, definite in outline. Each terminates anteriorly in a *single* foramen, that pierces the roof of the orbit beside the lacrymal bone.

The interorbital septum in the black-necked stilt is markedly deficient, and the anterior wall of the cranium does not fare much better in this respect. Supraoccipital foramen of the most usual form are found in this bird also, the muscular lines of the occiput being well defined above them. The ethmoidal wings are but feebly developed, and the descending spine of the lacrymal on either side falls far short of reaching this bony projection. Upon basal view we find the palatines long and narrow, with the vomer slender, and terminating in a sharp point beyond.

I should have mentioned that the most delicate vomer examined is that of the woodcock, in which bird it is drawn out to absolute hair-like dimensions. The hinder end of each articular part of the mandible in *Himantopus* has the appearance of being scooped out, so as to form a semilunarform cavity. Among all the *Limicolæ* the superficies of the cranial vault, restricted to the parietal region, is smooth and globular.

Several of the characters attributed to the skull of *Himantopus* are reproduced in *Recurvirostra americana*. Chief among these are the form assumed by the proximal ends of the mandible, the narrow ethmoidal wings, and the free-hanging ends of the lacrymals, though the main part of these bones project much farther from the skull than they do in the stilt. The avocet differs from *Himantopus* in having a more perfect interorbital septum, in the supraoccipital foramina being circular, in the vomer being broad and widely forked at its expanded anterior extremity, in the shallower glandular depressions, which in the avocet merge together in the median line, and are carried out on the projecting lacrymals. It is scarcely necessary to call attention to the vast difference in the form of the skeleton of the bills in these two birds. The avocet stands alone with his upturned mandibles, and even the beak of the stilt is quite unique.

Phalaropes have a very deficient interorbital septum; this is particularly the case in *Lobipes hyperboreus*, in which bird it may almost be said that it lacks any bony partition between the orbits or wall to the adjoining cranium. Wilson's phalarope (*Steganopus wilsoni*) is somewhat better off in this respect. In these birds, the margin of the foramen magnum is notched mesially and above; and as in all the limicoline birds, the pterygoids articulate with basi-pterygoidal processes at the base of the cranium. Skulls of both the American oyster-catchers are before me, and a very casual study is sufficient to convince one that they are deserving of far greater elaboration and detailed description than I will be permitted to bestow upon them on this occasion.

Anatomists will appreciate the nature of this disappointment, when I say, that not only is the complete skeleton of *Hæmatopus niger*,[1] and skulls of *H. palliatus*[2] at my hand, but, in addition, Kidder's type specimens[3] of *Chionis minor*, that were used in his description of the structure of that bird, in his valuable paper on "Contributions to the Natural History of Kerguelen Island;"[4] also a most perfect skeleton of *Alca torda*, presented to me several years ago by Mr Forbes.[5] Finally to say nothing of the gulls, petrels, and gallinaceous fowls to any number.

An engaging row of skulls is facing me as I write this, and it is interesting to mark the gradual subsidence of the one character,—the supraorbital glandular depression, powerfully sculpt in the skull of *Alca*, and riddled with foramina (a very large one on either side, anteriorly). Far more feebly impressed in *Larus*; remaining about the same in *Hæmatopus niger*; to be shallower still in *H. palliatus*; all of the latter three having the perforating foramina small, and less and less numerous. Then we ascend to *N. longirostris*, where it is still evident, less so in *N. arquata*, to finally become obsolete in *N. hudsonicus*. And what are we to say for its significance in *Himantopus*? So very marked, and with the single *anterior* foramen (see *Larus*) still persistent.

What we have said of these depressions applies with equal force to the crotaphite fossæ—though a longer series would show this better, as this feature has died out before reaching the oyster-catchers. The lacrymals are very prominent in these latter named birds, and from a superior view simulate the *Laridæ*, while its connections below with the ethmoidal wings are very much the same as in *N. borealis*, or *longirostris* as for

[1] No. 13636, Collection in the Smithsonian Institution.

[2] Two specimens in the Army Medical Museum.

[3] Now in the collection at the Smithsonian Institution.

[4] *Bulletin of the United States National Museum*, No. 3, 1876, by J. H. Kidder, M.D. (at that time) Passed Assistant-Surgeon, United States Navy.

[5] Mr W. A. Forbes, Prosector to the Zoological Society of London, an anatomist of great promise. Since died at the post of honour, on a scientific exploration, at Shonga, Africa.

that matter. Yet, on the other hand, but *very little* trimming would be necessary to convert the lacrymal of a curlew into that of a grouse. Again, the connections of the descending process of this bone in *Larus delawarensis* is *precisely* as I described it for *Phyacophilus solitarius*, only, of course, upon a large scale, the subject itself being so much larger.

I find in *Hæmotopus niger* the occipital prominence much elevated, but unpierced by the foramen described for other forms. The vomer, bifid behind, is carried far beyond the maxillo-palatines, to be forked at its tip. But one fenestra occurs in the interorbital septum, while the foramina for the exit of nerves from the brain-case are distinct for each pair.

Of the Vertebral Column.—There are fifteen vertebræ in the cervical portion of the column of *N. longirostris.* The only other complete skeleton I have of a curlew (*N. borealis*) shows the same number, so we may pretty safely predict that this count will hold good for the genus. Ribs are found free upon the two ultimate vertebræ, and in my specimen of the long-billed curlew, the thirteenth vertebra shows persistent sutures, upon the lines of anchylosis of the pleurapophyses on either side. So examples may be found where the thirteenth, fourteenth, and fifteenth, or last cervical may all possess free ribs. In the atlas, the neural arch is very broad from before backwards, with its posterior angles tipped with small nodules of bone. The cap for the occipital condyle is perforated by a minute foramen at its base, and just above the centre we find the neural spine of the axis, or second cervical, to be represented by a large and tuberous knob of bone, and the transverse processes in this vertebra, which are directed upwards, backwards, and outwards, are unusually stout and heavy. The "odontoid process" is small, and shows an articular facet on its inferior aspect. Beneath the hyopophysis is a strong plate of bone, pointing backwards, with thickened border below.

The third vertebra, has well-developed parapophysial spines; a closed vertebral canal, elliptical foramina, one on each side, in the lamina of bone extending between the zygapophysial processes; a neural and hypapophysial spine, the former being a small plate situated posteriorly. In the fourth vertebra these characters are all still present, though the foramina above are closed in only by an extremely slender inter-zygapophysial bar. The fifth vertebra is very much elongated; the mid portion of the centrum is represented by a median longitudinal lamina of bone, extending between the more solid and terminal pieces that support on their outer aspects the articular facets for the vertebræ before and behind it. The neural spine is reduced to a sharp line; the posterior zygapophyses are outstanding processes. The sixth, seventh, eighth, and ninth vertebræ are substantially the same in character as the fifth, though they are growing shorter as we proceed backwards. They show also the open carotid canal. In the tenth vertebra this is replaced again by a hypapophysis, a single plate placed anteriorly in the centrum beneath. The vertebral canal is still a closed passage, and the neural spine is absent. Extensive pneumatic foramina exist in all the ultimate segments of the cervical division of the spinal column. The eleventh and twelfth vertebræ are slowly changing, to bring about what we find strongly developed in the thirteenth. In this latter we observe a well-pronounced *double* neural spine, occupying a mid position on the neural arch. The post-zygapophyses are elevated, but still project outwards. Anteriorly the vertebra is very broad from side to side, owing to the far-spreading transverse processes, that here overarch the vertebral canal, that is closed in beneath by the anchylosed ribs, already alluded to above as being a character of this vertebra. The lateral aspects of the centrum show a deep elliptical pit on each side, with numerous circular pneumatic perforations at their bases. The hypapophysis is a single plate, occupying the mid portion of the centrum. In the fourteenth vertebra, the ribs, or rather the delicate pleurapophyses, have been liberated; the hæmal spine exhibits evidences of becoming tricornuate; the neural spine stands well above the vertebra, as a tuberous and solid mass, bearing sharp spines, directed backwards upon its outer and posterior angles. These are the continuations of the lateral raised rims of the neural spine proper, and they project also somewhat anteriorly. This is one of the most prominent features of the fifteenth or last cervical vertebra; it is explained, however, in the dorsal series, by its evolution into the ordinary quadrate dorsal neural spine, with the forked extremities of the limiting rim at their crests. The hæmal spine of the fifteenth vertebra is triplicated, having three plates, though they are not particularly prominent. In it, too, the free ribs are quite long, and are without uncinate processes.

Numenius borealis shows but few structural departures in its cervical vertebræ from those I have just described for *N. longirostris.* The cap of the atlas does not seem to be perforated at its base; the pleurapophyses of the thirteenth vertebra bear no striking resemblance as yet to free ribs, as they do in the long-billed curlew. The carotid canal is found traversing identically the same vertebræ in mid-neck. In both these curlews there are five vertebræ in the dorsal series, all articulating freely with each other. Above they have long osseous metapophysial filaments, that stretch for the length of one or nearly two vertebræ before and behind, in the middle of this region. The tendons have also become ossified and attached, and reach far backwards from each segment, those of the last running into the ilio-neural canals of the pelvis. The first dorsal vertebra shows two little lateral processes at the lower extremity of its hæmal spine; this plate is single and prominent in the next vertebra, but does not appear in any of the others. Each dorsal vertebra has a pair of ribs, of the most common pattern, as seen among birds. They connect with the sternum by costal ribs, and have freely articulated uncinate processes. These latter are very long and narrow, reaching nearly in mid-series to the second rib to their rear.

In curlews the pelvis also supports two pair of free ribs. The first pair has all the characters of the dorsals, being simply slenderer and longer The ultimate pair are devoid of uncinate processes, and their hæmapophyses only articulate along the posterior borders of the pair in front of them, so do not reach the sternum. I find in my specimen of *N. borealis* an additional piece, or free costal rib, attached to the posterior border of this last pair of costal ribs again on either side.

The number and arrangement of the vertebræ and ribs of the spinal column, as far as examined, agree very nearly with *Limosa fœda* and *Recurvirostra.*

In *Himantopus* the number of cervicals and dorsals are the same as in *Numenius,* but there appear to be one pair less of sacral ribs.

The genus *Batramia* also agrees with the curlews in this respect. *Gallinago* has an additional pair of dorsals, consequently seven articulating facets on either costal border of the sternum. It seems to possess, however, but fourteen cervical vertebræ. The arrangement in the phalaropes is as it is in *Himantopus*, *i.e.*, short of one pair of sacral ribs.

Enough has been presented, I think, to demonstrate the fact that these characters vary among the limicoline birds. I have other skeletons before me, but they have either been mutilated at the time of collection, or indifferently mounted from alcoholic specimens, making it simply impossible to gather any new facts or reliable data from them.

Of the Pelvis and Coccygeal Vertebræ (Plate IV. figs. 8, 9).—Viewing the pelvis of *Numenius longirostris* from above, we observe that the total pre-acetabular area is about equal in extent to the post-acetabular area. The ilia are long and narrow, with serrations in their anterior borders. They are pretty generally concave throughout, having a small triangular concavity, bounded by a raised rim, immediately in front of each cotyloid ring. About their anterior thirds they closely grasp the common neural spine of the sacrum between them, thus creating closed ilio-neural canals. Posterior to the acetabula, these bones present a convex surface, being drawn out behind into prominent processes, that curve inwards. They develop outstanding bony shelves, that overhang the anterior half of each ischiadic foramen. The sacrum does not unite with the post-acetabular part of the ilia, a very marked interspace existing between them. A double row of elliptical foramina pierce this former bone, as shown in the drawing in the plate. They occur between the transverse processes of the vertebræ, and have nearly the same direction.

Upon a lateral view, the long and pointed ischium is presented to us. Posteriorly, it reaches nearly as far backwards as the pubic bone, the latter resting against its inferior edge in this locality. The pubic bone does not quite close in the obdurator foramen in any of the curlews.

Above, we find the ischiadic foramen, which in *Numenius* is very large and elliptical in outline. The relations to each other of these foramina can best be seen by a study of the figure given in the plate.

After a careful count of the vertebræ of the sacrum on the inferior or inner side of the pelvis, there seem to be fourteen. The two anterior ones throw out diapophyses to the ilia, and bear the facets for the sacral ribs. In the third vertebra these processes are extended almost directly upwards; while in the fourth and fifth, again, they are horizontal, as in the first and second. From the points where the diapophyses of the fifth meet the ilia, these bones sweep outwards, and are fashioned to enclose the basin of the pelvis. The tenth sacral vertebra throws out a strong pair of transverse processes, that have widely-dilated extremities abutting against facets, especially developed to meet them, from the ilia, immediately posterior to the acetabulum on either side.

Foramina, for the exit of the sacral nerves, are double, one being placed above the other, the increase of calibre in the neural canal for the corresponding dilatation of the cord taking place in the sacral vertebræ from the fourth to the ninth inclusive.

Although more delicately constructed, the pelvis of *N. borealis* agrees substantially in all particulars with this bone in its more powerful relative, the sickle-bill.

There are ten coccygeal vertebræ in *N. longirostris*, which count includes the triangular and rather large pygostyle.

Among others of the *Limicolæ*, the form of the pelvis is stamped with the same general characters as I have described it for *N. longirostris*. To be sure, it varies in every genera in more or fewer details; but to show these correctly, and to give any just conception of them, would require a carefully executed series of drawings, which cannot be taken up in the present connection.

The foraminal openings in the sacrum of *Gallinago*, and more especially in *Batramia*, are in a single row on each side, but unusually large. The row is double in the phalaropes, *Totanus* and *Tringoïdes*. In the oyster-catchers the pelvis has something more than a bare suspicion of the gallinaceous type. Its general appearance is decidedly such.

In several of the genera the number of coccygeal vertebræ ungrasped by the pelvic bones varies. The curlews, as we have just seen, possess ten, including the pygostyle. This is the case also with *Hæmatopus* and others; but *Recurvirostra* appears to have but nine, in common with *Symphemia*, whereas a specimen of *Totanus flavipes* shows but eight. This cannot fail but be interesting if the count be constant. With the material I have at hand, however, I cannot present with safety any further facts than these here given.

Of the Shoulder Girdle (Plate IV. figs. 1, 2, and 5).—We find in *Numenius longirostris* the usual bones allotted to this arch, free, and articulated in the manner as commonly seen in the vast majority of the class. The shape of the furculum is upon the broad U-variety, and is broader in this curlew than it is in others of the same genus, and still more so than in the plovers. Viewing it laterally, we observe also that it is very decidedly curved upon itself, with the convexity directed forwards when *in situ*. When articulated, the long and pointed clavicular heads rest on either side against the inner aspects of the summits of the coracoids, while the tips extend backwards to meet the usual process furnished by each scapula. This brings the hypocleidium about opposite the middle of the anterior border of the sternum, from which it is separated by quite an interspace.

The clavicles are broader and larger at their superior or coracoidal extremities, being compressed from side to side. Above, the broad surface looks outwards; but it is gradually changed in direction as we descend to the hypocleidium, so that below it looks forwards (Plate IV. fig. 2). The hypocleidium is of a quadrate form, rather small, and has an extension of its posterior border carried up behind on the line of the median clavicular union.

In *N. borealis* (No. 12,595, Smithsonian Collection) the furculum possesses all the characters I have described for the long-billed curlew. As already intimated, however, the arch of the U is not as open, the clavicular heads are not so pointed, and the hypocleidium is nearly round in form, not being so perceptibly carried up on the clavicles at their point of meeting below. Among the plovers I find that it has the same general characteristics, and holds the same relative position when articulated to the other bones of the shoulder girdle.

In *Charadrius dominicus* the furculum is more delicately constructed, being somewhat smaller in proportion when compared with the other bones. The hypocleidium is very small in a specimen of *Ægialites vociferus* (Army Med. Mus., No. 150).

This holds good also for the avocet and the godwit, although in these birds it is a little larger in proportion, more especially in the godwit.[1] The outer aspect of the clavicular limbs above in *Gallinago wilsoni* and *Totanus flavipes* are grooved in the direction of the long axis of the bone on either side. We find this feature more or less marked also in *Tringa*. In these birds, too, the hypocleidium is formed very much as we found it in the curlews, this character being nearly aborted in *Hæmatopus*, although here the other general characters of the furculum remain the same.

The *coracoid* of *Numenius longirostris* is comparatively a short, thick-set bone, as scarcely any true shaft exists between its humeral and sternal extremities. Such as it is, however, is transversely elliptical on section, and occurs just below the inner process at the head of the bone. The sternal extremity is broad from side to side, in which direction it is also convex anteriorly and concave behind. Below, the sternal margin is divided into two deep concavities; the inner and broader one is completely occupied by the articular facet for the sternum. The outer is sharp and free, having attached to its upper horn a pointed and up-tilted little spine, that I will call the *costal spine* of the coracoid, it being opposite the costal border of the sternum. On the outer aspect of the bone we find the usual elliptical facet, that here forms about two-thirds of the glenoid cavity (Plate IV. fig. 5). The summit of the bone consists of a massive hooked process, directed forwards and inwards. Above and behind it is impressed by a shallow concavity, while its inner surface is devoted to an elongated facet for head of clavicle. Below this, on the inner side, we find another lamelliform process, curving inwards, upwards, and forwards, that at its tip also comes in contact with the clavicle when the bones are *in situ*. The posterior margin of this latter process is given up wholly to the scapula, which in life abuts against its entire length, as well as the shaft behind is to the glenoid cavity.

[1] *Limosa fœda* (No. 1652, Army Med. Mus. Collection) and *Recurvirostra americana* (Nos. 1596 and 1387, from the same collection).

In *Numenius borealis* the coracoid is a mere miniature of the bone we have just described for the "sickle-bill." Its costal process is, however, much less strongly marked, and would hardly attract special notice. The coracoids, as well as the other bones of the shoulder girdle, are non-pneumatic in the genus *Numenius*, and I believe generally so among the *Limicolæ*.

When articulated, the coracoids lean well forwards as they spring from their sternal beds in the curlews, while the scapulæ make angles with them of about 90°. They do not quite meet in the median line in any of the species, but are separated at this point by a thin compressed surface on top of the manubrium.

The coracoids touch each other in the median plane over the manubrial process in the genera *Recurvirostra* and *Hæmatopus*.

Symphemia semipalmata, Totanus flavipes, and Bartramia longicauda all have the costal process of the coracoid quite prominently developed; in *Limosa uropygialis* (Smithsonian Collection, No. 12,590) it is broad and quadrilateral in outline, and but slightly curved upwards.

The anterior extremity of the *scapula* in *N. longirostris* is decurved, broad, and compressed from above downwards. The blade of the bone, which is comparatively long, becomes thinner and slightly wider posteriorly, to be very obliquely truncate at the inner side of its posterior third. The angles thus formed are well rounded off, leaving this element of the shoulder girdle without any decided character attached to it (Plate IV. figs. 1 and 5, *s*). *N. borealis* has the hinder moiety of the scapula broader, more blade-like, the truncation more decided, and its tip in the articulated skeleton overhanging the anterior margin of the ilium. Among the plovers, and in all the phalaropes, the blade of this bone is long and narrow, being proportionately short in the black-necked stilt (*Himantopus mexicanus*). As a rule, in the *Limicolæ* it nearly always reaches back, in life, to the ilium on either side,—some forms of *Tringa* seemingly forming an exception.

Of the Sternum (Plate IV. figs. 6 and 7).—Avocets, godwits, plovers, snipes, and curlews, all being birds possessed of more or less power of flight, we naturally look for a correspondingly well-developed sternum in one subject. In this regard we are by no means disappointed, for, taking the general size of *N. longirostris* into consideration, this bone is unusually large. The manubrium is for the most part a thin compressed median plate, with sharp edge below and thickened border above. At its base, superiorly, it is contracted again to an edge, that just keeps the coracoids apart in the articulated skeleton. The coracoidal grooves lie in the horizontal plane; they are broad from above downwards, convex at their middles, and concave at their inner and outer limits. Anteriorly the margin of the keel is very sharp, being carried clear up to the base of the manubrial process. It appears above, however, merely as a line on the front of the fortified column of bone that descends in this situation, to be gradually lost as its expands, on either side of the keel below, within this anterior margin. The carinal angle in *N. longirostris* is rounded in front, being partly covered by the raised rim that bounds the entire length of the keel below. This latter part of the sternum is exceedingly deep, being carried backwards to the very end of the sternal body by a graceful curve (Plate IV. fig. 7).

Upon the costal border we observe six transverse facets for articulation with the hæmapophyses. They are limited beyond by a low quadrate costal process—a feebly-pronounced feature in the sternum of our curlew. So high do the sides of the sternal body itself arise, that it reminds one very much of a very deep spoon, with slender processes projecting from its free border in front, corresponding to the hinder border of the sternum. These processes are four in number, two on either side, making our sternum a four-notched one. Their shape and arrangement can best be seen by referring to my drawing in the plate, where they are shown in fig. 6. On the superior aspect of the sternum, in the median line, and just within the anterior boundary, we find a deep pit, with rounded margins. At its base there seem to be a few minute pneumatic perforations. The usual muscular lines are found to be strongly marked on the sternal body and keel in this curlew, being carried back in each case nearly to its xiphoidal extremity.

The chief differences presented to us in the sternum of *N. borealis* are a greater width of the mid-process posteriorly, and a very decided protrusion forwards of the carinal angle anteriorly. In all other respects the sternum of the Eskimo curlew seems to be the very miniature of the bone I have just described for the long-billed variety.

Professor Owen tells us that "the woodcock (*Scolopax*) has a pair of notches, with the outer boundary slender, and shorter than the broad intermediate tract; the gambets (*Totanus*), avocets, sandpipers (*Tringa*), curlews (*Numenius*), pratincoles (*Glareola*), have the four-notched sternum. In the godwits (*Limosa*, *Helias*) the medial notches are almost obsolete, and the lateral ones wide. The 'thick-knees' (*Œdicnemus*) and bustards (*Otis*) have the four-notched sternum, the notches being small."[1] To this we may add that the inner pair of notches in *Limosa uropygialis*, which are very small, are smaller than they are in *L. fœda*. The inner notches disappear altogether in *Gallinago wilsoni*, although the outer pair are very deep. They are about of equal size in *Hœmatopus niger* and *H. palliatus*, while in *Totanus* the inner pair again become smaller, which is still better seen in *Tringoïdes macularius* (No. 862, Collection in Army Medical Museum), and less so in *Heteroscelus*, *Steganopus wilsoni*, and other phalaropes, and have a sternum very much like *N. borealis*, only much smaller in size, though no smaller in proportion for the bird. The inner notches, however, seem to be smaller. *Bartramia* shows a small pair of inner notches in the sternum, with very deep outer ones.

Actodromus minutilla and *Ereunetes pusillus* both possess four notches, as does also the black-necked stilt (*Himantopus mexicanus*). So that, of all the material that I have been able to examine, or has been available, in this great snipe-plover group —the *Limicolæ*—the only form detected with but a single pair of notches at the xiphoidal extremity of the sternum is *Gallinago wilsoni*. The sternum in this bird differs also in other respects. The carinal angle is carried far forwards; the manubrium is almost completely aborted; the anterior border of the keel is very decidedly concave; and the pectoral muscular lines on the sides of the carina are raised and rounded welts.

Of the Appendicular Skeleton—The Pectoral Limb (Plate IV. fig. 4, and Plate V. fig. 4).—It follows, as a natural consequence,

[1] *Comp. Anat. and Phys. of Vertebrates*, vol. ii. p. 26.

the members of this group all being good strong flyers, that we find the skeleton to their ample wings a thoroughly well-developed one. As a rule, with the *Limicolæ* generally, the bones entering into the brachium, antibrachium, and manus are long, straight, and of considerable calibre. From the material I have at hand, I have failed to detect a pneumatic bone in either extremity. They certainly are not so in the curlews.

The *os humero-scapulare* seems to be absent, its place being filled by ligament as in other birds where this ossicle does not appear.

The *humerus* of *Numenius longirostris* has a shaft that is much straighter than is commonly seen among birds, where it is usual to describe it as being formed like a long *ſ*. Its proximal extremity is comparatively widely expanded, which expansion includes the graceful canopy that arches over the site of the pneumatic orifice in forms where it occurs. A deep notch divides this from the articular facet or head for the glenoid cavity.

The "radial crest" is well developed, and bent outwards almost at a right angle with the vertical plane of the bone when in a position of rest. Should a section of mid-shaft be made, the figure would be very nearly circular; it becomes triedral, proximally and roughly elliptical towards the distal end. This latter extremity offers one point of interest,—it consists in a strong lamelliform process, projecting from the radial border of the shaft, immediately above the oblique tubercle. It appears to be a prominently developed external condyle. When the skeletal limb is closed and *in situ*, this *humeral process* overlaps the neck of the radius; or, as in *Hæmatopus*, the head of this bone, which actually articulates in a semilunar facet at its base. If my memory serves me correctly, it is intended for muscular attachment.

This process is more or less developed in all of the members of this group, at this point on the humerus, so far as I have been able to examine them. Nothing of importance attaches to the remaining points for examination at this extremity of the bone in our curlew, they simply presenting the usual form as found in the majority of the class.

Viewed from above the shaft, the *ulna* is seen to have a long, gentle curve, extending from one end of the bone to the other, being the greatest near its proximal extremity.

The papillæ for the quill butts along the shaft are quite distinct in this bird, and still more in the oyster-catcher, where they present the unusual condition of being narrow and oblong in shape, and placed, as it were, obliquely on the shaft. To the inside of these a secondary row is seen, running down the shaft longitudinally. These little protuberances are scarcely perceptible in the phalaropes or in *Tringa*.

The *radius* of *N. longirostris* does not exhibit so much of a curve in its shaft as its companion in the antibrachium, though it is gently bent throughout its length. A concavity is scooped out of its shaft near the head, over which, I take it, tendons pass in life.

The *carpus* contains the two free bones ordinarily found there in birds articulating after the usual manner. In form these two carpal segments always remind me, the *ulnare*, of a human molar tooth from the milk set of the lower jaw, and the *radiale* of one of those chipped, irregular pebbles we sometimes see.

All of the *Limicolæ*, so far as I have seen, are endowed with a remarkably long hand. If we allow the bones of the carpus to be added to it, its length in the sickle-bill is fully equal to that of the ulna. Each bone lends its due share in proportion to produce this result, and one that strikes us at once in the articulated skeleton of the bird. The shaft of the second metacarpal is for the most part cylindrical in form, while its anchylosed companion is of very slender proportions. I find in *Numenius* and *Hæmatopus* a delicate, curved, and free joint, suspended from its distal end (Plate V. fig. 4, *x*).

There is an ample expanded portion springing from the posterior aspect of the first digit of second metacarpal. It is produced downwards as a flattened and peg-like process, not commonly seen. This phalanx supports below one more long and slender joint. The smaller digit of third metacarpal has a shape not unlike a compressed claw, as it hooks over the expanded portion of the finger at its side.

The Pelvic Limb.—After the process of maceration and drying, the femur of this curlew has all the appearance of a pneumatic bone, but careful search fails to discover the orifices at their accustomed site, though a few very minute openings are to be seen on the opposite side of the bone, below the facet. This, I must believe, would be an unusual locality for such foramina. The femoral shaft in *Numenius* is straight, smooth, and cylindrical, with all muscular lines nearly obsolete. A rough surface is found on the back of the trochanterian prominence, and this portion rears well above the facet at the summit.

The pit for ligamentum teres is very shallow, and rather irregular in outline. Several of the characteristic features of the distal extremity of the bone are more keenly defined than those just described for the proximal end. The intercondyloid notch is deeply excavated; the anterior border of the external condyle is a sharp crest, while the corresponding surface on the internal one is evenly rounded. Upon the reverse aspect we find the popliteal depression well sunken, and the notch for the head of fibula cleanly cut out. A tubercle and pit exist on its outer and condyloid side for ligamentous attachment.

The length of the *tibia* in this curlew is double that of the femur, and the shaft of the bone has a general convexity inclined outwards. Sections taken through its middle third are subellipses, and the expanded extremities are rather abruptly attached, more particularly the proximal one. Here the pro- and ecto-cnemial processes rise squarely from the shaft, showing but little of that tendency to merge gradually into it below. The ectocnemial process is shaped like a claw, with its point inclined downwards. Its fellow is much larger, slightly turned outwards, quadrilateral in figure, with the angles rounded off. They are produced upwards as a rotular process to a very slight extent. The fibular ridge stands out from the shaft on its outer aspect as a prominent and rather extended crest of bone.

At the distal extremity we find the inner condyle to be smaller than the opposite or outer one, as well as proportionately narrower from above downwards. In the groove between them anteriorly the tendinal bridge is ossified, the span being thrown directly across, and not obliquely, as it is in some birds. Prominent tubercles exist on either side, immediately above it, for ligamentous attachment, as an additional bridge is formed of this material at this point.

The *fibula* is compressed from side to side above, and club-shaped. After articulating with the ridge designed for it on the tibia, it merges into the shaft of this bone a little over half-way down, measuring from the proximal extremity.

Himantopus, with its pelvic limb of twenty-nine centimetres in length, has a fibula that descends but one-fourth the distance down the tibial shaft.

The *patella* in *Numenius* is, comparatively, very small, and of an odd, irregular shape. *Hæmatopus* has the bone only represented in a diminutive cartilaginous nodule, and I am inclined to think that this sesamoid will be found missing in other limicoline birds of our fauna. It appears, though of no very great size, in the willet and avocet.

The *tarso-metatarsus* of *Numenius* is but little over a centimetre shorter than its tibia. Upon the superior surface of its proximal extremity the articular facets for the tibial condyles are deeply impressed, and a prominent tubercle arises between them on the anterior rim. Behind, the hypo-tarsus is bulky, being both grooved and pierced for the passage of the tendons. The shaft of this bone is concave longitudinally for its entire length on the anterior aspect, and less so upon the posterior. The trochlear prolongations at the distal end are large, and the extremity much expanded, a feature still more prominent in the swift-footed *Hæmatopus*.

The oyster-catcher presents us with another very interesting point in its tarso-metatarsus, which is very well shown in the specimen I have in my hand. It consists in the outgrowth upon the site of the usual place for articulation of the "accessory metatarsal" of a little plate of bone, placed vertically, and formed almost like a spur, with squarely truncate extremity.

Another three-toed limicoline bird, *Himantopus*, is devoid of any such protuberance on its tarso-metatarsus, and, as a rule, the hallux being small in so many members of the group, this bone never becomes of any size among them.

In number, the phalanges of the podal digits are arranged upon the common plan, and in no instance offer us anything beyond the well-known characteristics that pertain to the skeletal foot of a typical wader.

DESCRIPTION OF PLATES IV. AND V.

Plate IV.

Fig. 1. Direct anterior aspect of left coracoid and scapula of *Numenius longirostris.* *s*, scapula; *c*, coracoid; life size, from a specimen taken by the author in Wyoming.

Fig. 2. The furculum of *Numenius longirostris*, from the same specimen; a three-quartering view from the right side, life size.

Fig. 3. Right lateral view of skull of *Numenius longirostris*, with mandible attached, from the same specimen, life size. *sf*, supra-occipital foramen; *q*, quadrate; *pt*, pterygoid; *j*, jugal; *pl*, palatine; *i*, points of meeting of nasal and maxillary; *h*, subnarinal bar; *k*, premaxillary; *j*, culmen; *n*, nasal; *l*, lacrymal; *eth*, ethmoidal wing.

Fig. 4. Right humerus of *Numenius longirostris*, anconal aspect, life size, from the same specimen.

Fig. 5. Lateral view of right scapula and coracoid of *N. longirostris*, life size, same specimen as the others.

Fig. 6. Inferior view of sternum of *Numenius longirostris*, life size, same specimen as above.

Fig. 7. Right lateral view of sternum of *Numenius longirostris*, life size, same specimen.

Fig. 8. Left lateral view of pelvis of *N. longirostris*, life size, from the same specimen.

Fig. 9. The pelvis of *Numenius longirostris*, viewed from above, life size, and taken from the same specimen.

Plate V.

Fig. 1. Basal and superior views of the skull of *Numenius longirostris*, life size; A, the basal view, lower mandible removed; B, the superior view, like lettering designating like parts. *pmx*, premaxillary; *v*, vomer; *pl*, palatine; *m*, maxillary; *n*, nasal, ; *eth*, lateral wing of ethmoid; *l*, lacrymal; *q*, quadrate; *pt*, pterygoid; *fm*, foramen magnum; *sf*, supraoccipital foramen; also in A, *sn*, the subnarinal bar, and *sn'* its position in dotted lines as drawn away from the premaxillary on either side. In B, *i*, the point of meeting of nasal and maxillary.

Fig. 2. Right lateral views of the skulls of *Numenius hudsonicus* (C, the upper figure), and *N. borealis* (D, the lower one). Life size, from the collection at the Army Med. Mus. (Nos. 457 and 928 respectively). *pmx*, the premaxillary; *n*, the nasal; *l*, the lacrymal; *q*, the quadrate; *pl*, palatine; *a*, articular; *d*, dentary; *h*, the subnarinal bar.

Fig. 3. Left lateral views, life size, of skulls of *Philohela minor* (E, No. 449, Army Med. Mus. Collection), *Gallinago wilsoni* (F, No. 898, Army Med. Mus. Collection), and *Himantopus mexicanus* (G, No. 1359, Army Med. Mus. Collection). *n*, nasal; *pl*, palatine; *pt*, pterygoid; *q*, quadrate; and *a*, articular.

Fig. 4. Palmar aspect of right manus of *Numenius longirostris*, showing also distal extremities of radius and ulna, life size. *r*, radius; *u*, ulna; *s*, scaphoid (radiale); *c*, cuneiform (ulnare); *p*, pollex; *x*, claw on pollex; *i'*, index metacarpal of carpo-metacarpus; *i''*, its first or proximal phalanx; *i'''*, its distal phalanx; *m'*, medius metacarpal of carpo-metacarpus; *m''*, its digit. Limb from the same specimen that furnished the drawings for the plate.

Fig. 5. Parts of right pelvic limb of *Numenius longirostris*, life size. *tm*, anterior view of the tarso-metatarsus; *tm'*, a view of the surface of its proximal extremity at right angles to the shaft; *hp*, the hypo-tarsus; *tm''*, a view of the surfaces of the distal extremity of tarso-metatarse at right angles to the shaft, showing the trochleæ for the podal digits; *T.* upper extremity of the tibia; *T'*, view of its proximal surface at right angles to the shaft; *F*, anterior aspect of the femur.

THE ANATOMY OF ACQUIRED FLAT-FOOT. By J. SYMINGTON, M.B., F.R.C.S.E., *Lecturer on Anatomy, Edinburgh.* (PLATE VI.)

THE anatomy of this comparatively common deformity does not appear to have received much attention in this country. Nearly half a century ago, it was considered by a writer in Todd's *Cyclopædia of Anatomy and Physiology* as probably due to a relaxation of the inferior calcaneo-scaphoid ligament, but he admits that he had no opportunity of dissecting a specimen, his ideas on its anatomy being derived from a careful examination on the living body. The account of flat-foot given in Holme's *System of Surgery,* 3rd edition, 1883, by such a well-known authority on Orthopædic Surgery as Dr W. J. Little, contains no anatomical details but what can be ascertained by external examination. Almost all the other English articles on this subject possess a similarly purely clinical basis. This may be attributed to the absence of specimens, the distortion, though common, not being fatal or requiring amputation. So far as I have been able to ascertain, there are no preparations of flat-foot in any of the following museums :—Hunterian, St Bartholomew's, University College, London Hospital, St Thomas', Guy's, Edinburgh University, and Royal College of Surgeons, Edinburgh. In fact, I have not been able to hear of a specimen in any of our museums.

Two valuable contributions, founded upon a careful examination of dissections, have however been made to this subject by C. Hueter [1] and G. Hermann von Meyer.[2]

By Hueter its anatomy is treated partly from a developmental point of view. He gives an excellent account of the position and shape of the tarsus in the newly-born child. The foot is then supinated, but as soon as the child begins to walk it becomes pronated. This prone position is followed by certain changes in the tarsal bones, especially in the os calcis, astragalus, and scaphoid. As a consequence of the altered position

[1] *Grundriss der Chirurgie,* Von Dr C. Hueter, ii. Hälfte, 1882.

[2] *Ursache und Mechanismus der Entstehung des erworbenen Plattfusses,* 1883.

of the bones, certain surfaces are subject to increased pressure and atrophy, while others relieved of pressure, grow. Flat-foot he regards as an over-pronation of the foot, and the changes in the tarsal bones are to be explained by the effects of alteration in pressure. The bones specially involved are the three mentioned above. He considers that there is a general relaxation of the ligaments of the foot, but he refers specially to the inferior calcaneo-scaphoid ligament, the surface of which, he says, presents a marked increase.

Dr G. Hermann von Meyer, in his monograph, endeavours to disprove the current view, that in consequence of the relaxation of the inferior calcaneo-scaphoid ligament, the head of the astragalus is displaced downwards. He maintains that there is no elongation of the above-mentioned ligament, and also that the inner border of the foot is not increased in length. The most important part of his paper, which will be considered subsequently, is that in which he describes the mechanism of displacement of the astragalus in relation to the rest of the tarsal bones.

During last winter session I met with an adult male subject in my practical anatomy rooms, in whom both feet presented the appearances typical of advanced flat-foot. He was a big, heavy man, six feet in height, but the muscles of the body generally were soft and flabby. There were no indications of his having suffered from rickets. After the muscles of the leg had been dissected, the feet were removed by amputating a few inches above the ankle, and kept for special examination. A plaster-of-Paris cast was taken of the left foot. The right foot was frozen, and several sections were made of it, while the left foot was dissected in the usual way. The deformity was slightly more marked in the left foot than in the right, but in both the arch could be restored by manipulation, but could not be maintained without artificial support, the weight of the body being sufficient to reproduce the deformity. From external examination there appeared to be abnormal mobility in all the tarsal joints.

As previously mentioned, Meyer maintains that the inner border of the foot is not increased in length in flat-foot. He endeavours to prove this, not merely by the mode of displacement of the bones, but by actual measurements. He measured five flat feet and six normal ones. The average of the inner borders of the flat feet equalled those of the normal feet, but the outer borders of the former averaged 1 cm. less than the latter. From this he concludes that there is no increase in the inner border, but that the outer border is diminished. There is an obvious fallacy here, for the facts given can be equally, and, I believe, more correctly, explained on the supposition that the normal feet selected were larger than the flat ones. This would account for the greater length of the outer borders of the normal feet, and the equality in the inner borders of the two sets may be attributed to an elongation in the flat-foot specimens. As both feet, in my case, were involved, they cannot be used for comparison; but there is another method by which this point can be determined.

In a paper[1] by Mr C. Hilton Golding-Bird, it is stated that the middle of the inner border of the foot corresponds normally to the first cuneo-metatarsal joint. The inner arch of the foot only extends as far forwards as the head of the first metatarsal bone, so that the greater part of the arch is in the posterior half. If the arch be flattened the posterior half will be more increased by the change than the anterior. Mr Golding-Bird measured a number of cases in the living body, and often found the posterior measurement to exceed the anterior by $\frac{1}{2}$ to $\frac{3}{4}$ of an inch. I have found this guide to the middle of the inner border of the foot to be a tolerably exact one. I examined nine feet very carefully in the dissecting-room, and found that in three of them the anterior and posterior measurements were equal, in two the posterior excess was ·5 cm., in one ·75 cm., and in the remaining three, 1 cm. In the left foot in my possession, the excess of the posterior segment over the anterior was 2 cm. Although the increase in length of the inner border is not so great as it would be were the arch flattened simply by extension in a longitudinal direction, there is still some increase in length. The muscles of the left foot were carefully dissected, but no peculiarity was observed, other than that the short muscles on the inner part of the sole of the foot were atrophied,

1 "Pes valgus acquisitus, Pes pronatus acquisitus, Pes cavus," *Guy's Hospital Reports*, vol. xli., 1883.

and had undergone partial fatty degeneration. This was probably secondary, the result of the pressure of the flattened arch. Professor Sayre (*Orthopædic Surgery*, p. 62) attributes a very important action in the maintenance of the inner arch of the foot to the tibialis anticus, and he gives its partial or complete paralysis as the cause of flat-foot. I could detect no special change in this muscle in either limb. Mr Golding-Bird says that he has failed to find the atrophy of this muscle described by Sayre in any of his cases,—50 in number,—although he methodically looked for it. The peronei muscles were not contracted; but their synovial sheath communicated with the ankle-joint by an opening in the capsule, which readily admitted the index finger.

Ankle-Joint.—The ligaments of this joint were so lax, that before any of them were divided, the tibia could be raised nearly three-quarters of an inch above the astragalus, and the finger could be easily passed through the opening in the capsule already mentioned, between the tibia and astragalus. The only ligament requiring particular notice was the external. Its three fasciculi were not so well defined as usual; the middle one was nearly horizontal, inclining from the os calcis forwards to the fibula. The posterior fasciculus was very rudimentary, its middle and outer parts being almost worn away by the pressure of the fibula against the os calcis. The ligaments of the ankle-joint were divided in order to see the interior of the joint. The normal articular surfaces presented no marked alterations, but additional ones had been produced by the contact of the fibula with the os calcis. The surfaces of these facets were formed by compact osseous tissue. There was a facet on the lower end of the fibula between the depression on its inner surface, and the groove on its posterior surface for the peronei muscles. It was three-quarters of an inch long, and three-eighths of an inch in breadth. Another facet, smaller in size, was found close to the apex of the malleolus. These two facets articulated with two others on the outer surface of the os calcis (see Plate VI.). The external calcaneo-astragaloid ligament was destroyed, and the synovial cavity of the ankle-joint was continuous with that of the posterior calcaneo-astragaloid, and also with the cavity between the abnormal articulations of the fibula and os calcis. Both Meyer and Hueter mention the articulation of the fibula and os calcis as always occurring in cases of advanced flat-foot.

The conditions of the ankle are of interest to the surgeon in connection with Professor A. Ogston's operation.[1]

After the examination of the ankle, and before any of the ligaments of the tarsus proper had been divided, the position of the astragalus in relation to the rest of the tarsus was determined. It is at the talo-tarsal joints that the deformity commences, and it is there that the displacements occur that constitute its most important features.

G. H. von Meyer devotes special attention to the mechanism of the movements of the astragalus. When the sole of the foot is placed upon the ground, and pressure exerted upon the astragalus from above, its body glides forwards upon the os calcis, while the head of the bone sinks downwards and inwards. This movement is described by Von Meyer as occurring round an oblique axis passing from the inner side of the upper surface of the neck of the astragalus to the middle of the lower border of the posterior surface of the os calcis. He shows that the outer border of the trochlear or superior articular surface of the astragalus moves forwards and downwards, while its inner border will perform a smaller movement in the opposite direction. As a consequence of this, the axis of the trochlear surface will incline more inwards—nearer the big toe. By the same movement the trochlear surface will acquire an inclination outwards, for, as we have seen, the outer border moves down, and the inner up. The transverse axis of the trochlear surface, which we may represent by a line connecting its outer and inner borders, must, however, on account of its connection with the bones of the leg, maintain its parallelism with the base. It does this by causing a valgus position of the rest of the tarsus. By an excess of its normal movement, the astragalus becomes displaced towards the inner side of the rest of the foot. An excellent method of representing this has been devised by Von Meyer. He indicates the sole of the foot by a triangle made by uniting three points, viz., the centre of the heel, and the heads of the 1st and 5th metatarsal bones. This triangle, marked *abc*, is drawn in Plate VI. fig. 1; but instead of the

[1] "On Flat-Foot and its Cure by Operation," *Lancet*, 26th January 1884.

middle of the posterior surface of the os calcis, I have taken the posterior point of support, viz., the internal tubercle of the os calcis. Instead of the whole of the astragalus being indicated it is represented by a point. This astragalus point is the highest spot on the axis of its trochlear surface. In Plate VI. it is marked by a cross. According to Meyer, the astragalus point falls, in a normal foot, within the triangle, but in a flat-foot to the inner side of the big toe line, *i.e.*, the line connecting the heel and the head of the first metatarsal bone. The centre of gravity of the loaded astragalus then falls internal to the sole of the foot. From Plate VI., a drawing of the left flat-foot in my possession, it is seen that in that specimen, not simply the astragalus point, but the whole of the trochlear surface, lies internal to the big toe line. In a model foot there can be no doubt but that the centre of gravity of the loaded astragalus ought to fall within this triangle; but in a number of feet I have found it to fall either upon, or even a few millimetres to the tibial side of the big toe line.

In order to compare, by the measurements mentioned above, flat feet with normal ones, von Meyer selected three apparently well-formed feet; two of these he found to have their astragalus points internal to the sole triangle, in one case 1 mm., in the other 6 mm. He therefore classifies them with the flat feet. As feet with undoubtedly well-marked arches may have their astragalus points a few millimetres to the inner side of the big toe line, these cases might more correctly be regarded as possessing a mechanical tendency to the deformity, rather than as examples of slight flat-foot.

The axis of the trochlear surface of the astragalus is directed in my specimen to the inner side of the head of the 1st metatarsal bone, in a normal foot it is generally towards the interval between the 2nd and 3rd toes. In the same specimen the height of the upper surface of the astragalus above the base was 55 mm., it ought naturally to be about 80 mm. to 90 mm.

After the position of the astragalus had been determined it was removed and its surfaces examined. The changes in the shape of the astragalus are practically confined to its head and neck. I have already stated that its articular facets belonging to the ankle-joint are practically normal, and the same is the case with its surfaces entering into the formation of the calcaneo-astragaloid joint. The only part of the body which is altered is its lower and outer angle. This lies just in front of its large concave facet. It is called, by von Meyer, the processus fibularis of the astragalus. When the astragalus is overpronated this process is pushed down into the depression on the upper surface of the greater or anterior process of the os calcis. According to Hueter, the depression becomes deepened and the process rounded. In this specimen the process was only slightly altered, but I noticed a facet on its anterior surface covered by articular cartilage. This facet came in contact with the outer part of the interosseous calcaneo-astragaloid ligament which separated it from the os calcis. On examining a number of recent bones I found that this cartilaginous facet is generally present, and that it articulates in the prone position with the interosseous ligament. This facet is about 5 mm. in height and about 15 mm. to 20 mm. in breadth. Its cartilage is continuous with that on the large concave facet, but the two surfaces are separated by a prominent border. So far as I know this facet has not been previously described, although it has a functional significance. When the astragalus is pressed upon from above, the descent of the body of the astragalus upon the os calcis is checked by the contact of this surface with the interosseous ligament.

Although the changes in the body of the astragalus are slight, those of the head are very decided. The outer and upper part of the head of the astragalus, in consequence of its displacement, is pushed against the scaphoid, and an abnormal facet formed. It is concave, somewhat round, and about 2 cm. in diameter. As a result of the pressure of the displaced bones the outer part of its neck is much shortened, and the upper part of the cartilaginous facet for the scaphoid is worn away. The cartilage covering the surfaces that articulate with the scaphoid and sustentaculum tali was normal, but that connected with the inferior calcaneo-scaphoid ligament was thickened, softened, and in a few places it was completely destroyed, and the subjacent bone was in a condition of porosis. This surface was undoubtedly larger than normal, and the inflamed condition may be attributed to the irritation resulting from pressure against the ground in standing or walking.

A. Ogston states that, in some cases, a prominent angle is formed on the head of the bone between this ligament and the scaphoid, which interferes with the restoration of the arch.

In Plate VI. fig. 2, a drawing is given of the dorsal aspect of the foot after removal of the astragalus. If this be compared with the appearances in a healthy foot, the changes in the os calcis, scaphoid, and inferior calcaneo-scaphoid ligament are very evident.

Os calcis.—This bone is altered in position in several respects. Its long axis is directed more towards the big toe than is usually the case, and its anterior end is lowered, so that the anterior tubercle rests upon the base. Still more marked is its rotation inwards. The valgus position of the os calcis can readily be seen either from above or from behind. In the view of the posterior surface the os calcis was seen to rest upon the internal tubercle, the external being raised above it so that a line connecting the two tubercles formed with the base an angle of 35° open to the outside. Professor von Meyer seems to consider that in a normal foot the external tubercle is rather lower than the internal one. He gives measurements, taken as above, of one normal foot and four flat feet. In the normal foot he found the tubercle line to form with the base an angle of 1° open to the inside. In the flat feet the average angle was 29°·5 open to the outside. In one of the flat feet the angle was 43°, so that in the latter case the difference between it and the normal would be 44°. I think these measurements exaggerate the degree of valgus of the os calcis, as in the feet I have examined, with the leg vertical, I always found that the internal was the lower of the two tubercles, and consequently there was an angle opened to the outside. There can be no doubt but that this angle is increased in flat-foot, but the deviation from the normal is not so extensive as given by Von Meyer. In looking at the bone from above, the larger articular facet looks more inwards than normal, and the sustentaculum tali is much nearer the base.

The changes in the position of the os calcis are more marked than those of its shape. I have already referred to the facets formed upon its outer surface, which articulate with the fibula. In my specimen the cartilage covering the facet on the anterior process of the os calcis had been completely destroyed, and the exposed bone was soft and spongy. A rough ridge was developed on the anterior part of the upper surface, which projected nearly three-quarters of an inch above the level of the cuboid, and its anterior edge somewhat overlapped it.

According to Hueter, the sustentaculum tali is much lower in relation to the body of the bone at birth than in the adult. By the prone position of the foot, this process is relieved of pressure, and grows upwards into a higher position in relation to the rest of the bone. Flat-foot, being an excessive pronation of the sustentaculum tali, grows still higher than its normal adult position. At page 1088, of his *Grundriss der Chirurgie*, he gives a view of the inner surface of the os calcis of a new-born child and of an adult. I cannot agree with these statements of Hueter, having satisfied myself, from an examination of the os calcis in newly-born children, that the sustentaculum tali has then practically the same relative height to the body of the bone that it has in the adult. Of course if the bone be rotated inwards the sustentaculum tali will be depressed. This is what has been done in Hueter's drawing of the infant's os calcis. If it be compared with his drawing of the adult bone, it will be at once apparent that in the former the bone has been rotated inwards, as much more of the upper surface of the body of the bone is shown in it than in the adult specimen. Again, in neither of my specimens of flat-foot is the sustentaculum tali higher in relation to the rest of the bone than in an ordinary adult.

Scaphoid.—This bone had no distinct alteration in its shape except the presence of a facet for articulation with one already described on the head of the astragalus. The pressure of the astragalus had worn away the upper part of the cartilaginous facet for articulation with the head of the astragalus, and also part of the upper surface of the scaphoid.

Inferior Calcaneo-Scaphoid Ligament.—This is generally described as being increased in length, and indeed this is often regarded as one of the principal causes of the descent of the head of the astragalus. As I have already stated, Von Meyer asserts that it is not increased in length. He measured it in six normal feet and five flat feet. In the former it varied from 27 mm. to 37 mm., in the latter from 27 mm. to 40 mm., from which it appears that the difference was very slight.

Professor von Meyer's plan for measuring it is not, I believe, a very satisfactory one. He measured it on the plantar surface from the most anterior part of the sustentaculum tali to the highest point on the tuberosity of the scaphoid. The question can easily be settled by an examination of the ligament from above, although, from the sustentaculum tali being placed obliquely in relation to the scaphoid, it is difficult to find a satisfactory point to measure from. If this surface of the ligament be examined it will be seen to be strengthened by fibres running from the sustentaculum tali, at the juncture of the facet on its upper surface with that on the upper surface of the greater process, forwards and outwards to the outer part of the under surface of the scaphoid. Measuring, in this situation, from the sustentaculum tali to the scaphoid, I found that in two normal feet the distance was 19 mm., in another, 22 mm., while in the left flat foot it was 35 mm. Independent of measurements the general increase in size of the ligament is quite apparent; at the same time this increase affects the inner much more than the lower part of the ligament.

The changes in the anterior part of the foot were much less marked than those already described in connection with the posterior part. The scaphoid, internal cuneiform, and first metatarsal bones rested upon the ground. On opening the calcaneo-cuboid joint the under surface of the rough ridge on the os calcis, overlapping the cuboid, was found to be smooth, and to articulate with the cuboid. The transverse arch, formed by the three cuneiforms and the cuboid, was diminished.

Although the bones forming the inner arch of the foot rested upon the ground, the outer border of the foot was not raised, so that the term flat-foot or pes planus is a very appropriate one for this condition.

The first step in this deformity is an over-pronation of the astragalus. This movement is checked by a number of powerful ligaments, especially the interosseous calcaneo-astragaloid, inferior calcaneo-scaphoid, internal calcaneo-astragaloid, and internal lateral ligament of ankle. In a well-developed foot, in which the muscles had been dissected, but the ligaments still entire, I divided the inferior calcaneo-scaphoid ligament and made firm pressure, through the tibia, upon the astragalus. This failed to produce any abnormal displacement of the astragalus. I then divided in the same foot the interosseous calcaneo-astragaloid ligament with a similar result. Cases have been recorded of flat-foot resulting from a wound on the inner part of the foot, dividing the inferior calcaneo-scaphoid ligament and tibialis posticus muscle. In such cases the ligaments remaining entire will be subject to extra strain, and flat-foot will gradually result from their relaxation.

EXPLANATION OF PLATE VI.

Fig. 1. View of the dorsum of the foot in a specimen of flat-foot to show displacement of astragalus. Lines connecting *a*, *b*, *c*, form triangle representing sole of foot. The cross on astragalus represents "astragalus point," *d* and *e* the facets on outer surface of os calcis.

Fig. 2. View of the dorsum of the same foot after removal of astragalus. *a*, sustentaculum tali; *b*, inferior calcaneo-scaphoid ligament, *c*, posterior surface of scaphoid; *d* and *e*, same as before; *f*, abnormal facet on scaphoid.

A NEW METHOD OF CUTTING SECTIONS FOR MICROSCOPICAL EXAMINATION. By JAMES W. BARRETT, M.B., M.R.C.S., *Demonstrator of Physiology at King's College, London.*

THE method of cutting sections here described, has but recently been introduced into this country; it is known as the "Celloidin method," and was first adopted for preparing extensive sections of eyes, with the parts *in situ*. Comprehending its great advantages over the ordinary methods, I have extended its use to all solid organs and tissues (pathological and histological), which require it, and believe that, where either *moderately thin and very extensive*, or *very thin and moderately* extensive sections are required, it will supersede the methods usually employed. With either object in view the preliminary process is as follows: —"The fresh tissue, suitably divided in the usual way, is hardened in Müller's fluid for from three to four weeks, the fluid being changed almost every day at first, then every two or three days, and subsequently at an interval of a week. It is then hardened in methylated alcohol for about a fortnight, and is finally transferred for a day or two to absolute alcohol. It is next placed in a *thin* solution of celloidin in equal parts of absolute alcohol and ether, and left there for a few days." (Celloidin in the solid form, or in solution, may be obtained from Zimmerman, Mincing Lane, London, E.C.)

If the very thin sections be required, the pieces put into the solution should be small. If the extensive sections are required the pieces should be of the required size and very thin, so as to allow the celloidin solution to penetrate easily.

They are next removed and placed in paper boats, which are then filled with this solution and are exposed to the air. When the ether and alcohol have been allowed to evaporate for some time, a crust forms on the surface. The boats are then immersed in a mixture of methylated alcohol andwater, the specific gravity of which should be, it is said ·820. As a matter of fact, any approximate mixture will answer equally well. They are left floating in this mixture for about three days, when the celloidin becomes very solid though elastic, and firmly imbeds the specimens.

They are now ready for cutting, but before describing the method of cutting, it is necessary to point out, that although other means may be found equally efficacious in effecting this preliminary process, yet that a careful attention to the most minute details will prevent much disappointment, until the worker is thoroughly conversant with the method.

It will be seen that the whole object is to infiltrate the tissue with a very coherent transparent material, which will not interfere in any way with the manipulation of the specimen after it is cut, and will permit either of very thin or of very extensive sections being obtained. I think every one will agree that by the ordinary gum and freezing method both these results are in most cases difficult to attain with any degree of certainty.

In order *to cut very thin and moderately extensive sections* the paper is torn from the boats, the superfluous celloidin is removed from the specimen, which is then placed in water for twenty-four hours, the water being changed frequently. It is next put into the ordinary freezing gum for a little while, and is then frozen and cut into sections by any of the ordinary freezing microtomes.

One point deserves attention. The specimen, when frozen, becomes very hard, and if the axis of movement of the knife is at right angles to its long dimension, the specimen will in all probability be uneven and wrinkled. The knife should be directed as obliquely as possible, otherwise the result often disappoints. The specimens are removed from the knife with a brush moistened in warm water and are then placed in water. If they are crumpled, they had better be transferred from the water to spirit and from spirit back to water; this little manœuvre, which lasts less than a minute, rarely fails to unfold them. They are next stained with any of the stains that are preferred, and are subsequently dehydrated *very carefully and thoroughly*. Ultimately they are placed in oil of Bergamot in order to clear them. Oil of cloves dissolves the celloidin, and the sections then usually fall to pieces.

After clearing, which is rapidly effected if the dehydration has been perfect, they are placed on a slide and are mounted in balsam. Oil of Bergamot does very well for clearing, but I am not sure yet whether any of the other essential oils are superior to it.

The preparation of *very extensive and moderately thin sections* can be effected by special microtomes obtainable from H. Katsch, of 25 Bayerstrasse, Munich, by which sections from 3 to 16 cm. in diameter can be prepared. The machines are so arranged that a long knife works with an oblique action and cuts the sections under methylated spirit. In preparing the specimen for cutting, the paper is removed from the boat in which it is contained, and it is then attached to a plate sunk in a trough full of spirit. The plate is raised by a screw, and so the thickness of the section is regulated. This method is of especial value for cutting sections of eyes, the parts being maintained in perfect position.

It would be injudicious to make any absolute statements as to the value of these methods, since there may be faults which I have not discovered, but it is my opinion at present that the method must come into general use and supersede the ordinary methods of section cutting. The chief obstacle at present is its expense. Celloidin itself is, when in the solid form, a firm white material, which can be dissolved in absolute alcohol, or in ether, or more rapidly in a mixture of the two. It is insoluble in water, and in mixtures of spirit and water. In effecting the dehydration of the sections, methylated alcohol (which is not absolute) should therefore be used.

In conclusion, I would recommend very strongly that any one who works with this material should for a time follow the directions given, or they will, like myself, at first be greatly disappointed. I should add, too, that Dr Hebb of the Westminster Hospital was kind enough to give me some very valuable assistance in the matter, which greatly aided me when I began to work at this method.

A NEW METHOD OF DEMONSTRATING SCHEINER'S EXPERIMENT. By JAMES W. BARRETT, M.B., M.R.C.S., *Demonstrator of Physiology at King's College, London.*

IT has frequently been noticed that the cause of the comparatively rare cases of monocular diplopia is some more or less linear opacity in the refracting media of the eye, which divides the aperture into two parts. If then the refraction of the eye be at fault, and the ciliary muscle be incompetent to correct it, diplopia results. In the case which came under my observation, the patient, who had a corneal opacity, about 6 mm. × 2 mm. was having his refraction tested by retinoscopy, the pupil being dilated and the ciliary muscle paralysed with homatropine. The opacity was oval in shape, and stretched obliquely across the cornea so as to partially divide the visible pupil into two parts. On placing a negative glass (− 5 D) in front of his eye he was rendered artificially hypermetropic, and his ciliary muscle being paralysed he was unable to correct it. The rays of light, being thus admitted into a hypermetropic eye by two apertures, did not meet on the retina, consequently two images were formed, and diplopia resulted. This may be regarded either as a demonstration of the artificial production of monocular diplopia or of Scheiner's experiment.

AN ABNORMAL DISPOSITION OF THE COLON. By R. BRUCE YOUNG, M.A. M.B., *Demonstrator of Anatomy, Glasgow University.*

THE following observations were made in the dissecting-room of Glasgow University, the subject was a middle aged female :—

Description.—On opening the abdomen the coils of the small intestine were found lying on the right side, while the cæcum was situated in the left iliac fossa. From the cæcum the great intestine ascended on the left side of the middle line, bound down to the posterior wall of the abdomen, and lying at first alongside of and immediately internal to the lower part of the descending colon. As it passed upwards, however, the ascending crossed in front, and then lay to the left of the descending portion of the colon, which, with the sigmoid flexure and the rectum, occupied the normal position. These two portions of the colon—ascending and descending—as they lay alongside of one another, were closely bound together by membranous adhesion. The continuity of the two parts of the colon in the left hyphochondrium could not be made out in the undissected state, owing to the presence of a thin membrane which completely shut off from view the upper part of the abdomen—this membrane being reflected from the posterior wall of the abdomen and from the surface of the ascending and descending parts of the colon to be attached to the anterior abdominal wall in a line corresponding with the lower margin of the costal cartilages on the left, and of the liver as far as the gall bladder on the right side. Where the membrane was reflected from the surface of the ascending part of the colon, it projected downwards in two pointed folds, one on each side of the intestine. This membrane, passing across the upper part of the abdomen, concealed not only the continuity of the course of the colon, but also the stomach and the beginning of the duodenum, the spleen, and the left portion of the liver. By means of a subsequent dissection, made by dividing the membrane from below and the left part of the diaphragm from above, the abrupt curve, in the region of the spleen, by which the ascending passed into the descending portion of colon was seen, and thus the whole extent of the great intestine, consisting of ascending and descending parts, sigmoid flexure and rectum, could be traced as it lay entirely on the left side of the abdomen. The transverse diameter of the ascending part measured $2\frac{3}{4}$ inches, being almost twice as great as that of the descending part. The whole length of the great intestine was 3 feet $7\frac{1}{2}$ inches.

The œsophageal end of the stomach lay directly in front of the aorta, and from it the stomach curved downwards to the left and then inwards again to its pyloric end, which did not cross the middle line, but lay over the aorta just above the point from which the inferior mesenteric artery was given off. Thus the œsophageal and pyloric ends of the stomach were situated in one vertical line, the stomach being entirely confined to the left side. A vertical distance of three inches separated the œsophageal and pyloric ends of the stomach.

The anterior surface of the stomach was attached by numerous bands of adhesion to the under surface of the left half of the diaphragm, while posteriorly the lesser sac of the peritoneum and the foramen of Winslow were obliterated by adhesions, which bound the posterior surface of the stomach to the abdominal wall. The layers of peritoneum, passing from the anterior and posterior aspects of the stomach, were continuous with the membrane which shut off the upper part of the abdominal cavity. So that this membrane was probably the great omentum adherent to the anterior wall of the abdomen.

The liver was firmly bound by adhesions to the under surface of the diaphragm. The duodenum, in its course from the pyloric end of the stomach, passed to the right, closely bound to the under surface of the liver, making a curve forwards round the fundus of the gall bladder, to which it was also adherent. Extending downwards from the inner side and apex of this curve of the duodenum, in the vertical antero-posterior plane, was a membranous layer, about two inches broad and one inch long, which lay two inches to the right of the middle line of the abdomen, and was attached below to the upper surface of the mesentery. There was thus a continuity of adhesion at this point between liver, duodenum, and upper surface of mesentery —a fact which, as will be seen, bears most importantly on the explanation of the present abnormality.

After curving round the gall bladder the duodenum ran upwards and backwards, and then turned inwards to its junction with the jejunum, close by the right side of the vertebral column about two inches below the origin of the superior mesenteric artery. A band of fibres tightly stretched was found extending fron the point of union of the duodenum and jejunum obliquely upwards across the aorta to the connective tissue around the cœliac axis on the left side — the musculus suspensorius duodeni.[1]

From this point the small intestine was traced downwards on the right side close to the middle line, as far as the upper part of the right iliac fossa, from which it ascended in the right lumbar region to the anterior surface of the lower end of the right kidney. In the whole of this part of its course the small intestine and its mesenteric attachment were bound down to the posterior abdominal wall by adhesions, but the remainder of the small intestine, as far as its junction with the colon in the left iliac fossa, lay, free from adhesions, in the fold of the mesentery, whose line of attachment to the posterior wall of the abdomen ran from the region of the kidney on the right side obliquely downwards across the middle line to the left iliac fossa. The small intestine measured 20 feet 5 inches in length.

The pancreas in its undisturbed position crossed over the origin of the superior mesenteric artery, and lay with its head in the concavity of the curve made by the duodenum round the gall

[1] Treitz, *Vierteljahrschrift für die practische Heilkunde*, Prag. 1853, Bd. i., S. 113, quoted by Luschka, *Anatomie des Menschen*, vol. ii., p. 207. Quain, 7th edit., p. 840. Cruveilhier, *Anatomie Descriptive*, vol. ii. p. 132. This band, as Professor Cleland is in the habit of pointing out in his lectures, seems to have more importance than is usually attributed to it, for it is owing to its agency that the lower end of the duodenum always retains a fixed position, no matter how much the rest of the duodenal curve may be displaced. The duodenum may curve downwards even as far as the right iliac fossa, and yet its junction with the jejunum is always on the left side of the superior mesenteric artery, beneath the transverse mesocolon, and in the last inch or so of its course it is always vertical, owing to the suspension of this part of the small intestine by the musculus suspensorius duodeni. The usual description of the duodenum, as consisting of superior, descending, and transverse portions is incorrect, in that it makes no mention of this terminal vertical portion, and thus fails to note the manner in which the musculus suspensorius duodeni acts on this part of the intestine.

bladder. Owing, however, to the depressed position of the pylorus the pancreas was on a higher level than the pylorus.

On dissecting out the vessels the superior mesenteric artery was found coming off below the cœliac axis, but, passing in the upper part of its course to the right instead of to the left of the aorta, it ran downwards to supply the whole of the small intestine except 3 feet 10 inches at the lower end. Instead of giving off a number of separate branches to the small intestine, this artery divided into three large branches. Two of these, to the upper part of the small intestine, were given off from the right side of the parent trunk, while the third, the terminal branch, was distributed to the greater part of the bowel supplied by the superior mesenteric artery.

The inferior mesenteric artery, just at its origin from the aorta, turned sharply across to the right, and then passed in a gentle curve downwards to the left, to supply the lower 3 feet 10 inches of the small intestine, which did not receive branches from the superior mesenteric. From the left side of the inferior mesenteric artery, 2 inches from its origin, a small branch was given off, which extended across the middle line, and bifurcated to supply the ascending and descending portions of the colon. A common trunk, springing from the aorta immediately beneath the origin of the inferior mesenteric, gave off the sigmoid and superior hæmorrhoidal branches, and from the left side of the aorta at the same level an accessory renal artery passed to the left kidney.

The inferior mesenteric vein crossed the middle line obliquely, just above the origin of the inferior mesenteric artery, to join the superior mesenteric vein, which accompanied its artery, at a point an inch before the communication of the superior mesenteric and splenic veins.

Causation of the Preceding Abnormalities.—The most prominent features of this case were the position of the large intestine, consisting only of an ascending and descending portion, in the left side of the abdominal cavity; its length, 3 feet 7 inches; and the displacement of the junction of the duodenum and the jejunum to the right side of the aorta. The displacement to the left, and arrest in growth of the large intestine, are two facts which, though intimately related, must be distinguished from one another. In publications on this subject several cases are recorded, in which the large intestine has been found on the left side of the abdomen. Some of these are referred to by Mr Lockwood in his paper "On Abnormalities of the Cæcum and Colon with reference to Development" (*Brit. Med. Journal*, 1882, vol. ii. p. 574), in which there is a full account of the literature of this subject. Dr John Reid describes two such cases (*Edin. Med. and Surg. Jour.*, vol. xlvi., 1836, p. 70), but in both of these cases the cæcum lay in the left lumbar region, and the course of the large intestine seems to have been more complicated than in the present, while in a case reported by Dr Hilton Fagge (*Guy's Hospital Reports*, p. 345, Case 57), where the large intestine was on the left side, the cæcum was situated in the pelvis. Sir James Y. Simpson noted a case (*Edin. Med. and Surg. Jour.* 1839, vol. lii. p. 26), in which the whole of the large intestine lay to the left side, which case seems more nearly than the others to have resembled the present, though differing slightly, in that the ascending colon was nearer the middle line, and that the cæcum was retained by adhesions, which bound it to the lining membrane of the pelvis. In the cases reported by Dr Reid and Dr Fagge no explanation of the peculiar position of the intestine is offered, but Sir James Simpson points to the probability of the bands of adhesion having been the cause of the displacement in his case, though he admits that there is no positive proof that these adhesions "were formed at such an age as would have enabled them mechanically to effect the displacement of the caput cæcum." He, however, gives his opinion in favour of the view that peritonitis in the fœtus is a common cause of abnormalities in the development of the intestines, and later writers, *e.g.*, Professor Turner (*Edin. Med. Jour.*, 1863, p. 113) and Mr Lockwood (*loc. cit.*) agree with him on this point. The difficulty in explaining cases of this sort seems to have been to prove that adhesions, when present, were due to peritonitis in the fœtus, and not the result of a later inflammatory process, while in cases in which no evidence at all of inflammation has been seen the cause of the displacement has been further, if not absolutely, obscured. Yet it must not be supposed that the absence of all appearance of peritonitic adhesions and false membranes in the adult is a proof that there has been no previous inflammatory process, for, as Professor

Turner points out (*loc. cit.*), the observations of other pathologists have since confirmed the view put forward by Sir James Simpson, when he asks (*loc. cit.*) whether the absence of the adhesions, which led to the visceral displacement in the early fœtus, may not in some cases depend upon their absorption during the intervening period.

In the present case, however, the results of inflammation are abundantly evident in the adhesions which exist between the stomach, liver, intestines, and the abdominal walls, as well as between the different parts of the intestines themselves—so that the only question here is, whether these adhesions existed during fœtal life in a position which would so affect development as to produce the individual abnormalities described.

Before proceeding to explain these abnormalities, it may be of advantage to note what the normal course of development of the intestines is. This has been described by Professor Flower (*Med. Times and Gazette*, 1872, vol. i. p. 291), and also by Professor Cleland in several of his papers (*Journ. Anat., and Phys.*, May 1868, May 1870, April 1883). These writers show that at an early period the alimentary tube is a mesial structure with a long loop projecting out at the umbilicus. The two ends of this primary loop are united by a narrow neck of mesentery, in which lies the trunk of the superior mesenteric artery, which is the artery of the loop. The upper end of this loop is at the pylorus, and from it the duodenum is formed, while from the lower end, at a later stage, the right half of the transverse and the whole of the ascending colon are formed by a process of elongation. The growth of this primary loop, therefore, takes place in two stages, the first a growth which, starting near the pylorus, forms the duodenum and elongates the whole small intestine, the second a growth from the colic end of the loop. When these two elongations from the upper and lower ends of the primary loop take place, the direction of growth is in opposite directions in the two instances. In consequence of this, and owing to the narrowness of the neck of the primary loop of intestine, a crossing of the cæcum over the duodenum occurs, and thus after a time the cæcum comes to occupy its adult position. The non-occurrence of this twisting of the cæcum over the duodenum would therefore lead to marked changes in the development and adult position of the intestines. Professor Cleland points out that, in addition to the primary, there are, in the developing alimentary canal, two secondary loops, one formed by the stomach above, and the other by the left half of the transverse and the descending colon below the primary loop. The arrangement of the vessels supplying the primitive alimentary tube corresponds with this separation of the intestine into three loops, the superior mesenteric artery going to the primary, the cœliac axis to the upper secondary, and the inferior mesenteric to the lower secondary loop, so that there are three loops or portions of the intestinal canal—a superior mesenteric, a cœliac, and an inferior mesenteric.

In the description of the present case, I pointed out that the mass of small intestine lay in the right side of the abdominal cavity, and that its upper part, where the duodenum joins the jejunum, was on the right side of the aorta, while the musculus suspensorius duodeni was tightly stretched across the aorta, indicating that some force had come into play, in order to effect this change in position of a part of the intestine which is normally situated to the left of the aorta. I also described the superior mesenteric artery as lying at its origin to the right instead of to the left of the aorta, and its branches to the small intestine, all coming off from the right instead of the left of the parent trunk. A similar arrangement of the superior mesenteric branches to the small intestine has been noted by Dr John Reid (*loc. cit.*), and also by Professor Chiene (*Journ. Anat. and Phys.*, 1868, p. 15).

The position of the point of junction of the duodenum with the jejunum, and of the upper part of the superior mesenteric artery on the right side of the aorta, prove that the cause which effected this change from the normal must have come into play in the young fœtus, for, from a very early date in development, these two portions of the intestine and its artery respectively occupy a constant position on the left of the aorta, however indefinite the situation of the free coils of the intestine or the distribution of its artery may be. As further proof of the early date at which changes in development took place, the circumstance that the stomach was situated entirely to the left of the middle line, leaves little room for doubt that the adhesions which were found in the adult fixing it in that position had been formed at a period of fœtal life before the pylorus had passed to the right side to reach its normal adult situation, and thus the stomach was retained altogether on the left side of the abdomen

An examination of the abdominal viscera in a fœtus about one and a half inches in length from the vertex to the coccyx affords strong proof in favour of this view, for there the stomach is found lying to the left of the mesial plane, with the folds of the great omentum hanging loosely from its inferior border, so that it is easy to understand how adhesion, as the result of fœtal peritonitis, might take place between the folds of the great omentum and the anterior wall of the abdomen on the left side, and thus the developing stomach would in the adult continue in the position which it occupied in the fœtus at the time when the inflammatory process occurred. The layers of the great omentum, adhering to the anterior wall of the abdomen, would form a membranous partition, shutting off the upper portion of the abdominal cavity, which partition persisting during growth explains the appearances here noted in the adult. During normal development, the crossing of the colon over the upper end of the primary loop, as the cæcum passes to reach its ultimate position in the right iliac fossa, causes the small intestine to occupy partly the left side in the abdomen. Bearing, then, in mind the facts noted above, as regards the early date at which developmental changes must have taken place in the present case, and finding that the small intestine as well as its vessels are placed altogether to the right of the middle line, and that the large intestine, on the other hand, is wholly confined to the left, and only measures 3 feet 7½ inches in length as compared with the normal 5 or 6 feet, it seems fair enough to assume that a change in the course of the large intestine must have taken place at a very early period in fœtal life, before, in fact, the large had completed its twist over the small intestine. Thus the coils of the small intestine, occupying the right side of the abdominal cavity, would in the course of growth act on the point of junction of the duodenum and the jejunum, so as to drag it towards the right side of the aorta, and put on the stretch the fibres of the musculus suspensorius duodeni, while the course of the vessels was correspondingly altered to the right side.

This non-occurrence of the twist of the colon over the duodenum is a point of the greatest importance, not only in that an explanation is thus afforded of the abnormalities in the present instance, but also because of the wide bearing that it seems to have in connection with abnormalities of the colon in general.

In the fœtus already referred to, the stomach and intestines of which are above described, the cæcum is situated a little to the right of the middle line of the abdomen, having just passed to the right between the pylorus and the coils of the small intestine,—so that it is evident that a band of false membrane, passing in the vertical antero-posterior plane from the curve of the duodenum to the upper surface of the mesentery, would have prevented this passage of the cæcum to the right from taking place. Such a band of false membrane has been described in the present case. That it was developed as the result of a peritonitis occurring in the fœtus, and formed an obstacle which prevented the twist taking place, so altering the course of the large intestine, is I think highly probable, not only because the date of the occurrence of the change in direction of the large intestine can thus be fixed to a time which is in harmony with the evidence on that point afforded by the other facts of the case, but because the explanation thus afforded of this primary alteration in the course of the large intestine enables us also to understand how the displacement occurred which resulted in the adult position of the portions of the large intestine. For if this band, passing from the duodenum to the mesentery, did check the progress towards the right, and passage over the duodenum of the cæcum and the developing colon, it follows that the further growth of the large intestine would cause the cæcum to glide downwards to the left of the coils of the small intestine, dragging with it the upper part of the inferior mesenteric loop of intestine, and the lower part of the small intestine, till the cæcum reached its adult position in the left iliac fossa, and the angle between the two portions of the inferior mesenteric loop being obliterated they came to lie side by side in the left half of the abdomen;

the greatly diminished length of the large intestine being thus in great measure due to the alteration in its normal course of development.

The two pointed folds which have been described as passing down, one on each side of the upper part of the ascending portion of the colon, from the undersurface of the adherent great omentum, are projections of peritoneum which have resulted from obliteration of the angle at the splenic flexure as the displacement of the colon took place.

Adhesions have been described between the two portions of the colon. These adhesions, if they occurred, as probably they did, at the same early date as the others, may, by binding the two portions of the colon together, have formed a secondary factor in determining, along with the inherent force of growth, the course of the cæcum towards the left iliac fossa. They also, no doubt, acted along with the displacement in preventing the growth of the colon.

I have already alluded to the position of the superior mesenteric artery and its branches, as proof of the early date at which changes must have taken place here. In the course and distribution of the inferior mesenteric we have, I think, still further confirmation of the view which has been taken of the date and manner of occurrence of the alteration in the course of development of the colon, and of its subsequent displacement. The peculiarity in the distribution of the inferior mesenteric artery was, that besides giving branches to the ascending and descending portions of the colon it supplied 3 feet 10 inches of the lower part of the small intestine. Now, supposing the change in course of the developing colon to have taken place at a stage of growth slightly earlier than that described in the fœtus which was examined, when only the inferior mesenteric loop of intestine, and none of the ascending or left half of the transverse colon, had as yet been developed, the right and middle colic branches of the superior mesenteric artery, which supply the ascending and right half of the transverse colon, could not yet have been developed, while the inferior mesenteric artery, with its branch which ascends to anastomose with the superior mesenteric, would be relatively perfect. So that, when the change in the course of development took place, and the cæcum, with the end of the small intestine, passed down to the left iliac fossa, the lower portion of this small intestine would naturally come to receive most of its blood supply from the nearest source, viz., the inferior mesenteric, and, by enlargement of capillaries and arterioles, there would result the adult condition of a large branch of the inferior mesenteric for the lower part of the small intestine. The bend of the inferior mesenteric on itself at is origin is thus explained by the sudden downward displacement of the colon, which occurred after the primary arrest of the twist of the intestines, while the curve of the artery to the right may be accounted for by the mass of the small intestine on the right side acting on the developing vessel. The small size of the branch which supplied the two portions of the colon must be taken in connection with the great diminution in length of the large intestine.

Again, by the fact of the sigmoid and superior hæmorrhoidal branches being given off by a separate common trunk from the aorta, and by the presence on the left side of an accessory renal artery, further evidence is afforded of disturbance at an early period of the normal development of vessels.

This case then seems to have been one in which a peritonitis occurring in the early fœtus led to the formation of adhesions and false membranes in various parts of the abdominal cavity. As a result of these formative changes following an inflammatory process, arrest of the twist of the large over the small intestine, and subsequent displacement of the colon, followed by transposition of the small intestine to the right side, as well as retention of the stomach in its fœtal position, and various changes in the course and distribution of the intestinal vessels took place.

The chief point of interest in this case are (1) the persistence, in the adult, of the adhesions, which in fœtal life gave rise to the abnormal disposition of the viscera, and (2) the non-occurrence of the twist in the developing intestine—a pathological fact, which, beyond the present instance, seems to be of importance in the causation of many abnormalities of the colon.

I wish to offer my heartiest thanks to Professor Cleland for his kind assistance in preparing this paper.

ON THE DELINEATION OF SKULLS BY COMPOSITE PHOTOGRAPHY.

By ÅRTHUR THOMSON, M.B., *Senior Demonstrator of Anatomy, University of Edinburgh.*
(PLATE VII.)

HITHERTO, in the study of Craniology one of the greatest difficulties has been to obtain a skull of the race under examination, embodying all the peculiarities characteristic of the crania of that race, without at the same time giving undue prominence to personal or individual variations. Numerous methods have been employed to arrive at such a result, long and elaborate tables of measurements have been published, from which averages have been deduced, and indices adopted for the purposes of comparison. This arrangement is of much scientific value, but it must be confessed affords little information to those not versed in this department of science.

Whilst by no means depreciating the value of these measurements, I consider that a graphic method of comparison is at least the one which appeals most forcibly to the uninitiated, and which, in addition, presents certain other novel features worthy of note. That the value of a graphic method of comparison of crania has long been recognised, is fully proved by the existence of numerous instruments specially designed to enable the observer to make an outline plan or chart of the skull which he is examining; subsequently this chart may be made use of to measure certain angles or compare the distances between certain points,—of such a nature are the craniograph and stereograph of Broca, which are amongst the instruments most frequently employed for this purpose. Another and more direct manner of obtaining outlines of skulls is to make use of tracings taken from sections of the cranium, the vertical mesial section being the one usually adopted. This plan answers well to enable us to compare many important features, but is open to the objection that it necessitates division of the skull, liberty for doing which we unfortunately cannot always obtain.

The drawings obtained by the above or similar methods resemble an architect's plan, in that they are orthogonal projections, that is to say, they are not subservient to the laws of perspective, and hence measurements taken from them may be relied upon as correct.

Photography has not been extensively used in this department, as it has been open to the objection that the representations produced are perspective views of the skulls which have been "taken," and hence, portions of the skull nearer the camera will bear a relatively larger proportion to parts of the skull more distant than they do by actual measurement. This is doubtless true, theoretically, especially when a lens of wide angle and short focus is employed, but, practically, it is reduced to a minimum, and may be disregarded if we adopt the precaution of making use of a lens of long focus. By that means the distance between the object and the camera being greater, the convergence of the rays is less, and hence approaches more nearly to the parallelism of the rays in the orthogonal projection; in other words, if we wish to estimate the proportions of a large pile of buildings, we do not stand close to it, in which position we would fail to form any just conclusion of the relative height of the tower to the rest of the edifice, but, seeking some point at a considerable distance, we obtain a view of the structure bearing a striking resemblance to the architect's elevation of the same.

Again, the photograph has this great advantage over the projections already spoken of, in that, by the portrayal of the alternations of light and shade, it gives us a faithful representation of the surface contours of the skull.

With these remarks in defence and in favour of the means by which I was enabled to obtain the present results, the next difficulty was to procure a graphic type of a series of skulls, and here I must express my thanks to Mr Francis Galton for the suggestions on composite photography published in his work, *Inquiries into Human Faculty and its Development.* Composite photography has, since the publication of this work, been employed by numerous investigators, but, so far as I am aware, it has not hitherto been made use of in this connection.

Though the results which I publish at present are not so complete as I would have desired, yet I think that they are of sufficient interest to warrant attention being drawn to them.

For the purpose of comparison I have produced composite photographs of Australian and European skulls, for the loan of which I am indebted to Professor Turner.

The Australian series consists of the photographs of eight male skulls combined, that of the Europeans being composed of the combination of four French male skulls. As will be seen from the plates, a profile and full-faced view of each series was obtained.

In order to procure these results attention had to be paid to the following points :—The skulls were photographed in a soft diffuse light, so that, as far as possible, strong contrast of light and shade was avoided; this was found necessary, as in the composite printing the thin portion of one negative might obscure or overprint the details exhibited by another in the same situation; next, in taking the full-face views, I required to reduce skulls of different sizes to a common scale. This was accomplished in the following manner :—A *vertical* line was drawn through the centre of the screen of the camera, and on this line two points were marked off, which, as each skull was focussed on the screen, were made to correspond to the fronto-nasal suture and superior alveolar border respectively. By this arrangement the distance between these points in all the skulls was reduced to a common measure, a fact which was taken advantage of in the further operations as a base line on which to key the plates. Whilst focussing, care was taken that the vertical line on the screen overlay the intermaxillary suture inferiorly and the suture between the nasal bones superiorly, as seen upon the ground glass. Care was also taken that equal halves of the skull appeared on either side of this vertical line, and in order to ensure an accurate correspondence of the photographs with each other, it was further necessary to place all the skulls in the same horizontal plane, the plane chosen being that which passes through the lower orbital margin anteriorly, and the upper part of the external auditory meatus posteriorly.

In taking the side views of the crania similar precautions were observed. Unfortunately for reasons connected with the apparatus at my disposal, I was unable to photograph the profile views on exactly the same scale as the full-face views. As the side views of the French and Australian series are reproduced to the same scale, they may be readily compared with each other. In this instance a *horizontal* line was drawn across the screen of the camera, and this line was made to occupy the horizontal plane already spoken of. As the image was focussed, a point was then taken on this line which was made to correspond to the upper part of the external auditory meatus, the line anteriorly passed through the inferior orbital margin, anterior to which another point was taken, to which the free margin of the nasal process of the superior maxilla was made to correspond. In this way a base line was obtained, which was of equal length in all the negatives, and which was made use of in the subsequent stages of the process in a similar manner to the vertical line in the full-face series. I may here state that, in using the terms superior and inferior in regard to the skull, I have disregarded the inversion of the image upon the screen of the camera. I was thus enabled to obtain two negatives of each skull in the series, one a face, the other a side view.

My next object was to procure a graphic type, by combining the negatives of the different series. This was attended with considerable difficulty, and it was only after repeated trials that I adopted the following plan:—The negatives were taken, and lines at right angles to each other were drawn through certain corresponding fixed points on the different plates, the vertical and horizontal lines I have already mentioned being made use of as bases upon which to superimpose the different images. I was thus enabled to key the negatives on to a sensitive plate in the same manner in which a lithographer registers his proof on the stone. By exposing this sensitive plate to light under successive negatives, I obtained a *composite* positive, from which I again printed a glass negative by super-position, from this *composite* negative I was then able to print off any number of silver prints. The plates which accompany this paper are reproduced from the *composite* negative by means of a photo-mechanical process, which, if not securing as perfect a result as the silver print, at least preserves the faithfulness of the original.

A glance at the plates will show that, though the individual skulls of the different series varied much in size, yet when reduced to a common scale they display a remarkable similarity in their contours and modelling. But, in addition to displaying what we may term the typical appearances of the crania of the group, individual variations are also represented, as shown in Plate VII. figs. 2 and 4. In fig. 2 we observe the outline of a skull, the highest point of which is placed higher and more posterior than that of its fellows. Again, in fig. 4 we notice an outline which, from the fronto-nasal suture to the inion, far exceeds that of any of the other crania in the same series,[1] and yet it is worthy to note how remarkably the contour of this line resembles those which lie immediately within it. As individual variations in this figure, we may draw attention to the varying projection of the superciliary arches.

It is hardly necessary to contrast the types of the two series, as the plates speak for themselves, but it may be as well to draw attention to one or two points.

In the full-face views of the Australian and European types, the marked difference in the general contours is at once evident, but in addition the figures also display notable differences in the shape and size of the orbits, as also in the appearance presented by the anterior nares. The difference in build of the malars and superior maxillæ is well shown, and the character of the frontal region well contrasted.

In studying the profile views, it is curious to observe how closely the outlines overlie one another, inferior to a line drawn from the external occipital protuberance to the fronto-nasal suture. The difference of contours in figs. 2 and 4 is evident, and it is interesting to see how straight the outline from mastoid process to external occipital protuberance is in fig. 4, also how this latter point very nearly approaches the maximum occipital point, whereas in fig. 2 the inion lies much anterior to it.

Fig. 4 as contrasted with fig. 2 also shows well the forward thrust of the superior maxillæ with a corresponding elongation of the zygomatic arches whereby the prognathism of the skull is produced.

There is doubtless much room for improvement in the production of these composite prints which experience only will teach

[1] These Australian skulls have been described by Professor Turner in his Report on the Crania of the Challenger Expedition, and profile and full-face views of this skull from the Riverina, N.S.W., are given in plate ii. figs. 1, 2, *Zool. Chall. Exp.*, part xxix., 1884.

us, still I think that already sufficient has been shown to prove the utility of such a method in comparing and contrasting type skulls of the different races.

EXPLANATION OF PLATE VII.

Fig. 1. Composite photograph of four French crania, full-face view.
Fig. 2. Profile of the same.
Fig. 3. Composite photograph of eight Australian crania, full-face view.
Fig. 4. Profile of the same.

[This Plate will appear in the January number of this *Journal.*]

2 Plates now enclosed

Plate VII

FIG. 1.

Artotype. FIG. 2. *J. G. Tunny.*

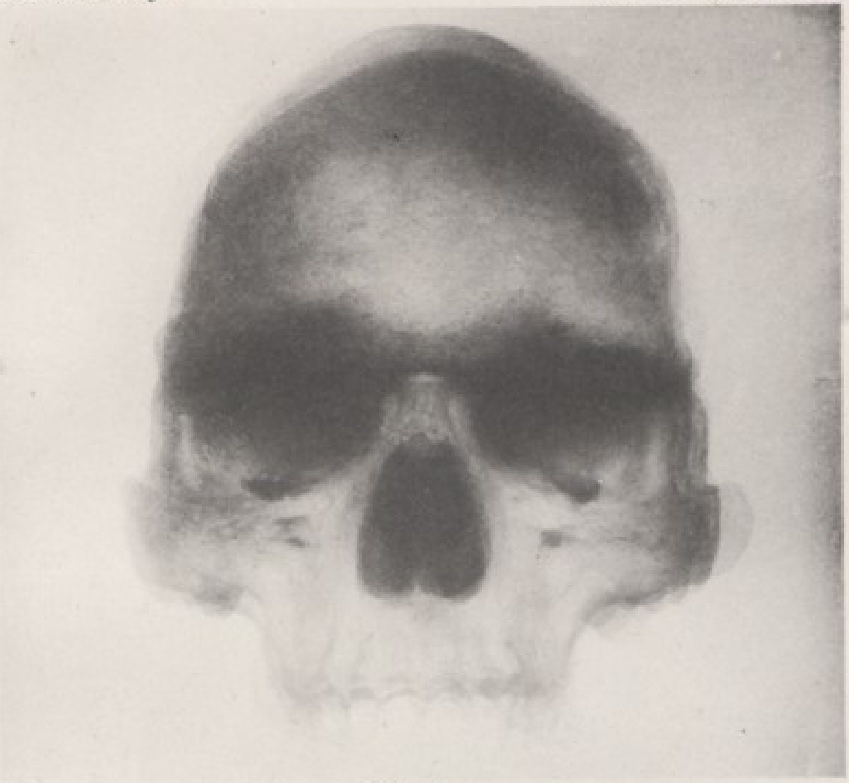


FIG 3.

Artotype. FIG. 4. *J. G. Tunny.*

Plate VII bis

REPAIR OF WOUNDS AND FRACTURES IN AGED PERSONS. By Professor HUMPHRY.

IT will have been observed by others, as well as by myself, that ulcers heal quickly in old persons; and that the processes of granulation and cicatrisation proceed in them, on the whole, with even greater rapidity than they do at earlier periods of life. We see this more especially in the leg, because ulcers are much more frequent in this region than in other parts; but the observation is not confined to them. I have noticed this reparative activity in the aged under many circumstances and in various parts of the body; and, my own experience indicating that the same holds good with regard to wounds and fractures, and that the commonly received opinion to the contrary on this head is erroneous, I ventured, in a note recently printed in the *British Medical Journal*, to ask for information from others, that I might ascertain whether their experience accorded with my own.

My attention was first directed to the subject by the case of a man, aged 88, who consulted me many years ago respecting a warty growth, with some ulceration, on the lower lip, which annoyed him, and which he wished to have removed. I excised a large piece of the lip by the usual V-incision, and the wound healed as rapidly and firmly as any of the kind I ever saw. About the same time, I operated for femoral hernia on a feeble woman, aged 75, and the wound was soundly healed in three days. Several similar cases have come under my own notice, and some have been sent in answer to my inquiry; not so many as I could have wished, but enough to establish the fact of the quick union of wounds in old people.

The statement must be qualified in a manner which savours rather of the paradoxical; namely, that wounds in old people heal quickly, provided they do not slough. That is to say, the apparently opposite tendencies exist at this time of life—namely, the tendency to slough and the tendency to heal quickly. Such, for instance, is the observation of oculists, whose testimony on the subject I have asked. They find that the cornea sometimes sloughs after the operation for cataract in old people; but that, when it does not slough, the wound heals quite as quickly as, or more quickly than, at an earlier time of life. So in other operations. The old person may sink, or the wound may slough or ulcerate; but, if these eventualities are escaped, a quick healing may be expected.

Certainly this would not have been anticipated. We should not have thought that, when the nutritive forces are generally failing, when strength and weight are diminishing, when repair is each year less and less able to keep pace with wear, as evinced, among other things, by the fact that exhaustion is more quickly induced and less quickly recovered from; when the brain is shrinking, and memory and other mental powers are lowering, and when the circulation is becoming weaker,—that, under these circumstances, the nutritive or reparative processes concerned in breach-closing, in the healing of wounds and ulcers, should manifest an increase of energy, at any rate, of rapidity, in carrying on their work. I do not know well how to explain it; but this exceptional phenomenon of nutrition is not pecular to old age. It may be observed in some other lowered conditions. The wounds in patients exhausted by large losses of blood usually heal quickly, as they also do after operations for cancer, and in many other debilitated conditions. I do not mean persons of naturally strumous temperament, but persons who have been weakened by illness or in other ways. So do, commonly, the gaps caused by carbuncles, and bed sores; and very remarkable is the quick healing of the stump left by the separation of the parts in senile gangrene—that is to say, this evidence of vital energy is manifested in the part next above that which was unable to keep alive at all: and, after fracture of the spine, we sometimes see quick sloughing and quick healing in closely adjacent parts. An exception must be made of certain impaired conditions of the nervous system in which wounds and sores are sometimes very troublesome.

The remarks I have made with regard to the repair in wounds and ulcers in old persons hold good also with regard to fractures. This is sufficiently proved by the cases given in reply to my inquiry; and in one of these, it was remarked that the limb in which the fractured tibia and fibula united in three weeks was partially paralysed and nearly useless, the knee being contracted; and in another case, the broken tibia in a most enfeebled helpless woman of 68 was pretty firmly united in three weeks.

Professor Gross, in his *System of Surgery*, observes that age is no barrier to union, and mentions the case of a lady, aged 100, in whom union of a fractured humerus took place in the usual time; and that of a women, aged 93, in whom a fracture of the upper third of the thigh was united in three weeks.

The contrary view, however, is prevalent. In Holmes's *System of Surgery* it is stated, that "in old age, the period is greatly protracted in proportion to the want of vigour of the individual." Chelius remarks that in advanced age the bone heals with difficulty. In the *International Encyclopædia of Surgery* a doubtful opinion is given; and the prevailing impression respecting the time required is probably to be attributed not so much to observation of the fact as to an *a priori* feeling that it is likely to be so; for we know how often that which is probable is assumed to be that which is real.

Moreover, the circumstance that fractures of the neck of the thigh-bone, which may be regarded as the old person's fracture, commonly does not unite at all by bone, the broken ends in many cases remaining quite separate, seems to give support to the view. It is well known, however, that this failure depends, not upon the age of the patient, or on any peculiarity in the structure of the bone, or upon any changes that take place in it during the later periods of life, though those changes are such as to cause rarefaction of its cancelli and greater liability to fracture, but upon other causes. Such causes, more particularly, are the separation of the broken surfaces, which commonly occurs; the buried position of the inner fragment in the cavity of the acetabulum, which prevents any overlapping of the fragments and any throwing out of uniting matter around it; as well as the comparative absence, and, when the fibrous covering of the neck is torn through all round, the complete absence of tissue in which that material can be produced; and also the bathing of the fractured surfaces by the synovial fluid. That these conditions, which are found to be more or less prejudicial to bony union of fractures into other joints, and not senility, are the real causes of failure in the case of the neck of the thigh-bone, is proved by the fact that union by bone will take place at this part of the skeleton as well as elsewhere, if the fractured surfaces be fixed in apposition, either by any kind of impaction or by well-adjusted appliances; and that this will occur in the aged has been often proved, and as is well shown by a specimen of firm bony union in a gentlemen, aged 81, who broke the neck of his thigh-bone a year before death. The treatment was very carefully conducted by Mr Wherry, who was near by at the time of the accident, and who, recognising the nature of the case, took every precaution to prevent further displacement of the fractured surfaces; in seven weeks union had taken place so firmly that the patient could raise the limb from the bed by the action of the muscles of the hip. The breakage was close to the head of the bone, as is shown by a line of fibrous tissue joining the fractured surfaces in the hinder part; whereas, in front, the union by bone is so complete that it is difficult at first sight to determine the line of fracture.

Notes of several cases have been sent me, in which union of broken neck of the thigh-bone in old persons was believed to have taken place, and in a short space of time; but, as the condition of the parts has not been verified by examination, and as in such cases it is almost impossible, without ocular inspection of the part, to determine whether bony union has actually taken place, I have thought it better to omit them from the series.

In the case of fractures, as in the case of wounds, a certain amount of nutritive vigour is necessary to bear, and turn to good effect, the vascular and other changes in the tissues associated with the work of repair; and, unless that exist, destruction by liquefaction or absorption of tissues may take place, instead of the condition requisite for healing. In the bones, indeed, a certain amount of absorption is the regular attendant upon repair. By it the surfaces in the proximity of a fracture are roughened, and rendered porous to admit the new uniting material—the soft callus-medium—to grow into and form one with them, just as the surfaces of a brick are rough, that the mortar may run into and set in, and adhere to them, and form a bond. Sometimes we find that, in old and very feeble people, the one requisite for reunion after fracture—the work of absorption or destruction of the broken ends—takes place in excess; whereas the other requisite—the work of forming the new uniting material—is deficient. Accordingly, the ends of the bones become porous and worm-eaten, and little or no callus is produced. That has been the case in this oblique fracture of the humerus, which occurred in a feeble man of 86, while he was pulling himself upstairs by the handrail. He was afterwards extremely restless, so that no retentive means could be effectually applied; one of the broken ends made its way through the skin, and he died in three weeks. The bone is light, and is worm-eaten near the fracture, and there is only a little crumbling osseous deposit upon it. The same condition is seen in each of these two thigh-bones, one of which was taken from an aged subject in the dissecting-room, and the other bears all the mark of senility. I do not know the history in either case, but in both there are absence of new material and evidence of too free removal of the old.

In the contrasting features, therefore, of liability to utter failure of repair and demolition of the injured part on the one hand, and in that of quick repair on the other, the bones resemble the soft parts; and I trust that the question for the solution of which I have asked assistance has now been sufficiently answered. We have thus established the fact that the repair of wounds and of fractures takes place in the old persons as quickly as in the middle-aged; and we ought to hear no more of the disqualification for reunion which has been attributed to old age. That this is no unimportant matter from a practical point of view, is sufficiently shown by a case mentioned by Mr Hodson, of Bishop Stortford, in which a fracture of the thigh-bone in an old woman was allowed to go untreated, because the medical men thought that at that time of life union of a broken bone was not to be expected.

In conclusion, I have to thank the gentlemen who have been good enough to forward the cases from which these notes[1] have been taken; and I may remark that it is only by the collection of cases in this way these and many other questions can be answered. The investigation by this method, for which the British Medical Association affords such unprecedented opportunities, has the double advantage of bringing a heavy battery of information to bear upon any one point where information is required, and further, of greatly benefiting those who communicate the information. There is no reading at all to compare with that of reading ourselves, our own experiences, and our own thoughts upon them. These were the feelings which influenced me when I ventured at the Cambridge meeting, four years ago, to suggest that some measure of the energies of the Association should be turned in this direction. I have never taken any part in the political movements which occupy the attention of some of the more active members, being of opinion that greater service might be rendered to the Association, to its individual members, and to the science and practice of medicine, by organising a plan for the collection and utilisation of the vast streams of experience which are daily allowed to flow away into the great abyss of waste.

[1] See *British Medical Journal*, July 12, 1884, where these notes of cases, communicated by various medical men, will be found appended to the paper from which these remarks have, in the main, been taken.

A CASE OF ABNORMAL DEVELOPMENT OF THE CORONARY ARTERIES OF THE HEART. By F. Charlewood Turner, M.D., *Physician to, and Demonstrator of Morbid Anatomy at, the London Hospital.*

This abnormality consisted in the presence of a large branch of the right coronary artery, which passed backwards between the root of the aorta and the right and left auricles, and took the place of the posterior branch of the left coronary artery which had not been developed.

The right coronary artery arose in the normal position, from the anterior sinus of Valsalva. The trunk of the vessel, which was of large size, but not much more than ¼ inch long, ran forwards and terminated beneath the wall of the right auricle, immediately above the margin of the right auriculo-ventricular orifice. It there divided into two primary branches of equal size, which ran in opposite directions along the margin of that aperture. That passing forward to the left of the auriculo-ventricular orifice had the normal distribution of the right coronary artery. The other branch ran backwards and to the right round the root of the aorta, passing between it and the inter-auricular septum, to the margin of the left auriculo-ventricular orifice. Skirting the left extremity of the mitral slit in the auriculo-ventricular groove, it took the place of the posterior branch of the left coronary artery, whose area of distribution it supplied. From the trunk of the right coronary artery, quite at its commencement, a small branch was given off, which ran forward and to the left over the infundibular portion of the ventricle.

The specimen was obtained from the body of a man apparently between fifty and sixty years old, of whom nothing was known, who died in the street, and whose body was brought by the police to the London Hospital. There was much atheroma with dilatation of the aorta, and the orifice of the left coronary artery was contracted. There was also fatty atrophy of the myocardium.

This abnormality in the development of the coronary arteries of the heart resulted from an enlargement of the small circumflex branch of the right coronary artery. In a case of abnormal distribution of the coronary arteries observed by Bochdalek, and described in *Virchow's Archiv*, vol. xli., in which the left coronary artery was absent, its place was in part supplied by a branch of the right coronary similar to the above.

ABNORMAL URETERS. By W. Stephenson Richmond,

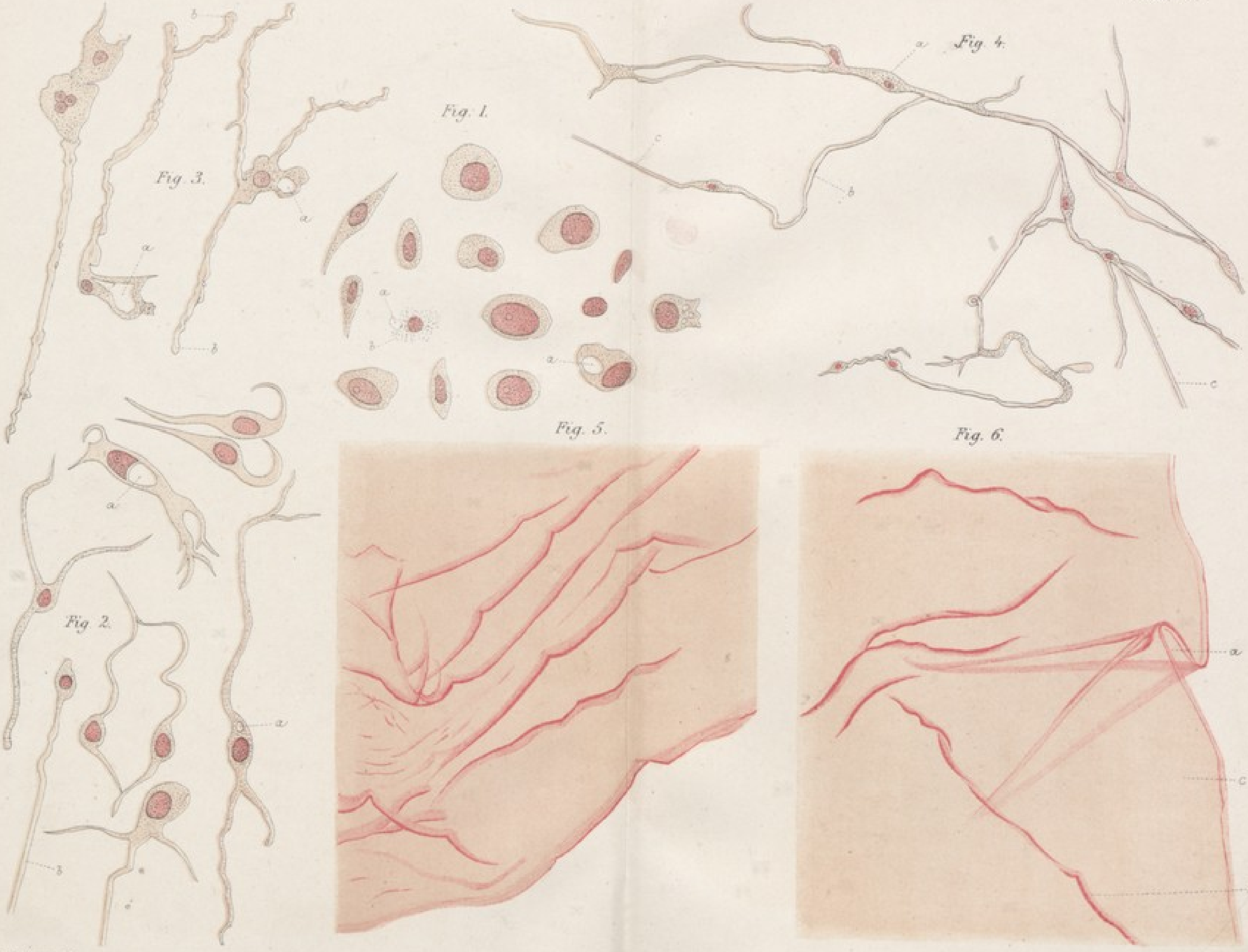
St Bartholomew's Hospital.

In the dissection of a male subject, four ureters were discovered emerging from the hilum of each kidney. After proceeding about four inches towards the bladder they became united, forming a pelvis, from which sprang the ureter proper.

On making a section of one of the kidneys, the hilum was found to be occupied by a quantity of fat and connective tissue, imbedded in which the ureters could be traced to the infundibula, communicating with the calices and pyramids. Thus there was no pelvis within the hilum, but the calices united to form infundibula, of which these ureters seemed to be the continuation, and they became united in a pelvis some distance removed from the kidney.

The interest of the case is not entirely anatomical.

The man had evidently suffered from some bladder mischief, for the walls of this vessel were very much thickened and the kidneys themselves were enlarged. The question which raises itself is whether, presuming some difficulty existed in emptying the bladder, such a condition of things could be brought about by mere mechanical means, viz., by the pressure of the secretion from the kidney forcing down and elongating the infundibula to such an extent as that which I have described. I mention this as a possible cause, but I think it was really a matter of development. For in the same body there were other signs of abnormal urino-genital development. Attached to the hydatids of Morgagni were fibrous nodules which I have before described in this *Journal* (vol. xvii.), and which I shortly tried to prove were the remains of that portion of the Wolffian body which generally becomes obliterated. This being the case it is almost certain that they are both abnormalities of development. But had the former existed without the latter, one would have been more easily satisfied with a pathological explanation. Both the above specimens are preserved in the Museum of St Bartholomew's Hospital.



A. C. Youman del.

F. Huth, Lithr Edinr

Fig. 7.

Fig. 8.

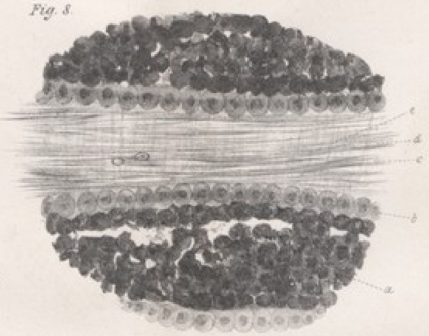


Fig. 11.

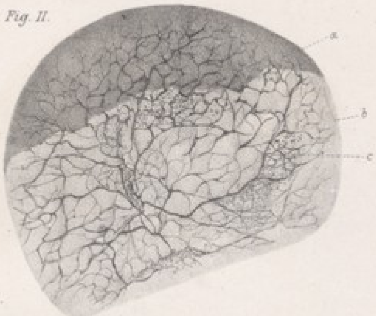


Fig. 9.

Fig. 10.

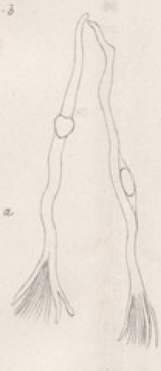
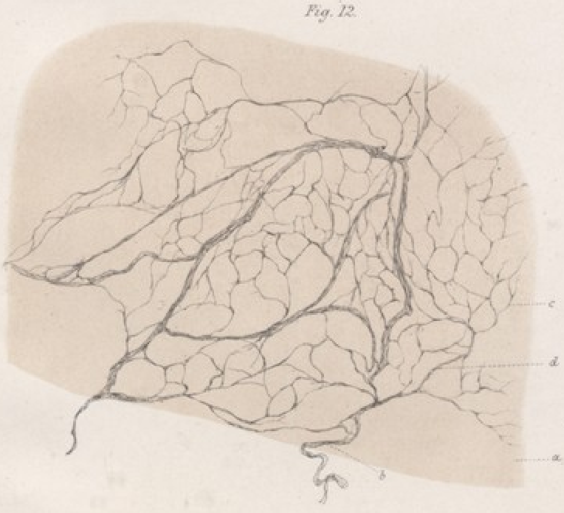
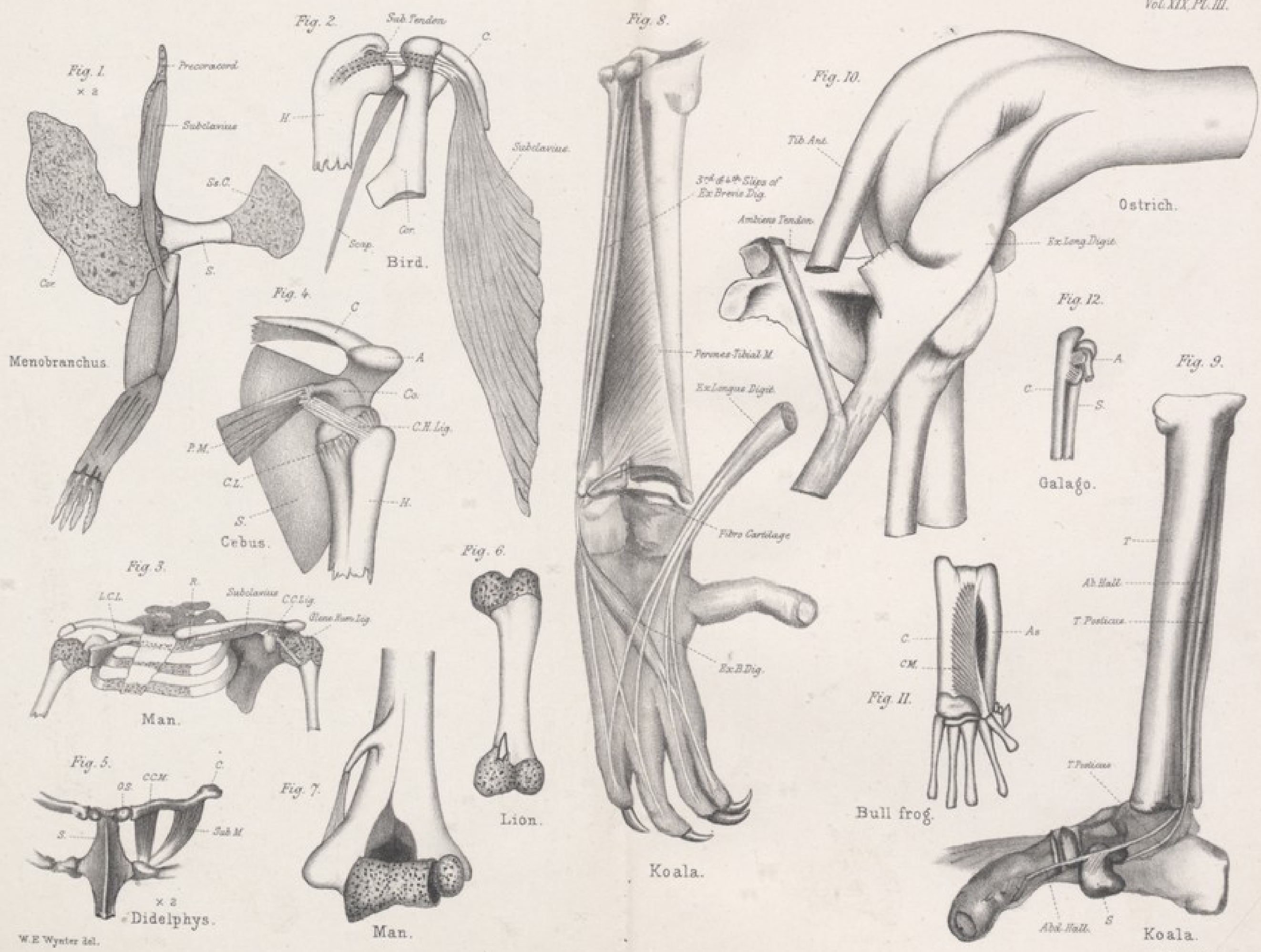


Fig. 12.

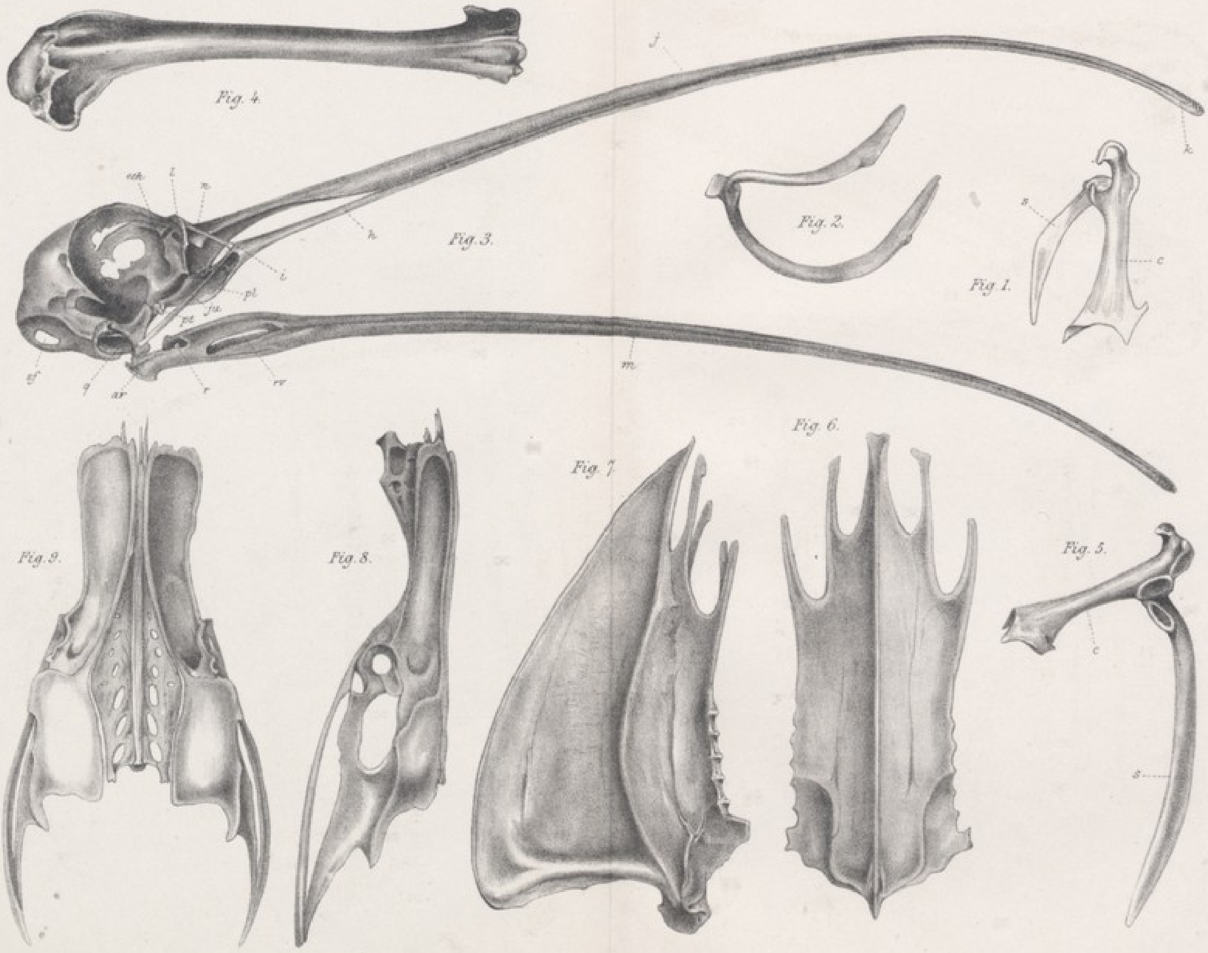


A. C. Younan del. F. Huth, Lithr Edinr



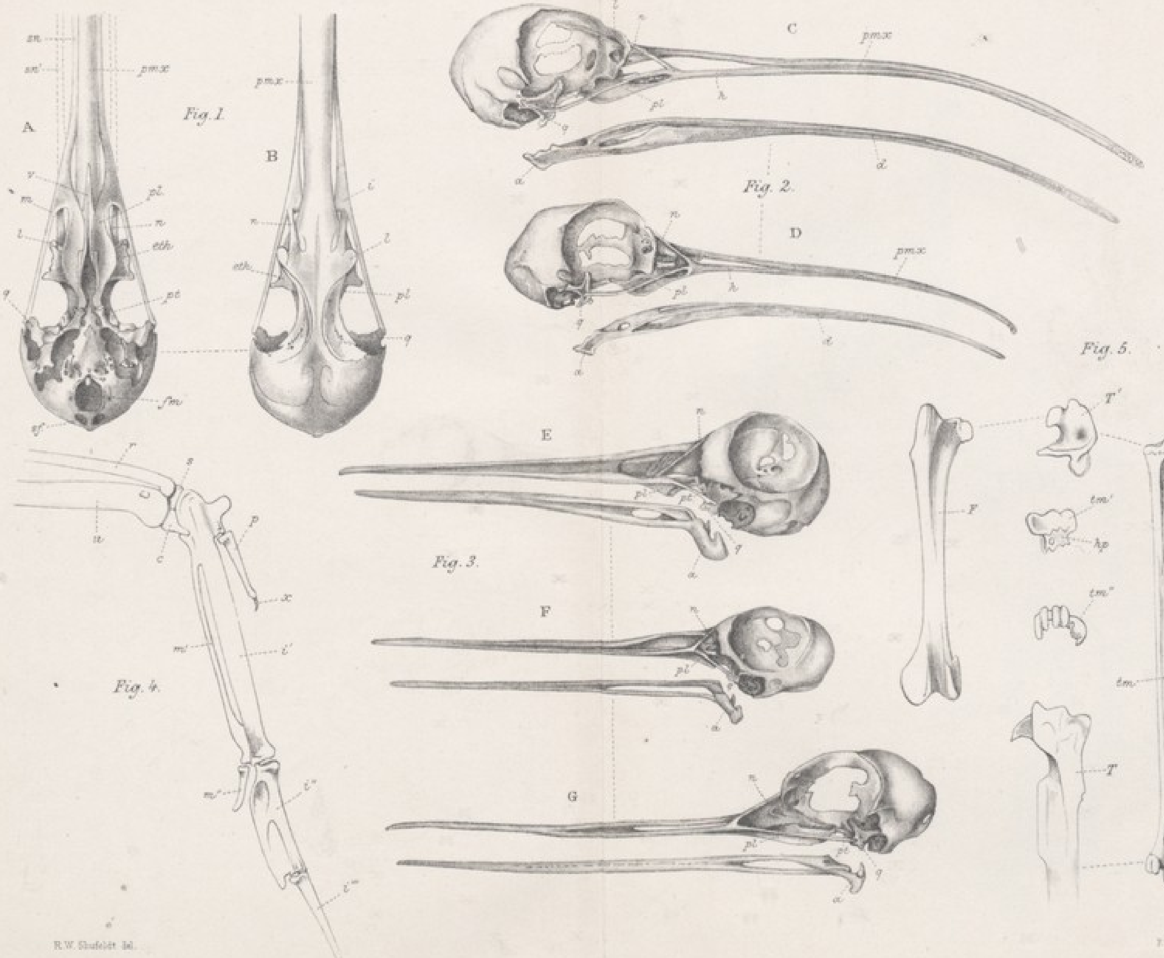
W. E. Wynter del.

F. Huth, Lith.r Edin.r



R. W. Shufeldt del.

F. Huth, Lithr Edinr



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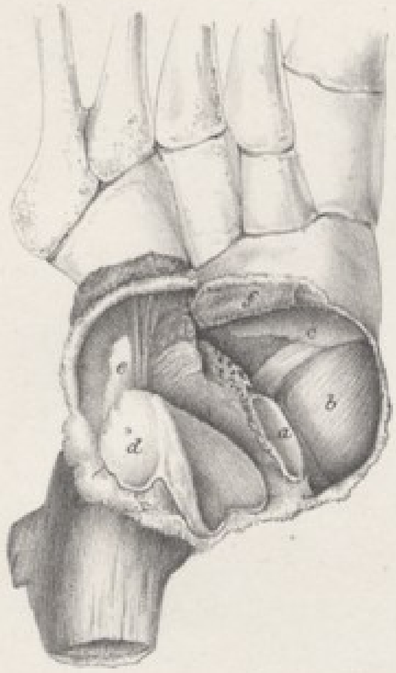

Fig. 2.

Fig. 1.

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J. Symington del. F. Huth, Lith.r Edin.r

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[Reprinted from the JOURNAL OF THE FRANKLIN INSTITUTE, Feb., 1886.]

A NEW APPLICATION OF THE PRINCIPLE OF COMPOSITE PHOTOGRAPHY TO THE IDENTIFICATION OF HANDWRITING.

BY PROF. PERSIFOR FRAZER, D. Sc. (Univ. de France.)

FRANCIS GALTON was the first to point out in fugitive memoirs, and notably in his epoch-making work, "The Human Faculty," that one could sift the common from the accidental features of a number of objects by exposing them to a sensitized plate in such a manner that the similar parts of the different objects should occupy as nearly as possible the same part of the plate, and that each object should be exposed for only a fraction of the length of time necessary to complete a picture on the film used. This fraction depended generally, if not always, on the number of objects and on the sensitiveness of the film. For example, if there were eighteen objects and the plate took thirty-six seconds to develop, each object would ordinarily be exposed for two seconds. It is easy to see that the result in the finished picture would be that those features which all the objects had in common would be re-enforced by each separate exposure, whereas those features which were accidental or variable, and which would be different for every individual, would be exposed for but two seconds and would be so indistinct as practically to fade away. Where the object was to catch a family likeness by exposing all the members male and female to the same portion of the plate, the result is a curious medley of faint whiskers, and moustache; of hair parted in the middle and at the side; of female gowns with buttons to the throat and of male shooting jackets thrown open. But out of all this faint halo of confusion and blur, there starts a characteristic face which is the family type. Very often, too, this type face resembles noticeably two different members of a family between whom no one can find a resemblance. It is this latter fact (which might have been expected) that induced me to look to the process for aid in resolving the difficult problem of identity of origin in handwriting. When a number of animals of the same race are thus treated, the method secures the fixing of the race or family characteristics, etc , as the case may be. When a number of pictures or coins bearing different representations of the same individual or scene are the objects, the result is to obtain either the average appearance of the same thing under different conditions (as for instance a man at different times of life), or the average of the impression made by identically the same thing on different artists. In this case, the merit of the process is that it constructs its image out of all that many pairs of trained eyes have seen, without giving undue weight to any one pair. So far then, these efforts have been directed to re-finding a lost or concealed existence through multiple testimony, very much as the law tries to get at the truth by examining a number of witnesses.

The case of handwriting is, however, a different one. With a given mental image before one of what one desires to write; and with a given relation of will-power, nerve sensitiveness and muscular force, the same signature could be repeated a thousand times, provided that all these conditions were invariable, and no others were superadded. So far from this being the case, however, every one of the factors just named, which produce a signature depends on physical and mental—in other words, on extraneous influences, to a very large degree. A desire to make an up stroke, and the movement commenced to effect this, is met by an unexpected obstacle in the paper, a slight twinge in the shoulder, or a sudden noise, and the projected line would show (were we sufficiently cognizant of the detailed working of all the complicated parts of our mental machinery) just the order in which the different sentient and executive parts of us had been affected, and to what extent. But while these ever-recurring accidents result in preventing the signature from ever being made exactly as intended,* the fact that no two of them effect the same kind or amount of deviation leaves it in the power of the experimenter to extract from this process the "ideal" signature—a signature which probably never was seen as it appears, and yet which so combines all the visible results of a particular will acting on a particular arm to trace a known design with a pen or pencil on paper, that it may justly be called the *type* signature of that writer. What was said of the resemblance of every object of a group to the composite made of that group (provided the objects chosen have any claim to be so associated), while often differing widely from other members of the same group, is true of handwriting. It has been remarked that the composite signature is an ideal, and never

* The word "intended" is used to imply the effect of the will through the hand if not modified by these accidents, and not conscious intention.

was realized. This is because the lines along which the strongest reenforcement is made are those where locally varying deviations most frequently cross. To put it in another form, suppose the lines *a b*, *c* and *d* to be in agreement as follows: At the point *a′*, *b* does not cross, but *c* and *d* do. At *b′*, *c* does not cross, but *d* and *a* do. At *c′*, *d* does not cross, but *a* and *b* do. The line which, without very minute inspection, would represent to the eye part of the ideal signature, would be that traced through the points *a′*, *b′*, *c′*, *d′*, because those points having superposed lines of three out of the four signatures would be darker, while the variations at each of these points would be indistinct.

In examining with care a composite signature as just described, it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variation of a particular kind is noticeable, and other regions where there is little or none. The more writings of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed, it cannot *naturally* exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to the observer to study the variations as to study the ideal signature. Indeed, the variations are all important in the matter of identification, and if there were no variations the method would be inapplicable. A comparatively small number of signatures will give the maximum and minimum of variation in any given region of one of the letters forming it. Moreover, the kind of variation is easily observed where there are a number together, so that the most perfect adept at forgery could hardly hope to simulate the microscopically minute characteristics of variations which are simply the visible expression of a series of indefinitely complex relations of muscle and nerve.

In a case which was recently brought before the Orphans' Court in this city, this principle of composite photography was for the first time applied by me to the purpose of identifying handwriting, and from the experience thus far gained, it is thought that it will better accomplish the object than will the mere opinions of the most experienced experts.

Philadelphia, January 19, 1886.

THE APPLICATION OF COMPOSITE PHOTOGRAPHY

—TO—

Handwriting and Especially to Signatures.

By PERSIFOR FRAZER,

Docteur ès-Sciences Naturelles (Univ. de France); Professor of Chemistry at the Franklin Institute; Correspondent of the k. k. Geologische Reichsanstalt in Vienna, Etc., Etc.

Composite Photography applied to Handwriting. By Dr. Persifor Frazer.

(Read before the American Philosophical Society, January 16, 1886.)

The following preliminary note on this subject appeared in the Journal of the Franklin Institute for February, 1886:

Francis Galton was the first to point out in fugitive memoirs, and notably in his important work, "The Human Faculty," that one could sift the common from the accidental features of a number of objects by exposing them in succession to a sensitized plate in such a manner that the images of the similar parts of the different objects should occupy as nearly as possible the same parts of the plate; and that each object should be exposed for only a fraction of the length of time necessary to complete a picture on the film used. This fraction depended generally, if not always, on the number of objects and on the sensitiveness of the film. For example, if there were eighteen objects and the plate took thirty-six seconds to develop, each object would ordinarily be exposed for two seconds. It is easy to see that the result in the finished picture would be that those features which all the objects had in common would be re-enforced by each separate exposure, whereas those features which were accidental or variable, and which would be different for every individual, would be exposed for but two seconds and would be so indistinct as practically to fade away. Where the object was to catch a family likeness by exposing all the members male and female to the same portion of the plate, the result is a curious medley of faint whiskers and moustache; of hair parted in the middle and at the side; of female gowns with buttons to the throat and of male shooting jackets thrown open. But out of all this faint halo of confusion and blur, there starts a characteristic face which is the family type. Very often, too, this type-face resembles noticeably two different members of a family between whom no one can find a resemblance. It is this latter fact (which might have been expected) that induced me to look to the process for aid in solving the problem of identity of origin in handwriting. When a number of animals of the same race are thus treated, the method secures the fixing of the race or family characteristics, etc., as the case may be. When a number of pictures or coins bearing different representations of the same individual or scene are the objects, the result is to obtain either the average appearance of the same thing under different conditions (as for instance a man at different times of life), or the average of the impression made by identically the same thing on different artists. In this case, the merit of the process is that it constructs its image out of all that many pairs of trained eyes have seen, without giving undue weight to any one pair. So far, then, these efforts have been directed to re-finding a lost or concealed existence through multiple testimony, very much as the law tries to get at the truth by examining a number of witnesses.

At first sight one would suppose, however, that the case of handwriting was a different one, but I think that the analogy with the above cases will appear strong on due reflection. With a given mental image of what one desires to write before one; and with a given relation of will-power, nerve sensitiveness and muscular force, the same signature could be repeated a thousand times, provided that all these conditions were invariable, and no others were superadded. So far from this being the case, however, every one of the factors just named which produce a signature, depends on physical and mental—in other words, on extraneous influences, to a very large degree. The movement commenced to effect an up stroke is met by an unexpected obstacle in the paper, a slight twinge in the shoulder, or a sudden noise, and the resulting line would show (were we sufficiently cognizant of the detailed working of all the complicated parts of our mental machinery to interpret it) just the order in which our different sentient and executive functions have been affected, and to what extent. But while these ever-recurring accidents result in preventing any signature from being made exactly as intended,* the fact that no two of them effect the same kind or amount of deviation leaves it in the power of the experimenter to extract from this process the "ideal" signature—a signature which probably never was seen as it appears, and yet which so combines all the visible results of a particular will acting on a particular arm to trace on paper a known design with a pen or pencil, that it may justly be called the *type* signature of that writer. What was said of the resemblance of every object of a group of objects which have any claim to be associated together, to the composite made of that group, even though it differ widely from other members of the same group; is true of handwriting. It has been remarked that the composite signature is an ideal, and never was realized. This is because the lines along which the strongest re-enforcements are made are those where locally varying deviations most frequently cross. To put it in another form, suppose the lines a b, c and d to be in agreement as follows: At the point a', b does not cross, but c and d do. At b', c does not cross, but d and a do. At c', d does not cross, but a and b do. The line which would represent to the eye part of the ideal signature, would be that traced the points a', b', c', d', because those points having superposed lines of three out of the four signatures and would be darker, while the variations at each of these points would be indistinct.

In examining with care a composite signature as just described, it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variations of a particular kind are noticeable, and other regions where there are few or none. The more the manuscripts of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed, it cannot

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naturally exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to the observer to study the variations, as to study the ideal signature. Indeed, the variations are all important in the matter of identification, and if there were no variations the method would be inapplicable, because an exact copy might be made by tracing. A comparatively mall number of signatures will give the maximum and minimum of variation in any given region of one of the letters forming it. Moreover, the kind of variation is easily observed where there are a number together, so that the most perfect adept at forgery could hardly hope to simulate the microscopically minute characteristics of variations which are simply the visible expression of a series of indefinitely complex relations of muscle and nerve.

In a case which was recently brought before the Orphans' Court n Philadelphia, this principle of composite photography was for the first time applied by me to the purpose of identifying handwriting, and from the experience thus far gained, it is thought that it will (at least in many cases) more surely lead to the truth than will the mere opinions of he most skillful expert.

Philadelphia, January 19, 1886.

We judge of force and weakness; of the stability and instability; of expression and character chiefly by applying the experience that we have gained through the observations of our lives to the images we see before us. In the more complex studies of nature the image is rendered n colors and their shades, and all these increase almost indefinitely the delicate phases and modifications of the thought which is suggested. They are just so many words added to the language in which external nature speaks to us.

But an almost infinite number of facts are impressed on our minds with convincing force without recourse to other than the plainest and simplest combinations of lines. A being, whether civilized or savage, recognizes instantly the impossibility of a tree growing with its roots in the air, or a man standing on the vertical face of a wall. The French caricaturists have demonstrated how much of character and expression may be given by a few lines which when looked at minutely resemble the scrawls of an infant on a sheet of paper, yet when viewed from a certain distance in its general effect tell us a whole story without the use of a word. It is undeniable that the power to do this is based upon the fact that certain accentuated lines appear in the figures of men and things under a given set of circumstances, and by taking these and omitting all else we have a sort of skeleton image divested of unessentials. This skeleton image is in its way a sort of composite, arrived at, it is true, by a different method from that here employed, but nevertheless representing the sum of the artist's experiences in a great many more or less similar cases, and the greatness of the historical painter lies just in his power to represent an important event or risis by the effects which it makes visible on those who are participators in and spectators of it. Here is no place to admit variation, the attiudes, or, in other words, the lines of the figures in such a composition must be normal and intelligible to the mass of mankind ; must be, in short, a composite or abstraction of the lines that would survive were a hundred thousand such scenes to be instantaneously photographed : all else weakens the effect intended. Composite photography is a method of obtaining the essence of a number of objects and, in so far as those objects are typical of similar phenomena, of recording the relations of things to each other, the effects produced by a certain force or certain forces on matter. The composite will enable the mind, armed with some experience in life, to ascend from the individual cases to the underlying cause or motive.

Is it necessary, then, to prove that a line made by a human arm and hand is liable to the variations which such an arm or hand must produce when influenced, as they always are, by indefinitely numerous physical and mental forces? Is it necessary to devote much time to the proof that a line on paper so produced is as much a resultant of organic processes as the outline of the human figure or the expressions of the human face? It is a kind of fossil like the print of a footstep or of a leaf which, while it consists of nothing having life, or that ever need have had life, and possesses none of the material of the body which made it, is capable like the impressions above referred to of telling a great deal of the characteristics of its creator : it is, in fact, as organic as the forms of living things by which we judge them, for their forms or images do not possess life either.

Such methods as composite photography, or composite drawing or painting of any kind which can be accomplished when the hand has the skill to reproduce what the memory has stored away, are applicable only to the representation of resultants which do not vary within too wide limits, and are especially applicable where such variations depend upon the influences brought to bear on sentient things, and when they do not occur *per saltum*, but gradually and by imperceptible steps.

If the purpose be to represent an average of some object which presents images differing radically from each other at successive views there must be a very large number of such images selected to photograph, and then an ill-defined but darker blur will show vaguely on what part of the field on the whole the images have been most numerous. For phenomena of this kind the method is not adapted to offer its best results, though it still may be used to ascertain some facts in a general way.*

The attempt to apply the composite system of photography to the curves representing the rate of mortality in cities and towns, or to the

*In a pleasant letter received from Mr. Francis Galton, F. R. S., in answer to a copy of the preliminary note given above, which I sent him, he mentions that an attempt was made at the Kew Observatory to apply the principle of composite photography to the meteorological charts, without great success, though with more than Mr. Galton would have anticipated.

changes of the weather, &c., &c., is not likely to be rewarded by striking results, except to the extent which I have stated above, because these curves are composed of data taken at such intervals of time that there is no necessary sequence between them ; they are affected by causes which are in no respect to be likened to the gradual unfolding of human expression by relaxations and constrictions of the muscles, the sum of all the changes not perceptibly altering the field first obtained, but altering the "values," as the artist calls it, or the relative importance of the rôles assumed by each unit of the image to the rest. These changes are as characteristic and delicate in the line made voluntarily by a living being as in the lines which its form involuntarily makes on the retina, and therefore one set is as susceptible of concentration and averaging as the other.

The merely formal and always repeated parts of a letter or other document have an entirely different character value from those parts which are composed of words and letters thrown together to represent a certain state of things, and which may never be repeated in exactly the same order. Obviously no composite of phrases can be expected unless the phrase have a technical significance, but separate words can be selected to form bases of composites, or even the two or three words which enter into an idiom, one of those well-trodden short cuts of language to a given idea. Such partial phrases (rendered frequently in other languages by a single word), as "in order that ;" "as well as ;" "not only ;" "but also," &c., will be found in the handwriting of any one accustomed to write much, and may be taken as elements out of which to construct composites of the words of which they consist ; but the value of such elements in helping one to a knowledge of the character of the person who penned them, or even of the general character of the writers' handwriting is not as great in these cases as it is in the signature and the few formal words which precede it in a letter. There are several reasons for this ; one is that these formulas occur in different connections with the accompanying text, indicating very different attitudes of mind in the several cases. The sense of what is written must have a large influence in the manner of writing it, and therefore the letters composing these words will be larger or lighter ; or more or less quickly and angularly written as the idea of the sentence by reflex action evokes different emotions in the mind of the writer. A circumstance equally noticeable will be the place on the paper which the words occupy ; whether there is an abundance of room to write the words, or whether they are cramped in order to bring them into a smaller space. In cases where the words of such a subphrase are divided between two lines, they will almost surely not appear as they would when they follow each other in their natural order. But more even than these is the fact that the signature and its connected words, "Yours truly," &c., are always indicative of the task completed, the information conveyed. They are words of ceremony and endorsement, no matter what the contents of the letter may be. They are invariably repeated and come to be a purely conventional sign, of which the parts resemble more or less the letters in the body of the writing in different people. This symbol usually occupies very nearly the same part of the page—at least as to its distance from the right or left hand edge of the paper—and this tends to fix it as a distinguishing sign. All these facts lead to a distinction between a signature, and that writing by the same hand which accompanies original composition.

There are, of course, peculiarities in every hand which can be traced both in the signature and in the body of the text. Such are very apparent when the writer labors under a physical disadvantage, such as a maimed or deformed hand or arm, but in lesser degree these peculiarities are present in every handwriting and constitute the general constant of "will-power, nerve sensitiveness and muscular force" employed by a given individual in this perfunctory habit.

I say *general* constant to imply that this relation must be regarded without paying too much attention to detail, for probably on no two occasions of a man's life do these factors exist in him in *absolutely* the same proportions, and even if they did, the least change of environment would alter the results thus accomplished. But the signature of a man being divested as much as possible of the accidents due to his outside influences, it follows that the signature is the production of his hand least likely to yield an insight into his condition when writing it. On the other hand, the fact that he selects one particular way of expressing his identity bestows upon it something of a resultant of the various motives which actuate him, and makes it a sort of digest of the points of his character called into play in the performance of the act. We may look for the same sort of character in a signature that we find in a photograph or a picture, and the same causes may prevent either the one or the other from faithfully representing the peculiarities of the individual, by representing that individual as he appears when conscious that he is being observed; or, in other words, a character is assumed which corresponds to the taste of the individual and represents more or less how he would like to be seen by the public. When the character is observed to exist throughout the entire mass of his writing, it may be assumed that it represents accurately the man, for no amount of patience and study would enable one to retain such peculiarities under all the varied circumstances attending the act of writing, if it were not inherent in the individual himself. In any case, however, the result is a likeness which all who know the original will recognize, even though one or two features may be made more prominent in pose than in repose, and that constitutes the chief value of the analysis of signatures for identification independently of what we may learn from them of the mental attributes of their signers.

It is not always entirely obvious how signatures with many light flourishes, or accompanied by intricate lines connecting their several parts, should be superposed, for these appendices are so easily affected by minute causes that it seldom happens that two will cover each other exactly. It is not to be expected that such parts will survive in the resulting type signature, but the breadth of the space covered by the blur and parallelism of the faint lines will give evidence of the extent to which these ornaments have grown from caprice to a habit.

As a general rule there are several places—sometimes as many as eight or nine in a long signature—when the darkening of the lines indicates a general conformity of the pen's path to one direction, and it would seem that these places were not peculiar to any one part of a letter, nor that they were less in a hair line than in a heavy stroke. They appear to be dependent upon the anatomy and muscular structure of the individual in connection with his method of performing the act of writing his signature. For instance, some writers can only form one or two letters without moving the writing hand; only a word or so without shifting the elbow; others describe with the forearm of the writing hand a curve around the elbow which remains stationary; others slide the forearm along into parallel positions while writing. All these habits have different effects upon the handwriting which results, though they are not always to be easily detected, owing to the fact that other habits are cultivated at the same time to counteract the defect which each of these methods, when not so compensated, would have impressed upon the appearance of the chirography.

Thus, he who writes with an elbow pivoted immovably upon the table must learn to move the fingers over a greater space at some part of the line, to avoid the curve which would unconsciously result. This more vigorous movement of the fingers is likely to produce heavier strokes in the part of the signature where the compensation is naturally applied. So that a fixed elbow and heavy letter in the middle of the signature may stand to each other in the relation of cause and effect.

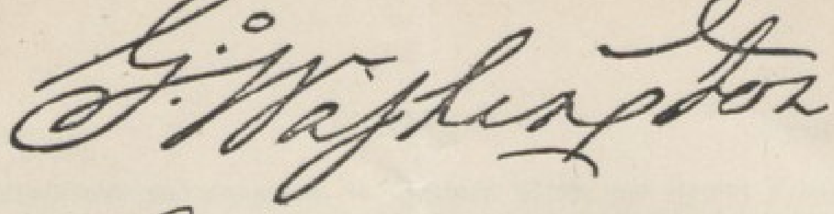
In signatures when the divergence is wide and the agreement correspondingly small, it has been my custom to use the dark portions as centres to adjust the various signatures on, and this plan will sometimes furnish a good composite when other plans fail.

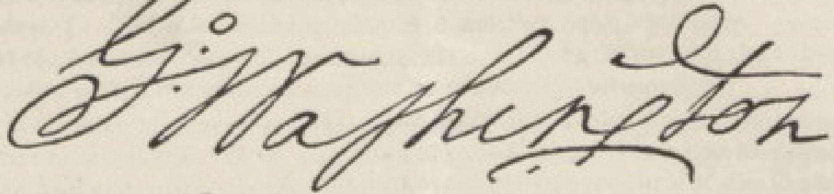
Desiring an illustration to accompany this paper, I sought a signature which would serve as a fair test of the process. Manifestly such a signature must be well known to a large number of persons, and enough examples of it must exist to bring out the type character of their combination. Those individuals whose signatures are known to the largest number of persons are usually bankers or persons authorized to sign firm drafts, checks, &c., and these not unnaturally object to having the minutest characteristics of their writing brought to the knowledge of the public, though for the reasons stated above a study of what the composite teaches would convince the intending forger that his task was a far more difficult one than that of simply reproducing a design. On the other hand signatures of dead bankers and dissolved firms soon pass out of the remembrance of those who were once familiar with them, and therefore have no more significance than the sign manuals of unknown writers, or those which are purely fictitious.

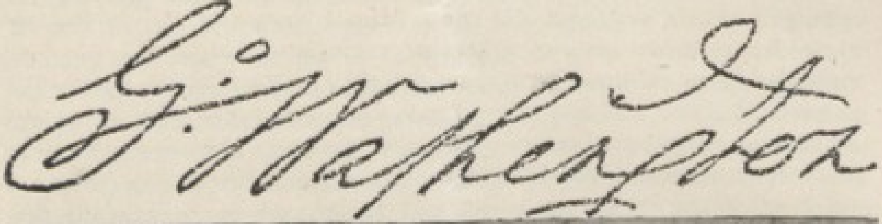
George Washington's signature was one of the first to suggest itself, because many persons were familiar with it, and there are numerous well-authenticated documents in existence which bear it; but it has proved to possess other advantages which were not known when it was selected. As in everything else, Washington was deliberate, pains-taking and uniform in his method of writing his signature and the consequence is that it makes an excellent composite for illustration.

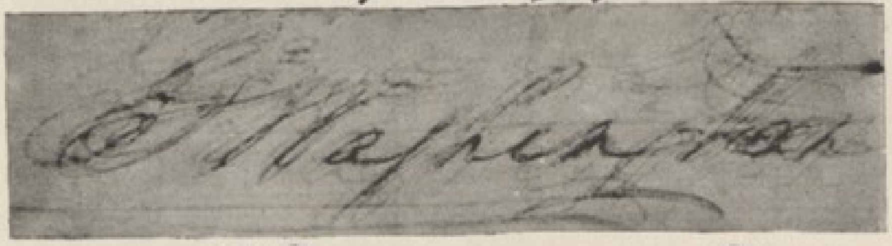
In writing his signature Washington put pen to the paper five times. First he wrote the "G W" in one connected line. Secondly, he raised his hand and made the small "o" between the upper parts of the G and W, and the two dots which appear in all but signature No. 7. Thirdly, his hand and arm were placed in position to write "ashing," these six letters occupying a breadth of almost exactly $1\frac{3}{4}$ inches in every signature except the third, when they are extended to $1\frac{15}{16}$ inches. This is about as much of the arc of a circle (of which the centre is the elbow pivoted on the table) as one with a forearm of average length can cause to coincide with the tangent, or the straight line across the paper which the lower parts of the letters follow, unless unusual effort be made and a great deal more movement be given to the fingers. The "g" ends in a curved flourish, of which the convex side is turned upwards below the right centre of the name. [Note. The lower loop of the "g" in all the signatures and in the composite was cut off in preparing the plate.] Fourthly, he wrote the final "ton." Fifthly, he added the very peculiar flourish above the right centre of the name, with the object of dotting the "i" and crossing the "t" at the same stroke.

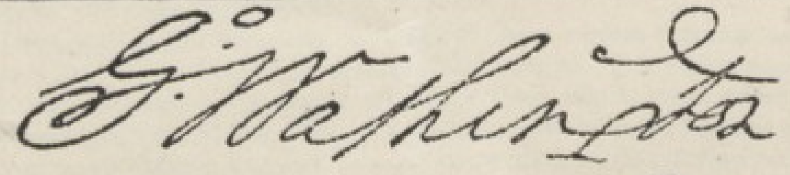
In examining the composite, the effect of these various separate movements becomes manifest in its strengthened portions. It is hardly possible that any one during the period of sixteen years, which these signatures represent, or from 1776 to 1792, should have so schooled his hand to write a long name that the first inch or so of the writing should always occupy the same relative position to the body of the signature. It would take at least that much action for the hand and arm and pen to be brought into normal signature-writing condition; and especially is this so when this part of the writing is accompanied by flourishes as it is in the case we are considering. The "G W" and the little "o" and the dots at the top were the prelude, after which the arm was moved into position to write the main body of the signature or the "ashing." Of course, from the manner of making the dots, and the extremely small space they cover, their re-enforcement of each other in the composite was almost impossible, and, in fact, like other subordinate characters, they disappear almost completely. This latter is the part of the name which one would have expected to exhibit the greatest amount of uniformity, as in point of fact it does, with the exception of its terminal "g," which shows more variation than any of the other letters, because at this point the limit of coincidence between the tangent line of the writing and the curve, of which the right forearm was the radius, had been passed, and a freer movement of the fingers was compensating for the increasing divergence. [Note. It is likely that Washington sometimes raised the hand between the end of the long "s"

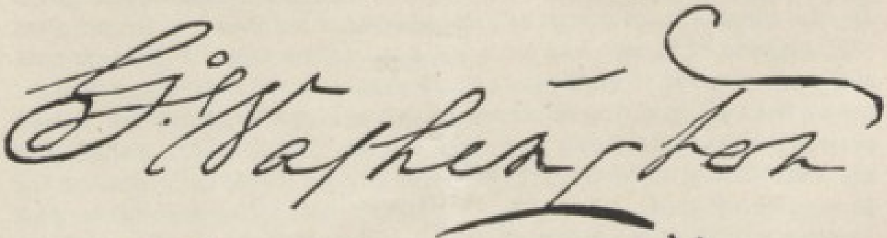
1 

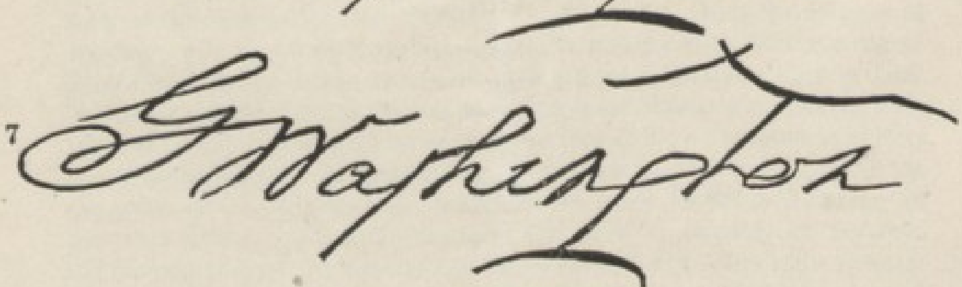
2 

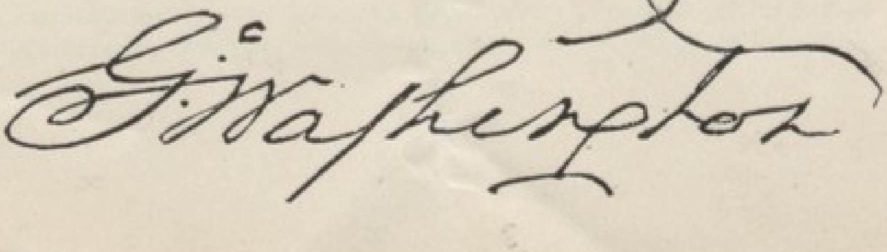
3 

4 

5 

6 

7 

8 

and the beginning of "h," but he does not appear to have moved the elbow. All but the second signature are consistent with this view, and in the 1st, 3d and 5th it is plainly indicated. In the others, as in the flourish above the sixth signature, the pen may not have marked.] The fourth separate act of the penman was the formation of the "ton" after a movement of the arm. The breadth of the space occupied by these three letters is from $\frac{5}{8}$ to $\frac{7}{8}$ of an inch, or considerably within the range of coincidence of the curve and straight line before referred to; and owing to this fact there is only a moderate degree of re-enforcement of the letters in the composite, because these letters might fall into the first or last parts of the 2-inch space which was the limit of movement with a fixed elbow. It is worthy of note that even in this case the middle letter of the three is darker in the composite than either of the outside letters. The fifth and last movement was the flourish which dots the "i" and crosses the "t" by one stroke. This was done in the freest of free hands—often, as it seems probable, without resting hand or arm on the table at all. Therefore there is no coincidence of the lines in this part of the composite and the *region* of variation is wider than that of any other part of the signature.

All the signatures used in the accompanying plate (seven in number) are unquestionably genuine. With the exception of one, which is the property of the writer, they were carefully chosen from a number of authenticated signatures in the possession of the Historical Society of Pennsylvania.

No. 1 is on a letter, dated December 18, 1776, from near the Falls of Trenton, and addressed to Washington's brother Samuel.

No. 2 is on a letter dated Headquarters, November 4, 1777, and is addressed to the writer's great-grandfather, Lt.-Col. Persifor Frazer, then a prisoner of war in Philadelphia.

No. 3 is on a letter dated September 27, 1777, and is to Wm. Henry, of Lancaster.

No. 4 is the Composite of all the rest.

No. 5 is on a letter dated Headquarters in Morristown, February 22, 1777. The person to whom the letter was addressed is not stated.

No. 6, dated September 26, 1793, is affixed to the commission of David Lenox.

No. 7, of the same date, is affixed to David Lenox's appointment as agent for the relief and protection of American Seamen.

No. 8, dated May 24, 1799, closes a letter to Thomson Mason.

THE APPLICATION OF COMPOSITE PHOTOGRAPHY

—TO—

Handwriting and Especially to Signatures.

By PERSIFOR FRAZER,

Docteur ès-Sciences Naturelles (Univ. de France); Professor of Chemistry at the Franklin Institute; Correspondent of the k. k. Geologische Reichsanstalt in Vienna, Etc., Etc.

Composite Photography applied to Handwriting. By Dr. Persifor Frazer.

(Read before the American Philosophical Society, January 16, 1886.)

The following preliminary note on this subject appeared in the Journal of the Franklin Institute for February, 1886:

Francis Galton was the first to point out in fugitive memoirs, and notably in his important work, "The Human Faculty," that one could sift the common from the accidental features of a number of objects by exposing them in succession to a sensitized plate in such a manner that the images of the similar parts of the different objects should occupy as nearly as possible the same parts of the plate; and that each object should be exposed for only a fraction of the length of time necessary to complete a picture on the film used. This fraction depended generally, if not always, on the number of objects and on the sensitiveness of the film. For example, if there were eighteen objects and the plate took thirty-six seconds to develop, each object would ordinarily be exposed for two seconds. It is easy to see that the result in the finished picture would be that those features which all the objects had in common would be re-enforced by each separate exposure, whereas those features which were accidental or variable, and which would be different for every individual, would be exposed for but two seconds and would be so indistinct as practically to fade away. Where the object was to catch a family likeness by exposing all the members male and female to the same portion of the plate, the result is a curious medley of faint whiskers and moustache; of hair parted in the middle and at the side; of female gowns with buttons to the throat and of male shooting jackets thrown open. But out of all this faint halo of confusion and blur, there starts a characteristic face which is the family type. Very often, too, this type-face resembles noticeably two different members of a family between whom no one can find a resemblance. It is this latter fact (which might have been expected) that induced me to look to the process for aid in solving the problem of identity of origin in handwriting. When a number of animals of the same race are thus treated, the method secures the fixing of the race or family characteristics, etc., as the case may be. When a number of pictures or coins bearing different representations of the same individual or scene are the objects, the result is to obtain either the average appearance of the same thing under different conditions (as for instance a man at different times of life), or the average of the impression made by identically the same thing on different artists. In this case, the merit of the process is that it constructs its image out of all that many pairs of trained eyes have seen, without giving undue weight to any one pair. So far, then, these efforts have been directed to re-finding a lost or concealed existence through multiple testimony, very much as the law tries to get at the truth by examining a number of witnesses.

At first sight one would suppose, however, that the case of handwriting was a different one, but I think that the analogy with the above cases will appear strong on due reflection. With a given mental image of what one desires to write before one; and with a given relation of will-power, nerve sensitiveness and muscular force, the same signature could be repeated a thousand times, provided that all these conditions were invariable, and no others were superadded. So far from this being the case, however, every one of the factors just named which produce a signature, depends on physical and mental—in other words, on extraneous influences, to a very large degree. The movement commenced to effect an up stroke is met by an unexpected obstacle in the paper, a slight twinge in the shoulder, or a sudden noise, and the resulting line would show (were we sufficiently cognizant of the detailed working of all the complicated parts of our mental machinery to interpret it) just the order in which our different sentient and executive functions have been affected, and to what extent. But while these ever-recurring accidents result in preventing any signature from being made exactly as intended,* the fact that no two of them effect the same kind or amount of deviation leaves it in the power of the experimenter to extract from this process the "ideal" signature—a signature which probably never was seen as it appears, and yet which so combines all the visible results of a particular will acting on a particular arm to trace on paper a known design with a pen or pencil, that it may justly be called the *type* signature of that writer. What was said of the resemblance of every object of a group of objects which have any claim to be associated together, to the composite made of that group, even though it differ widely from other members of the same group; is true of handwriting. It has been remarked that the composite signature is an ideal, and never was realized. This is because the lines along which the strongest re-enforcements are made are those where locally varying deviations most frequently cross. To put it in another form, suppose the lines *a b*, *c* and *d* to be in agreement as follows: At the point *a'*, *b* does not cross, but *c* and *d* do. At *b'*, *c* does not cross, but *d* and *a* do. At *c'*, *d* does not cross, but *a* and *b* do. The line which would represent to the eye part of the ideal signature, would be that traced the points *a'*, *b'*, *c'*, *d'*, because those points having superposed lines of three out of the four signatures and would be darker, while the variations at each of these points would be indistinct.

In examining with care a composite signature as just described, it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variations of a particular kind are noticeable, and other regions where there are few or none. The more the manuscripts of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed, it cannot

*The word "intended" is used to imply the effect which would be produced by the action of the will through the hand on the paper if not modified by these accidents, and not solely conscious intention.

naturally exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to the observer to study the variations, as to study the ideal signature. Indeed, the variations are all important in the matter of identification, and if there were no variations the method would be inapplicable, because an exact copy might be made by tracing. A comparatively mall number ot signatures will give the maximum and minimum of variation in any given region of one of the letters forming it. Moreover, the kind of variation is easily observed where there are a number together, so that the most perfect adept at forgery could hardly hope to simulate the microscopically minute characteristics of variations which are simply the visible expression of a series of indefinitely complex relations of muscle and nerve.

In a case which was recently brought before the Orphans' Court n Philadelphia, this principle of composite photography was for the first time applied by me to the purpose of identifying handwriting, and from the experience thus far gained, it is thought that it will (at least in many cases) more surely lead to the truth than will the mere opinions of· he most skillful expert.

Philadelphia, January 19, 1886.

We judge of force and weakness ; of the stability and instability ; of expression and character chiefly by applying the experience that we have gained through the observations of our lives to the images we see before us. In the more complex studies of nature the image is rendered n colors and their shades, and all these increase almost indefinitely the delicate phases and modifications of the thought which is suggested. They are just so many words added to the language in which external nature speaks to us.

But an almost infinite number of facts are impressed on our minds with convincing force without recourse to other than the plainest and simplest combinations of lines. A being, whether civilized or savage, recognizes instantly the impossibility of a tree growing with its roots in the air, or a man standing on the vertical face of a wall. The French caricaturists have demonstrated how much of character and expression may be given by a few lines which when looked at minutely resemble the scrawls of an infant on a sheet of paper, yet when viewed from a certain distance in its general effect tell us a whole story without the use of a word. It is undeniable that the power to do this is based upon the fact that certain accentuated lines appear in the figures of men and things under a given set of circumstances, and by taking these and omitting all else we have a sort of skeleton image divested of unessentials. This skeleton image is in its way a sort of composite, arrived at, it is true, by a different method from that here employed, but nevertheless representing the sum of the artist's experiences in a great many more or less similar cases, and the greatness of the historical painter lies just in his power to represent an important event or risis by the effects which it makes visible on those who are participators in and spectators of it. Here is no place to admit variation, the attiudes, or, in other words, the lines of the figures in such a composition must be normal and intelligible to the mass of mankind ; must be, in short, a composite or abstraction of the lines that would survive were a hundred thousand such scenes to be instantaneously photographed : all else weakens the effect intended. Composite photography is a method of obtaining the essence of a number of objects and, in so far as those objects are typical of similar phenomena, of recording the relations of things to each other, the effects produced by a certain force or certain forces on matter. The composite will enable the mind, armed with some experience in life, to ascend from the individual cases to the underlying cause or motive.

Is it necessary, then, to prove that a line made by a human arm and hand is liable to the variations which such an arm or hand must produce when influenced, as they always are, by indefinitely numerous physical and mental forces? Is it necessary to devote much time to the proof that a line on paper so produced is as much a resultant of organic processes as the outline of the human figure or the expressions of the human face? It is a kind of fossil like the print of a footstep or of a leaf which, while it consists of nothing having life, or that ever need have had life, and possesses none of the material of the body which made it, is capable like the impressions above referred to of telling a great deal of the characteristics of its creator : it is, in fact, as organic as the forms of living things by which we judge them, for their forms or images do not possess life either.

Such methods as composite photography, or composite drawing or painting of any kind which can be accomplished when the hand has the skill to reproduce what the memory has stored away, are applicable only to the representation of resultants which do not vary within too wide limits, and are especially applicable where such variations depend upon the influences brought to bear on sentient things, and when they do not occur *per saltum*, but gradually and by imperceptible steps.

If the purpose be to represent an average of some object which presents images differing radically from each other at successive views there must be a very large number of such images selected to photograph, and then an ill-defined but darker blur will show vaguely on what part of the field on the whole the images have been most numerous. For phenomena of this kind the method is not adapted to offer its best results, though it still may be used to ascertain some facts in a general way.*

The attempt to apply the composite system of photography to the curves representing the rate of mortality in cities and towns, or to the

*In a pleasant letter received from Mr. Francis Galton, F. R. S., in answer to a copy of the preliminary note given above, which I sent him, he mentions that an attempt was made at the Kew Observatory to apply the principle of composite photography to the meteorological charts, without great success, though with more than Mr. Galton would have anticipated.

changes of the weather, &c., &c., is not likely to be rewarded by striking results, except to the extent which I have stated above, because these curves are composed of data taken at such intervals of time that there is no necessary sequence between them ; they are affected by causes which are in no respect to be likened to the gradual unfolding of human expression by relaxations and constrictions of the muscles, the sum of all the changes not perceptibly altering the field first obtained, but altering the "values," as the artist calls it, or the relative importance of the rôles assumed by each unit of the image to the rest. These changes are as characteristic and delicate in the line made voluntarily by a living being as in the lines which its form involuntarily makes on the retina, and therefore one set is as susceptible of concentration and averaging as the other.

The merely formal and always repeated parts of a letter or other document have an entirely different character value from those parts which are composed of words and letters thrown together to represent a certain state of things, and which may never be repeated in exactly the same order. Obviously no composite of phrases can be expected unless the phrase have a technical significance, but separate words can be selected to form bases of composites, or even the two or three words which enter into an idiom, one of those well-trodden short cuts of language to a given idea. Such partial phrases (rendered frequently in other languages by a single word), as "in order that ;" "as well as ;" "not only ;" "but also," &c., will be found in the handwriting of any one accustomed to write much, and may be taken as elements out of which to construct composites of the words of which they consist ; but the value of such elements in helping one to a knowledge of the character of the person who penned them, or even of the general character of the writers' handwriting is not as great in these cases as it is in the signature and the few formal words which precede it in a letter. There are several reasons for this ; one is that these formulas occur in different connections with the accompanying text, indicating very different attitudes of mind in the several cases. The sense of what is written must have a large influence in the manner of writing it, and therefore the letters composing these words will be larger or lighter ; or more or less quickly and angularly written as the idea of the sentence by reflex action evokes different emotions in the mind of the writer. A circumstance equally noticeable will be the place on the paper which the words occupy ; whether there is an abundance of room to write the words, or whether they are cramped in order to bring them into a smaller space. In cases where the words of such a subphrase are divided between two lines, they will almost surely not appear as they would when they follow each other in their natural order. But more even than these is the fact that the signature and its connected words, "Yours truly," &c., are always indicative of the task completed, the information conveyed. They are words of ceremony and endorsement, no matter what the contents of the letter may be. They are invariably repeated and come to be a purely conventional sign, of which the parts resemble more or less the letters in the body of the writing in different people. This symbol usually occupies very nearly the same part of the page—at least as to its distance from the right or left hand edge of the paper—and this tends to fix it as a distinguishing sign. All these facts lead to a distinction between a signature, and that writing by the same hand which accompanies original composition.

There are, of course, peculiarities in every hand which can be traced both in the signature and in the body of the text. Such are very apparent when the writer labors under a physical disadvantage, such as a maimed or deformed hand or arm, but in lesser degree these peculiarities are present in every handwriting and constitute the general constant of "will-power, nerve sensitiveness and muscular force" employed by a given individual in this perfunctory habit.

I say *general* constant to imply that this relation must be regarded without paying too much attention to detail, for probably on no two occasions of a man's life do these factors exist in him in *absolutely* the same proportions, and even if they did, the least change of environment would alter the results thus accomplished. But the signature of a man being divested as much as possible of the accidents due to his outside influences, it follows that the signature is the production of his hand least likely to yield an insight into his condition when writing it. On the other hand, the fact that he selects one particular way of expressing his identity bestows upon it something of a resultant of the various motives which actuate him, and makes it a sort of digest of the points of his character called into play in the performance of the act. We may look for the same sort of character in a signature that we find in a photograph or a picture, and the same causes may prevent either the one or the other from faithfully representing the peculiarities of the individual, by representing that individual as he appears when conscious that he is being observed; or, in other words, a character is assumed which corresponds to the taste of the individual and represents more or less how he would like to be seen by the public. When the character is observed to exist throughout the entire mass of his writing, it may be assumed that it represents accurately the man, for no amount of patience and study would enable one to retain such peculiarities under all the varied circumstances attending the act of writing, if it were not inherent in the individual himself. In any case, however, the result is a likeness which all who know the original will recognize, even though one or two features may be made more prominent in pose than in repose, and that constitutes the chief value of the analysis of signatures for identification independently of what we may learn from them of the mental attributes of their signers.

It is not always entirely obvious how signatures with many light flourishes, or accompanied by intricate lines connecting their several parts, should be superposed, for these appendices are so easily affected by minute causes that it seldom happens that two will cover each other exactly. It is not to be expected that such parts will survive in the resulting type signature, but the breadth of the space covered by the blur and parallelism of the faint lines will give evidence of the extent to which these ornaments have grown from caprice to a habit.

As a general rule there are several places—sometimes as many as eight or nine in a long signature—when the darkening of the lines indicates a general conformity of the pen's path to one direction, and it would seem that these places were not peculiar to any one part of a letter, nor that they were less in a hair line than in a heavy stroke. They appear to be dependent upon the anatomy and muscular structure of the individual in connection with his method of performing the act of writing his signature. For instance, some writers can only form one or two letters without moving the writing hand; only a word or so without shifting the elbow; others describe with the forearm of the writing hand a curve around the elbow which remains stationary; others slide the forearm along into parallel positions while writing. All these habits have different effects upon the handwriting which results, though they are not always to be easily detected, owing to the fact that other habits are cultivated at the same time to counteract the defect which each of these methods, when not so compensated, would have impressed upon the appearance of the chirography.

Thus, he who writes with an elbow pivoted immovably upon the table must learn to move the fingers over a greater space at some part of the line, to avoid the curve which would unconsciously result. This more vigorous movement of the fingers is likely to produce heavier strokes in the part of the signature where the compensation is naturally applied. So that a fixed elbow and heavy letter in the middle of the signature may stand to each other in the relation of cause and effect.

In signatures when the divergence is wide and the agreement correspondingly small, it has been my custom to use the dark portions as centres to adjust the various signatures on, and this plan will sometimes furnish a good composite when other plans fail.

Desiring an illustration to accompany this paper, I sought a signature which would serve as a fair test of the process. Manifestly such a signature must be well known to a large number of persons, and enough examples of it must exist to bring out the type character of their combination. Those individuals whose signatures are known to the largest number of persons are usually bankers or persons authorized to sign firm drafts, checks, &c., and these not unnaturally object to having the minutest characteristics of their writing brought to the knowledge of the public, though for the reasons stated above a study of what the composite teaches would convince the intending forger that his task was a far more difficult one than that of simply reproducing a design. On the other hand signatures of dead bankers and dissolved firms soon pass out of the remembrance of those who were once familiar with them, and therefore have no more significance than the sign manuals of unknown writers, or those which are purely fictitious.

George Washington's signature was one of the first to suggest itself, because many persons were familiar with it, and there are numerous well-authenticated documents in existence which bear it; but it has proved to possess other advantages which were not known when it was selected. As in everything else, Washington was deliberate, pains-taking and uniform in his method of writing his signature and the consequence is that it makes an excellent composite for illustration.

In writing his signature Washington put pen to the paper five times. First he wrote the "G W" in one connected line. Secondly, he raised his hand and made the small "o" between the upper parts of the G and W, and the two dots which appear in all but signature No. 7. Thirdly, his hand and arm were placed in position to write "ashing," these six letters occupying a breadth of almost exactly $1\frac{3}{4}$ inches in every signature except the third, when they are extended to $1\frac{13}{16}$ inches. This is about as much of the arc of a circle (of which the centre is the elbow pivoted on the table) as one with a forearm of average length can cause to coincide with the tangent, or the straight line across the paper which the lower parts of the letters follow, unless unusual effort be made and a great deal more movement be given to the fingers. The "g" ends in a curved flourish, of which the convex side is turned upwards below the right centre of the name. [NOTE. The lower loop of the "g" in all the signatures and in the composite was cut off in preparing the plate.] Fourthly, he wrote the final "ton." Fifthly, he added the very peculiar flourish above the right centre of the name, with the object of dotting the "i" and crossing the "t" at the same stroke.

In examining the composite, the effect of these various separate movements becomes manifest in its strengthened portions. It is hardly possible that any one during the period of sixteen years, which these signatures represent, or from 1776 to 1792, should have so schooled his hand to write a long name that the first inch or so of the writing should always occupy the same relative position to the body of the signature. It would take at least that much action for the hand and arm and pen to be brought into normal signature-writing condition; and especially is this so when this part of the writing is accompanied by flourishes as it is in the case we are considering. The "G W" and the little "o" and the dots at the top were the prelude, after which the arm was moved into position to write the main body of the signature or the "ashing." Of course, from the manner of making the dots, and the extremely small space they cover, their re-enforcement of each other in the composite was almost impossible, and, in fact, like other subordinate characters, they disappear almost completely. This latter is the part of the name which one would have expected to exhibit the greatest amount of uniformity, as in point of fact it does, with the exception of its terminal "g," which shows more variation than any of the other letters, because at this point the limit of coincidence between the tangent line of the writing and the curve, of which the right forearm was the radius, had been passed, and a freer movement of the fingers was compensating for the increasing divergence. [NOTE. It is likely that Washington sometimes raised the hand between the end of the long "s"

Francis Galton on Composite Portraits

COMPOSITE PORTRAITS[1]

I SUBMIT to the Anthropological Institute my first results in carrying out a process that I suggested last August in my Presidential Address to the Anthropological Subsection of the British Association at Plymouth, in the following words:—

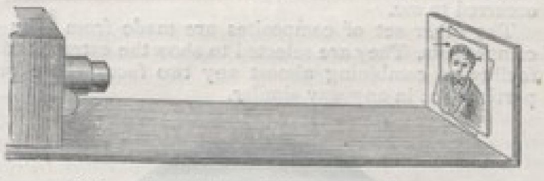
"Having obtained drawings or photographs of several persons alike in most respects, but differing in minor details, what sure method is there of extracting the typical characteristics from them? I may mention a plan which had occurred both to Mr. Herbert Spencer and myself, the principle of which is to superimpose optically the various drawings and to accept the aggregate result. Mr. Spencer suggested to me in conversation that the drawings reduced to the same scale might be traced on separate pieces of transparent paper and secured one upon another, and then held between the eye and the light. I have attempted this with some success. My own idea was to throw faint images of the several portraits, in succession, upon the same sensitised photographic plate. I may add that it is perfectly easy to superimpose optically two portraits by means of a stereoscope, and that a person who is used to handle instruments will find a common double eyeglass fitted with stereoscopic lenses to be almost as effectual and far handier than the boxes sold in shops."

Mr. Spencer, as he informed me, had actually devised an instrument many years ago, for tracing mechanically, longitudinal, transverse, and horizontal sections of heads on transparent paper, intending to superimpose them and to obtain an average result by transmitted light.

Since my Address was published, I have caused trials to be made, and have found as a matter of fact that the photographic process of which I there spoke, enables us to obtain with mechanical precision a generalised picture; one that represents no man in particular, but portrays an imaginary figure, possessing the average features of any given group of men. These ideal faces have a surprising air of reality. Nobody who glanced at one of them for the first time, would doubt its being the likeness of a living person. Yet, as I have said, it is no such thing; it is the portrait of a type, and not of an individual.

I begin by collecting photographs of the persons with whom I propose to deal. They must be similar in attitude and size, but no exactness is necessary in either of these respects. Then by a simple contrivance I make two pin-holes in each of them, to enable me to hang them up one in front of the other, like a pack of cards, upon the same pair of pins, in such a way that the eyes of all the portraits shall be as nearly as possible superimposed; in which case the remainder of the features will also be superimposed nearly enough. These pin-holes correspond to what are technically known to printers as "register marks." They are easily made; a slip of brass or card has an aperture cut out of its middle, and

threads are stretched from opposite sides, making a cross. Two small holes are drilled in the plate, one on either side of the aperture. The slip of brass is laid on the portrait with the aperture over its face. It is turned about until one of the cross threads cuts the pupils of both the eyes, and it is further adjusted until the other thread divides the interval between the pupils in two equal parts. Then it is held firmly, and a prick is made through each of the holes. The portraits being thus arranged, a photographic camera is directed upon them. Suppose there are eight portraits in the pack, and that under existing circumstances it would require an exposure of eighty seconds to give an exact photographic copy of any one of them. The general principle of proceeding is this, subject in practice to some variation of details, depending on the different brightness of the several portraits. We throw the image of each of the eight portraits in turn upon the same part of the sensitised plate for ten seconds. Thus, portrait No. 1 is in the front of the pack; we take



the cap off the object-glass of the camera for ten seconds, and afterwards replace it. We then remove No. 1 from the pins, and No. 2 appears in the front; we take off the cap a second time for ten seconds, and again replace it. Next we remove No. 2, and No. 3 appears in the front, which we treat as its predecessors, and so we go on to the last of the pack. The sensitised plate will now have had its total exposure of eighty seconds; it is then developed, and the print taken from it is the generalised picture of which I speak. It is a composite of eight component portraits. Those of its outlines are sharpest and darkest that are common to the largest number of the components; the purely individual peculiarities leave little or no visible trace. The latter being necessarily disposed equally on both sides of the average, the outline of the composite is the average of all the components. It is a band, and not a fine line, because the outlines of the components are seldom exactly superimposed. The band will be darkest in its middle whenever the component portraits have the same general type of features, and its breadth or amount of blur will measure the tendency of the components to deviate from the common type. This is so for the very same reason that the shot-marks on a target are more thickly disposed near the bulls-eye than away from it, and in a greater degree as the marksmen are more skilful. All that has been said of the outlines is equally true as regards the shadows; the result being that the composite represents an averaged figure, whose lineaments have been softly drawn. The eyes come out with appropriate distinctness, owing to the mechanical conditions under which the components were hung.

A composite portrait represents the picture that would rise before the mind's eye of a man who had the gift of pictorial imagination in an exalted degree. But the imaginative power even of the highest artists is far from precise, and is so apt to be biased by special cases that may have struck their fancies, that no two artists agree in any of their typical forms. The merit of the photographic composite is its mechanical precision, being subject to no errors beyond those incidental to all photographic productions.

I submit several composites made for me by Mr. H. Reynolds. The first set of portraits are those of criminals convicted of murder, manslaughter, or robbery accompanied with violence. It will be observed that the features of the composites are much better looking than those of the components. The special villainous irregu-

[1] Made by combining those of many different persons into a single resultant figure. By Francis Galton, F.R.S. Paper read before the Anthropological Institute, April 30.

larities in the latter have disappeared and the common humanity that underlies them has prevailed. They represent, not the criminal, but the man who is liable to fall into crime. All composites are better looking than their components, because the averaged portrait of many persons is free from the irregularities that variously blemish the looks of each of them. I selected these for my first trials because I happened to possess a large collection of photographs of criminals through the kindness of Sir Edmund Du Cane, the Director-General of Prisons, for the purpose of investigating criminal types. They were peculiarly adapted to my present purpose, being all made of about the same size and taken in much the same attitudes. It was while endeavouring to elicit the principal criminal types by methods of optical superimposition of the portraits, such as I had frequently employed with maps and meteorological traces,[1] that the idea of composite figures first occurred to me.

The other set of composites are made from pairs of components. They are selected to show the extraordinary facility of combining almost any two faces whose proportions are in any way similar.

The accompanying woodcut is as fair a representation of one of the composites as is practicable in ordinary printing. It was photographically transferred to the wood, and the engraver has used his best endeavour to translate the shades into line engraving. This composite is made out of only three components, and its three-fold origin is to be traced in the ears, and in the buttons to the vest. To the best of my judgment the original photograph is a very exact average of its components; not one feature in it appears identical with that of any one of them, but it contains a resemblance to all, and is not more like to one of them than to another. However the judgment of the wood engraver is different. His rendering of the composite has made it exactly like one of its components, which it must be borne in mind he had never seen. It is just as though an artist drawing a child had produced a portrait closely resembling its deceased father, having overlooked an equally strong likeness to its deceased mother, which was apparent to its relatives. This is to me a most striking proof that the composite is a true combination. [I trust that the beauty of the woodcut will not be much diminished by the necessarily coarse process of newspaper printing.]

It will, I am sure, surprise most persons to see how well defined these composites are. When we deal with faces of the same type, the points of similarity far outnumber those of dissimilarity, and there is a much greater resemblance between faces generally, than we who turn our attention to individual differences are apt to appreciate. A traveller on his first arrival among people of a race very different to his own, thinks them closely alike, and a Hindu has much difficulty in distinguishing one Englishman from another.

[1] "Conference at the Loan Exhibition of Scientific Instruments," 1878, Chapman and Hall. Physical Geography Section, p. 312, "On Means of Combining Various Data in Maps and Diagrams," by Francis Galton, F.R.S.

The fairness with which photographic composites represent their components is shown by six of the specimens. I wished to learn whether the order in which the components were photographed made any material difference in the result, so I had three of the portraits arranged successively in each of their six possible combinations. It will be observed that four at least of the six composites are closely alike. I should say that in each of this set the last of the three components was always allowed a longer exposure than the second, and the second than the first, but it is found better to allow an equal time to all of them.

The stereoscope, as I stated last August in my address at Plymouth, affords a very easy method of optically superimposing two portraits, and I have much pleasure in quoting the following letter, pointing out this fact as well as some other conclusions to which I also had arrived. The letter was kindly forwarded to me by Mr. Darwin; it is dated last November and was written to him by Mr. A. L. Austin from New Zealand, thus affording another of the many curious instances of two persons being independently engaged in the same novel inquiry at nearly the same time, and coming to similar results.

"*Invercargill, New Zealand, Nov.* 6, 1877.

"To Charles Darwin, Esq.

"SIR,—Although a perfect stranger to you, and living on the reverse side of the globe, I have taken the liberty of writing to you on a small discovery I have made in binocular vision in the stereoscope. I find by taking two ordinary *carte-de-visite* photos of two different persons' faces, the portraits being about the same sizes and looking about the same direction, and placing them in a stereoscope, the faces blend into one in a most remarkable manner, producing in the case of some ladies' portraits in every instance a *decided improvement* in beauty. The pictures were not taken in a binocular camera, and therefore do not stand out well, but by moving one or both until the eyes coincide in the stereoscope, the pictures blend perfectly. If taken in a binocular camera for the purpose, each person being taken on one half of the negative, I am sure the results would be still more striking. Perhaps something might be made of this in regard to the expression of emotions in man and the lower animals, &c. I have not time or opportunities to make experiments, but it seems to me something might be made of this by photographing the faces of different animals, different races of mankind, &c. I think a stereoscopic view of one of the ape tribe and some low caste human face would make a very curious mixture; also in the matter of crossing of animals and the resulting offspring. It seems to me something also might result in photos of husband and wife and children, &c. In any case the results are curious if it leads to nothing else. Should this come to anything you will no doubt acknowledge myself as suggesting the experiment and perhaps send me some of the results. If not likely to come to anything a reply would much oblige me.

"Yours very truly,

"A. L. AUSTIN, C.E., F.R.A.S."

Dr. Carpenter informs me that the late Mr. Appold, the mechanician, used to combine two portraits of himself, under the stereoscope. The one had been taken with an assumed stern expression, the other with a smile; and this combination produced a curious and effective blending of the two.

Convenient as the stereoscope is, owing to its accessibility, for determining whether any two portraits are suitable in size and attitude to form a good composite, it is nevertheless a makeshift and imperfect way of attaining the required result. It cannot of itself combine two images; it can only place them so that the office of attempting to combine them may be undertaken by the brain. Now the two separate impressions received by the brain through the stereoscope do not seem to me to be relatively constant in their vividness, but sometimes the image seen by the left eye prevails over that seen by the right, and *vice versâ*. All the other instruments I am about to describe accomplish that which the stereoscope fails to do; they create true optical combinations. As regards other points in Mr. Austin's letter, I cannot think that the use of a binocular camera for taking the two portraits intended to be combined into one by the stereoscope would be of importance. All that is wanted is that the portraits should be nearly of the same size. In every other respect I cordially agree with Mr. Austin.

The best instrument I have as yet contrived and used for optical superimposition is a "double image prism" of Iceland spar. The latest that I have had were procured for me by Mr. Tisley, optician, 172, Brompton Road. They have a clear aperture of a square, half an inch in the side, and when held at right angles to the line of sight will separate the ordinary and extraordinary images to the amount of two inches, when the object viewed is held at seventeen inches from the eye. This is quite sufficient for working with *cartes-de-visite* portraits. One image is quite achromatic, the other shows a little colour. The divergence may be varied and adjusted by inclining the prism to the line of sight. By its means the ordinary image of one component is thrown upon the extraordinary image of the other, and the composite may

FIG. 1.

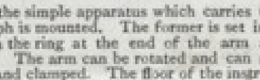


FIG. 2

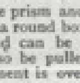


FIG. 3.

FIG. 1 shows the simple apparatus which carries the prism and on which the photograph is mounted. The former is set in a round box which can be rotated in the ring at the end of the arm and can be clamped when adjusted. The arm can be rotated and can also be pulled out or in if desired, and clamped. The floor of the instrument is overlaid with cork covered with black cloth, on which the components can easily be fixed by drawing pins. When using it one portrait is pinned down and the other is moved near to it, overlapping its margin if necessary, until the eye looking through the prism sees the required combination; then the second portrait is pinned down also. It may now receive its register-marks from needles fixed in a hinged arm, and this is a more generally applicable method than the plan with cross threads, already described, as any desired feature—the nose, the ear, or the hand, may thus be selected for composite purposes. Let A, B, C, . . . Y, Z, be the components. A is pinned down, and B, C, . . Y, Z, are successively combined with A, and registered. Then before removing Z, take away A and substitute any other of the already registered portraits, say B, by combining it with Z; lastly, remove Z and substitute A by combining it with B, and register it. FIG. 2 shows one of three similarly-jointed arms, which clamp on to the vertical rod. Two of these carry a light frame covered with cork and cloth, and the other carries FIG. 3, which is a frame having lenses of different powers set into it, and on which, or on the third frame, a small mirror inclined at 45° may be laid. When a portrait requires foreshortening it can be pinned on one of these frames and be inclined to the line of sight; when it is smaller than its fellow it can be brought nearer to the eye and an appropriate lens interposed; when a right-sided profile has to be combined with a left-handed one, it must be pinned on one of the frames and viewed by reflection from the mirror in the other. The apparatus I have drawn is roughly made, and being chiefly of wood, is rather clumsy, but it acts well.

be viewed with the naked eye or through a lens of long focus, or through an opera-glass (a telescope is not so good) fitted with a sufficiently long draw-tube to see an object at that short distance with distinctness. Portraits of somewhat different sizes may be combined by placing the larger one further from the eye, and a long face may be fitted to a short one by inclining and foreshortening the former. The slight fault of focus thereby occasioned produces little or no sensible ill-effect on the appearance of the composite.

The front and profile faces of two living persons sitting side by side or one behind the other, can be easily superimposed by a double image prism. Two such prisms set one behind the other can be made to give four images of equal brightness, occupying the four corners of a rhombus, whose acute angles are 45°. Three prisms will give eight images; but this is practically not a good combination, the images fail in distinctness, and are too near together for use. Again, each lens of a stereoscope of long focus can have one or a pair of these prisms attached to it, and four or eight images may be thus combined.

Another instrument I have made, consists of a piece of glass inclined at a very acute angle to the line of sight, and of a mirror beyond it, also inclined, but in the opposite direction to the line of sight. Two rays of light will therefore reach the eye from each point of the glass; the one has been reflected from its surface, and the other has been first reflected from the mirror, and then transmitted through the glass. The glass used should be extremely thin, to avoid the blur due to double reflections; it may be a selected piece from those made to cover microscopic specimens. The principle of the instrument may be yet further developed by interposing additional pieces of glass successively less inclined to the line of sight, and each reflecting a different portrait.

I have tried many other plans; indeed, the possible methods of optically superimposing two or more images are very numerous. Thus I have used a sextant (with its telescope attached); also strips of mirrors placed at different angles and their several reflections simultaneously viewed through a telescope. I have also used a divided lens, like two stereoscopic lenses brought close together, in front of the object-glass of a telescope.

I have not yet had an opportunity of superimposing images by placing glass negatives in separate magic-lanthorns, all converging upon the same screen; but this or even a simple dioramic apparatus would be very suitable for exhibiting composite effects to an audience, and if the electric light were used for illumination the effect on the screen could be photographed at once. It would also be possible to construct a camera with a long focus, and many slightly divergent object glasses, each throwing an image of a separate glass negative upon the same sensitised plate.

The uses of composite portraits are many. They give us typical pictures of different races of men, if derived from a large number of individuals of those races taken at random. An assurance of the truth of any of our pictorial deductions is to be looked for in their substantial agreement when different batches of components have been dealt with, this being a perfect test of truth in all statistical conclusions. Again, we may select prevalent or strongly marked types from among the men of the same race, just as I have done with two of the types of criminals by which this memoir is illustrated.

Another use of this process is to obtain by photography a really good likeness of a living person. The inferiority of photographs to the best works of artists, so far as resemblance is concerned, lies in their catching no more than a single expression. If many photographs of a person were taken at different times, perhaps even years apart, their composite would possess that in which a single photograph is deficient. I have already pointed out the experience of Mr. Appold to this effect. The analytical tendency of the mind is so strong that out of any tangle of superimposed outlines it persists in dwelling preferably on some one of them, singling it out and taking little heed of the rest. On one occasion it will select one outline, on another a different one. Looking at the patterns of the papered walls of our room we see, whenever our fancy is active, all kinds of forms and features; we often catch some strange combination which we are unable to recall on a subsequent occasion, while later still it may suddenly flash full upon us. A composite portrait would have much of this varied suggestiveness.

A further use of the process would be to produce from many independent portraits of an historical personage, the most probable likeness of him. Contemporaneous statues, medals, and gems would be very suitable for the purpose, photographs being taken of the same size, and a composite made from them. It will be borne in mind that it is perfectly easy to apportion different "weights" to the different components. Thus, if one statue be judged to be so much more worthy of reliance than another that it ought to receive double consideration in the composite, all that is necessary is to double either the time of its exposure or its illumination.

The last use of the process that I shall mention is of great interest as regards inquiries into the hereditary transmission of features, as it enables us to compare the average features of the produce with those of the parentage. A composite of all the brothers and sisters in a large family would be an approximation to what the average of the produce would probably be if the family were indefinitely increased in number, but the approximation would be closer if we also took into consideration those of the cousins who inherited the family likeness. As regards the parentage, it is by no means sufficient to take a composite of the two parents; the four grandparents and the uncles and aunts on both sides should be also included. Some statistical inquiries I published on the distribution of ability in families[1] give provisional data for determining the weight to be assigned in the composite to the several degrees of relationship. I should, however, not follow those figures in the present case, but would rather suggest for the earlier trials, first to give equal "weights" to the male and female sides; thus the father and a brother of the male parent would count equally with the father and a brother of the female parent. Secondly, I should "weight" each parent as 4, and each grandparent and each uncle and aunt as 1; again, I should weight each brother and sister as 4, and each of those cousins as 1 who inherited any part of the likeness of the family in question. The other cousins I should disregard. The weights as previously mentioned, would be bestowed by giving proportionate periods of exposure.[2]

Composites on this principle would undoubtedly aid the breeders of animals to judge of the results of any proposed union better than they are able to do at present, and in forecasting the results of marriages between men and women they would be of singular interest and instruction. Much might be learnt merely by the frequent use of the double image prism, as described above, which enables us to combine the features of living individuals when sitting side by side into a single image.

I have as yet had few opportunities of developing the uses of the composite photographic process, it being difficult without much explanation to obtain the requisite components. Indeed, the main motive of my publishing these early results is to afford that explanation, and to enable me to procure a considerable variety of materials to work upon. I especially want sets of family photographs all as nearly as possible of the same size and taken in the same attitudes. The size I would suggest for family composites is that which gives one-half of an inch interval between the pupil of the eye and the line that separates the two lips. The attitudes about which there can be no mistake are: full face, an exact profile, say, always showing the right side of the face, and an exact three-quarters, always showing the left; in this, the outer edge of the right eye-lid will be only just in sight. In each case the sitter should look straight before him. Such portraits as these go well into *cartes de visite*, and I trust that not a few amateur photographers may be inclined to make sets of all the members of their family, young and old, and of both sexes, and to try composites of them on the principles I have described. The photographs used for that purpose need not be in the least injured, for the register marks may be made in the case into which they are slipped, and not in the photographs themselves.

[1] "Hereditary Genius," p. 317. Column D. Macmillan, 1869.

[2] Example:—There are 5 brothers or sisters and 5 cousins whose portraits are available; the total period of desired exposure is 100 seconds. $5 \times 4 + 5 = 25$; $\frac{100}{25} = 4$; which gives $4 \times 4 = 16$ seconds for each brother or sister, and 4 seconds for each cousin ($5 \times 16 + 5 \times 4 = 100$).

THE SEICHES OF THE LAKE OF GENEVA[1]

AMONG the best-established phenomena of terrestrial physics is that which from ancient times has been known at Geneva under the name of *seiches*. Its true nature has been only recently recognised, and the obscurity which still envelops its causes gives it an interest calculated to attract the attention of men of science of every country. It is not necessary to have a knowledge of science to recognise in the neighbourhood of Geneva sudden irregular changes of very varied amounts, which sometimes affect the level of the lake. They are analogous to small tides whose existence is well established, but whose origin is not determined. For eight years Prof. Forel has worked at the problem by studying the characteristics of the progress of the phenomenon. The following is a *résumé* of his observations and conclusions.

Previous to Prof. Forel, eminent naturalists, among them Jallabert, Bertrand, H. B. de Saussure, J. P. E. Vaucher, had pointed out the existence of these *seiches*, described them, and hazarded hypotheses to account for them, hypotheses which for the most part cannot be maintained. Former observations furnish some guiding points to examine the question. They were made mainly near Geneva, where the oscillations of the level of the lake are much more marked than anywhere else on its shores. It is, however, at a much less favourably situated point of the shore that M. Forel has undertaken his regular investigations. Morges, his usual residence, is situated on the north shore of the lake, opposite its greatest breadth, and a little to the east of the line dividing its total length into two equal parts. There, by means of ingenious instruments, the movements of the liquid surface have been registered with regularity and sagacity, and veritable discoveries have been the result of the work.

Vaucher, at the beginning of the century, had already surmised that *seiches* must exist in all lakes, that they take place at all seasons and at all hours of the day, that they are more frequent in spring and in autumn, more frequent especially when the atmosphere is subject to strong variations in pressure. He valued approximately their duration, and predicted their character of permanence, which assimilated them to the incessant oscillations of the fluid mass. He believed, as H. B. De Saussure announced in 1779, that "prompt and local variations in the weight of the air could contribute to the phenomenon and produce momentary fluxes and refluxes by causing unequal pressures on the different parts of the lake." The movement of the liquid will then be an oscillation of libration. Vaucher admitted that this oscillation was progressive. His conclusion did not appear justified; he did not take into account the rhythm of the *seiches*, which, in reality, shows itself with a remarkable regularity whatever be their amplitude, and the duration of which is connected with the dimensions of the lake in length and depth.

[1] Researches by Dr. F. A. Forel, Professor at the Academy of Lausanne. *Bulletins de la Section Vaudoise des Sciences Naturelles*, 1873 and 1875. *Arch. des Sc.*, 1874-76.

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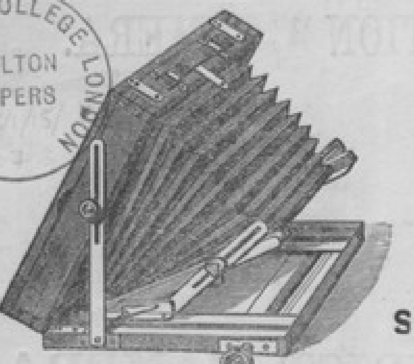
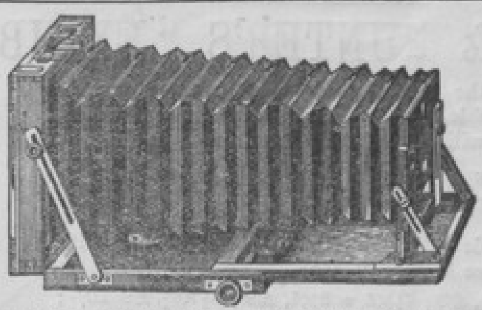
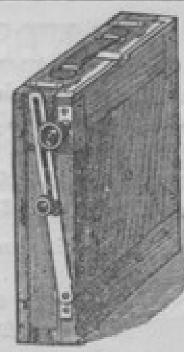

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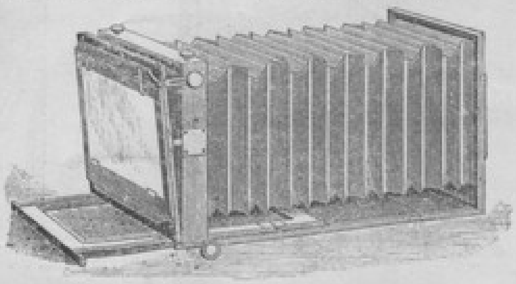

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Printed and Published by THOMAS PIPER and GEORGE CARTER, at 5, Furnival Street (lately known as Castle Street), Holborn, London, E.C., FRIDAY, JUNE 18, 1886.

THE PHOTOGRAPHIC NEWS.

Vol. XXX. No. 1459.—*August* 20, 1886.

CONTENTS.

ABNEY'S INSTRUCTION IN PHOTOGRAPHY.*

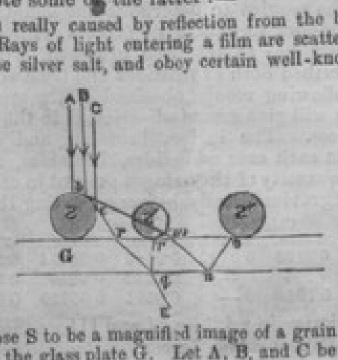
So much more is the seventh edition just issued than the previous editions, that something beyond a passing notice is required of this, the standard manual of the English photographic practitioner.

To begin with, we must enter a mild protest as to a handbook of such size and importance being issued in a paper cover. It is true that the possessor can have it bound, but in order to do so he must part with it, perhaps for some weeks, and just at the time when he wants it most. Moreover, the cost of specially binding one copy would probably be five times the amount which the publisher would have to charge extra on account of the binding.

Apart from the careful revision, amplification, and bringing up to date of the general mass of information contained in the book, the main additions are a comprehensive chapter on "Paper Negative Processes" (twelve pages), and a very detailed account of the whole working of the Platinotype process; not a mere account of how to use commercial platinotype paper, but really full and sufficient directions for working the process. To this is added the list of defects and remedies as published by Pizzighelli and Hubl.

There is, besides the above, some new matter which will more interest the photographer who has a speculative turn, or who likes to travel away from the beaten track—such as Abney's studies on the intensity of illumination, the fixing power of sulphite of soda, and remarks on halation. We may quote some of the latter:—

Halation is really caused by reflection from the back of the glass plate. Rays of light entering a film are scattered by the particles of the silver salt, and obey certain well-known optical



laws. Suppose S to be a magnified image of a grain of the silver salt lying on the glass plate G. Let A, B, and C be three of the rays falling on S. They will each be reflected according to the ordinary laws of reflection. A, which falls on the top of the grain, will be reflected vertically back. B will be reflected to *m*, the top surface of the glass, and be refracted to *n*, and will be totally reflected from *n* to *o*, where another particle, S', may be situated; B, by reflection, will then act on S'. The ray C will be reflected intermediately between S and S' to *p*, and will be refracted to *q*. Part will pass out to *t*, and part be reflected to *r*, where another grain of silver (S") may be situated, and, therefore, the ray C will also act on S" as well as on S. This will be the case, although no direct rays fall on S' and S".

Our advice with regard to Abney's book is—"get it."

* "Instruction in Photography," by Captain Abney, R.E., F.R.S. Seventh edition, crown 8vo, 380 pages. Price three shillings and sixpence. London: Piper and Carter, 5, Furnival Street, E.C. 1886.

DECHAN'S METHOD FOR THE DETECTION AND ESTIMATION OF IODINE, BROMINE, AND CHLORINE.

A SATISFACTORY method of separating and estimating the halogens when all are together in the same mixture, has long been one of the needs of the analyst, and it is not too much to say that up to now no moderately easy method has been devised which gives anything like satisfactory results. We therefore are pleased to note that M. Dechan has devised a method depending on the successive liberation of the halogens by chromic compounds, and we reproduce the details from the *Journal of the Chemical Society*.

The various methods which have been proposed for the qualitative determination of iodine, bromine, and chlorine, in the presence of each other, are either so complicated or so uncertain, that any simplication of the process of working, which would at the same time yield more accurate results, must be of interest to the analyst. The detection of iodine in the presence of bromine and chlorine has been shown by Cook (Trans., 1885, 471) to be readily accomplished. The presence, however, of small quantities of bromine and chlorine is admitted to be much more difficult of detection. For quantitative purposes, the separation of the halogens is a problem of even still greater difficulty, and is one which up to the present has been but imperfectly solved.

A strong solution of potassic dichromate at the ordinary temperature has little or no action on potassic iodide; if, however, the temperature be raised to the boiling point of the liquid, the iodide is completely decomposed in accordance with the equation—

$$5K_2Cr_2O_7 + 6KI = 3I_2 + 8K_2CrO_4 + Cr_2O_3$$

and the whole of the iodine is liberated, whereas bromides and chlorides are not in the least affected. On adding dilute sulphuric acid, and again distilling, the bromine is alone liberated. A simple process of separating the halogens may be based on these facts.

The solution of potassic dichromate which I have found to yield the best results, is prepared by dissolving 40 grms. of the salt in 100 c.c. of water. A solution of this strength is without any effect on bromides or chlorides, but the iodides are rapidly decomposed by it. For the purpose of decomposing the bromides and liberating the bromine, a dilute solution of sulphuric acid is added to the dichromate solution. The acid solution is composed of equal parts by volume of acid (1·84 sp. gr.) and water, and should be added to the dichromate solution in the proportion of 8 c.c. of the dilute acid to every 100 c.c. of water originally taken to prepare the dichromate solution. The chlorides are partially decomposed by the acid solution with the formation of chloro-chromic anhydride, CrO_2Cl_2; this, however, is not carried over with the distillate in solutions of the above strength.

For qualitative analysis, the following method has been adopted: a medium-sized boiling tube is fitted with a delivery-tube, bent twice at right angles, one of the limbs of the tube being long enough to reach to the bottom of an ordinary test-tube. The potassic dichromate and water are placed in the tube in the proportions already indicated, together with the substance to be analysed. The contents of the tube are heated, and when ebullition commences, the end of the delivery-tube is dipped beneath the surface of a little water, to which has been added a drop of carbon bisulphide, contained in an ordinary test-tube: the merest trace of iodine is thus shown. The boiling is continued so long as the escaping vapours turn a drop of starch solution blue. Should the boiling be prolonged, care must be taken not to allow the liquid to become concentrated below two-thirds of its original bulk. When the vapours no longer affect the starch solution, the tube is withdrawn from the flame, and a quantity of the dilute acid added in the proportions already stated. The contents of the tube are again boiled, and the escaping vapours tested for bromine by means of a little chloroform, or a solution of potassic iodide and starch. When all the bromine has been evolved, the contents of the boiling tube are rinsed into a clean beaker, diluted with water, and tested in the ordinary way for chlorine. For qualitative purposes, care must be taken to employ pure potassic dichromate; this ought to be specially tested for chlorine before being used.

For quantitative determinations, the following arrangements must be provided for: prolonged boiling, for about one hour, with some means of keeping the volume of liquid at not less than two-thirds of its original bulk without requiring to take the apparatus apart. The reason why the liquid must not be concentrated beyond the point indicated, is, that in liberating the bromine with the aid of the dilute acid, traces of chlorochromic anhydride are given off if the liquid becomes too concentrated, and this, coming into contact with the potassic iodide solution, liberates some of the iodine.

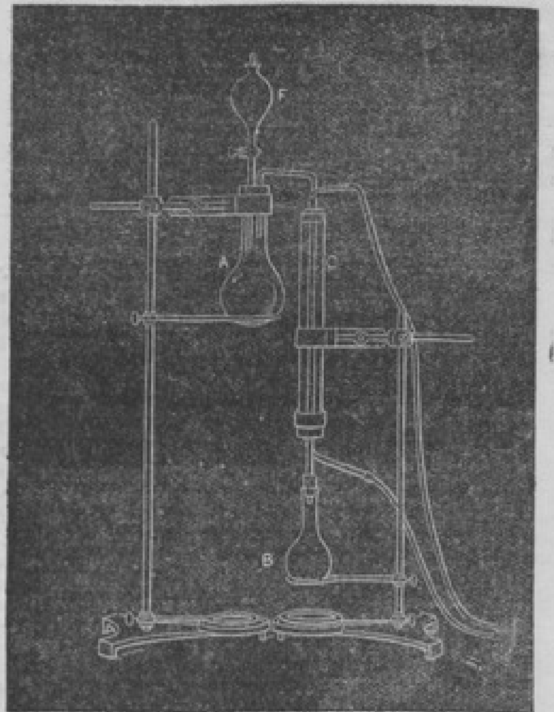
The accompanying sketch shows the arragement of the apparatus used for quantitative determinations:—

The flask A has a capacity of 150 c.c.; the separating funnel F serves for keeping up the volume of liquid, and also for adding the dilute acid. The flask B, attached to the lower end of the condenser C, contains the potassic iodide solution for the purpose of dissolving the liberated iodine. It has a capacity of about 100 c.c.

The details of the process are as follows:—100 c.c. of water, 40 grams of the potassic dichromate, and about 0·4 gram of the substance to be analysed, are placed in the flask A; the apparatus is then put together as shown in the sketch, the contents of A heated to boiling, and the iodine which distils over is received in the flask B. After boiling for ten minutes, the flask B may be removed, and a test-tube containing a solution of starch inserted in its place. The boiling is continued until a drop of starch solution is no longer turned blue by the condensed vapours. When this occurs, the burner is removed for a moment, and 8 c.c. of the dilute acid added by means of the separating funnel. The contents of B, together with the other parts of the iodine distillate, are rinsed into a beaker, and the iodine determined by means of decinormal thiosulphate solution.

The flask B is now charged with a fresh solution of potassic iodide, attached to the condenser as before, and the distillation continued. When all the bromine is driven over—which is known by the condensed vapours no longer turning a solution of potassic iodide and starch blue—the quantity of iodine liberated by the bromine is estimated as before, and the equivalent amount of bromine determined by calculation.

The contents of A are rinsed into a beaker and diluted



with water, which decomposes the chlorochromic acid formed, into chromic acid and hydrochloric acid. Nitric acid is now added, and the chlorine precipitated with argentic nitrate in the usual way.

Comparing the process herein described with those already published, it will be readily admitted to be more easy of application, and will, I feel sure, be found to be capable of yielding more regular and accurate results. Those who require to determine the quantity of bromine in kelp liquors, for which no process with any pretension to accuracy has as yet been proposed, will find the one here described both expeditious and trustworthy.

The following results obtained in the analysis of three mixtures will give some indication as to the capabilities of the process. The iodine, bromine, and chlorine were present in each case as iodides, bromides, and chlorides, and the quantity of the halogen present in each salt was determined gravimetrically before preparing the mixtures:—

No. of Mixture.	Chlorine. Taken.	Chlorine. Found.	Bromine. Taken.	Bromine. Found.	Iodine. Taken.	Iodine. Found.
I. ...	0·0123	0·0122	0·0126	0·01254	0·01443	0·01441
II. ...	0·056	—	0·0252	0·0250	0·0288	0·02833
III. ...	0·194	—	0·0504	0·05009	0·0576	0·05628

The chlorine in mixture II and III was not determined; and if the apparatus had been constructed so as to do away with the use of cork in the fittings, the results would, I feel sure, have been nearer those demanded by theory.

THE PHOTOGRAPHERS' CONVENTION AT DERBY.

THE Convention—as mentioned in the NEWS last week—met at Derby according to the pre-arrangements, and the programme which we published a month ago was very closely adhered to.

On the opening day, the 12th instant, the chair was taken promptly at nine by the Mayor of Derby, and after the Chairman, A. Pringle, J. T. Taylor, and R. Keene had said a few words each, those present took up their cameras and toured to Haddon Hall and Chatsworth.

In the evening W. England occupied the chair; after he had said a few words as to the aims and ends of the Convention, several papers were read, the more important of which either appear in the News this week, or will be published in due course.

The second day was devoted to visiting Dovedale, and the evening meeting was presided over by Richard Keene. A committee was formed to make arrangements for next year's Convention, and Glasgow was determined upon as the place of meeting. A lantern exhibition then took place.

Altogether the attendance at the Convention may be estimated at from 80 to 100, and we may hope that on each succeeding year the attendance will be larger and larger. J. J. Briginshaw was re-elected with acclamation to the post of honorary secretary, and all communications regarding the Convention should be addressed to him at 21, Albert Road, Walthamstow.

SUCCESS.

BY H. P. ROBINSON.*

I think it just possible that at a Convention like the one we are now holding, in which business is so delightfully mixed up with other things, all the papers read need not be of that strictly scientific or artistic character which is demanded in communications to a Society. Therefore I will avoid technicalities, and turn my paper into a little essay or homily, and take "Success" as my text.

In photography (apart from invention) there are two kinds of success—business success, and the success which results in the production of the most perfect pictures. These two successes seldom go together, and are, indeed, often very wide apart. From a business point of view I am afraid that photography, as a profession, has, of late years, greatly changed for the worse, and I think many of my hearers will agree with me. It is not now the best photographer, but the most shameless tout that makes the most money. There was a time when the photographer who could do the best work, and did it himself just as a painter paints his own pictures, secured the best patronage; then followed a period when the business photographer, knowing little of the art himself, employed skilful assistants, and devoted all his energies to "fighting the battle of the business in the shop." That is, he attended in his reception room, and beguiled his customers into ordering what they did not want. From that time all hope of our art being admitted as one of the professions began to dwindle, and it became an ordinary shop-keeping business—and worse. The enterprising photographer is now not content to wait for sitters or rely on the ordinary methods of advertising, but resorts to the meanest tricks to obtain custom. Solicitation for sittings is general—the tout goes after the servant that he may get at the master, and this occurs with all stations of life in which there is a possible sitter, from the monarch to the tradesman. I think it will more clearly let you know what it has come to if I read you a short but ingenuous letter I have lately received. I preserve the original spelling.

"Dear Sir,—A Short time back I bought your "Photographic Handy Book," No. 6, with the expectation of finding a system of wording or I might say a kind of letter writer when or for the perpose of Soliceting Patranage by writing. You know it is imposable for a profeshional man to solicet and be at home to. Therefore it requires particcular solicetation or rather wording to be soficient inducement to draw them into the Studio. If you can assist me in anyway I shall be greatly oblige for your kindness."

Now I am always troubled if I cannot comply with any request made to me by a brother photographer, but what was I to do in this case? If there is one thing that has degraded our art more than another, it is this touting. I had reluctantly to tell my correspondent, in Ruskin's phrase, that I was quite precisely the last person in the world to write a "Tout's Polite Letter Writer."

Let us get away from this degrading view of success, and try to find the way to that higher and nobler success which should be our aim in picture making. The way to success may be described shortly in the three words, "Never be satisfied." Take an honest pleasure in your work, admire it if you like, but never make up your mind that better cannot be done. I know very well that a year or two ago I wrote a paper in which I tried to persuade the photographer to be satisfied when his picture was "good enough," but this was directed against those who strove after the impossible, and who only succeeded in depriving their pictures of all life and spirit. "Good enough" implies something better than the merely good. It is a wise saying that the good is often the enemy of the best. It is not enough to be good, it is the "little bit better" that makes the work of genius.

There is nothing more disappointing than the "might have been." The portrait would have been better if the expression was not so gloomy; the landscape might have been more successful if that figure had been in the right place, or was more appropriately dressed; the architectural subject would have been worthy of a medal if the lines had been upright. How often do we hear remarks such as these!

It has often been said, perhaps ironically, that nothing succeeds like success. But how are we to estimate what success is? We must know what it is before we strive for it. An approximate definition may be that it is doing everything as well as it can be done. This is only partially correct. It would be nearer right to say that it is doing everything worth doing correctly that is entirely successful.

Finally, is success worth achieving? Is success to be its own exceeding great and only reward, or are those who win success to reap only the revilings of these to whom they have hitherto looked for encouragement and support—those who once were, and still ought to be, leaders of photographic opinion? I think it will be admitted, by all impartial minds, that those photographers who have competed for and won medals at exhibitions, have allowed singularly little of the trade element to influence them in competing. I take credit to myself (and I freely claim the same for others) that I have steadily kept in mind in every thing I have exhibited, that my efforts, however weak, should be to add to the honour and glory of the art; and I admit that I have had a very sufficient reward in the appreciation of my brother photographers. I may also mention that I have been asked by many medal holders, including amateurs who have no commercial interests, both at home and abroad, to speak on this subject, and I do not desire now to speak so much for myself as for those very numerous winners of medals, who appear to have incurred the displeasure of one whose journal has hitherto been the support of all that was honorable in our art. Only the other day the editor of the Photographic News, in alluding in an editorial note to the Glasgow Exhibition, at which no medals were offered, said, "So we may expect to see nothing of the works of those *enterprising traders* who look upon medals as a means of making the untrained public regard them as 'the salt of the earth.'" As it turned out, these "enterprising traders" exhibited very largely.

And this is success, to have the meanest motives imputed to the most successful! There are a large number of medal winners in England and Scotland, and this snub, to call it nothing worse, applies to all. I am afraid that many photographers whose pride and happiness it has been to support the Photographic News are not unlike that often-quoted "Struck Eagle" of Byron's, who—

"Viewed his own feather on the fatal dart,
And winged the shaft that quivered in his heart:
Keen were his pangs, but keener far to feel,
He nursed the pinion which impelled the steel."

It is a Socialist doctrine that all men ought to be equal in all things, in which case one would no more deserve a medal than another, a comfortable creed oftener held by those who "have not" than those who "have;" but I think we may leave Socialism to the congenial street mud in which it usually wallows, and not intoduce it into photography. There can be no doubt that medals have done great good and educed better work than would have been done without them, and thereby materially aided in the advancement of the art. I do not expect to be a competitor much longer, therefore the awarding of medals in the future has little to do with me personally; but I know that the honourable incentive of competing for medals has

* A communication to the Convention.

brought out of me the best work of which I was capable, and which, otherwise, would not have been done. The endeavour to win medals—or, in other words, the struggle to produce the best that their materials would allow, that they may obtain the recognition of their fellows—has been the means of many photographers finding success.

COMPOSITE PORTRAITURE.

BY JOHN T. STODDARD.*

THE composite portraits which are published to-day were made from groups of undergraduates of Smith College. Figs. 1 and 2 each contains forty-nine members of the last senior class; fig. 4 is a composite of a selected group of the same class, containing twenty individuals; while fig. 3 was made from ten members of the class of 1885, who formed an elective division in physics. The average age of all the groups is about twenty-two years.

These portraits may serve as text and illustration for a few remarks on some points of interest in this method of obtaining "pictorial averages."

The great difference between figs. 1 and 2 strikes one at once, and yet they were both made from exactly the same negatives, and under the same conditions, except that in fig. 2 the negatives were so adjusted that the pupils of the eyes in each case fell upon the same points of the sensitive plate, while in fig. 1 the distance from the line of the eyes to the mouth was made constant.

The result of these different modes of adjustment is apparent in the multiple mouth which disfigures fig. 2, and in the less clear definition of the eyes in fig. 1, in which the component eyes fell upon slightly differing points in the same horizontal line.

The question at once arises, which of these faces, if either, in its general outline and expression, is the true average of the group? In seeking the typical features, should we choose fig. 1, and correct the dimness of the eyes, or take fig. 2, and substitute a single mouth in the middle of the blur? As far as I can learn, this question of adjustment and its results has not before been raised. It is, however, a question of importance to all who are interested in composite photography; for only those composites which are made according to the same method of adjustment can be properly compared as types.

In any group of persons not chosen with special reference to facial symmetry, the ratio of the distance between the pupils of the eyes to that between the line of the eyes and the mouth is a variable one; and adjustment to either distance as a constant for the group will give its corresponding and differing composite. Mr. Galton makes the distance from eyes to mouth constant ("Inquiries into Human Faculty," p. 359). The portraits of American Men of Science (*Science*, v. No. 118) seem (from the tendency to multiple mouths and noses, especially noticeable in fig. 1) to have been made, as fig. 2 was, by matching the eyes, though in these cases the beard prevents the prominence of the disfigurement which this adjustment gives in the case of smooth faces.

If a fixed distance between eyes and mouth be taken for adjustment, the composite will have a single distinct mouth, but will differ in form according to the distance chosen; if it be that of the shortest or of the longest face in the group, the composite face will be correspondingly short or long, and the indistinctness of the eyes at a maximum. But if, on the other hand, a component face of average length (that is, one in which the ratio of the distance between the pupils of the eyes to that between the line of the eyes and the mouth is a mean one) be chosen, the resultant portrait will show a minimum indistinctness of eyes, and give what we may fairly call the pictorial average of the group. The average ratio which must serve for fixing the fiducial lines can be obtained from direct measurements on the negatives. This will not be a formidable task, if, as is usual, the negatives are taken so that the distance between the pupils is the same in all; since in this case it is only necessary to measure the distance from eyes to mouth in each, and take the mean.

This point is one which should be carefully attended to in making composites, for it would seem to be the only normal method of adjustment, all other adjustments giving more or less pronounced variants from the type.

Composites made in this way lose something of the deep-eyed, earnest expression which is the result of superposing all the eyes of the components on exactly the same points. This loss, however, is a real gain in the truthfulness of the composite portrait, for the deep dark eyes do not represent the average, but rather a summation, and hence exaggeration of earnest expression. The face in fig. 1 is, I believe, a fairly normal composite of the group of forty-nine from which it was made; fig. 4 is from a group selected for facial symmetry—that is, constancy of the ratio indicated, and is a type of this group with the exaggeration which comes from superposition of the eyes. Questions as to the possible dependence of the result on the order in which the components are taken, and on the time given to each exposure, occur to every one who interests himself in composite photography.

In Mr. Galton's earliest paper on the subject, he speaks of six composites made from the same three components taken in their six possible combinations, and says: "It will be observed that four at least of the six composites are closely alike, . . . the last of the three components was always allowed a longer exposure than the second, and the second than the first; but it is found better to allow an equal time to all of them." In a later experiment, composites were made of four differently coloured disks, whose images were superposed in four different orders, while the times of the successive exposures were equal. The result was four composite disks of precisely uniform tint. The inference from this is, of course, that the order of exposure makes no difference when the times of exposure are equal (equal illumination of the image is assumed). The experiments which I have made on this point by taking composite portraits from the same components in different orders (with equal times of exposure) have shown that the order of exposure does affect the result. I have also repeated Galton's other experiment in several modified forms, both with disks of coloured paper and with coloured glasses (by transmitted light), and obtained results which, especially in the case of the coloured glasses (by far the fairest test), confirm those of Galton.

Experiments of this kind are far more satisfactory than those in which composite portraits are made from the same components taken in different orders: for one has to decide in the one case merely on the identity or difference of tint of disks or rectangles placed side by side on the same plate; in the other, of faces with their manifold detail.

Answers to both of these questions as to order and time of exposure would be found in knowledge of the rate at which light acts upon the silver salts of the photographic plate.

If the rate of this action is constant up to the point of a full-timed plate, then the order in which the negatives are taken can make no difference, provided each successive fractional exposure is of equal length, and the image is in each case equally illuminated. If the velocity with which the chemical action proceeds is not constant, then the order will obviously make a difference in the result, unless the exposures are prolonged or shortened, or the illumination made stronger or weaker, as the velocity decreases or increases.

As far as I am aware, we have no knowledge of the rate of chemical action in this instance, except that which is given by the experiments above referred to, and which points to a constant rate of action within the limits of ordinary photographic exposures. Thus Galton's process appears as a valuable auxiliary in the investigation of an interesting point of the obscure field of photographic chemistry.

The possibility of the "prepotency" of some individual of the group as a disturbing element was suggested in *Science* v. No. 118, and has since been discussed by Mr. Jastrow in vol. vi. No. 134. Since the composite portrait is the result of the action of light on the silver salts, it would seem plain that no one face, however "individual," "powerful," or "characteristic" it may be, can be prepotent in controlling the result. We must conclude that the apparently prepotent face is merely a close approximation to the type or average of the group.

In the hope that more may be induced to do something in composite photography, I would say that excellent results can be obtained with an apparatus which is by no means elaborate or costly. A camera for the purpose can be made of soft wood by any skilful carpenter. It need differ from the usual form only in having a mirror, which is hung within, so that it can swing down to an angle of 45° for the adjustment, and up against the top for exposures; and an opening in the top, over which a ground-glass plate is fixed. On this ground glass the fiducial lines are drawn in lead-pencil, and the images focussed and adjusted. It must be at the same optical distance from the lens (the light being reflected to it by the mirror) as the ground

* *Science*.

Fig. 1. — Forty-nine members of the last senior class.

Fig. 2. — The same as fig. 1, but adjusted for the eyes.

Fig. 3. — Ten members of the same class, forming division in physics.

Fig. 4. — Twenty members of the last senior class.

glass at the back of the camera. A piece of ground glass placed behind the negative will serve very well in place of a condensing lens for lighting them, and it is not necessary to enclose the gas jet in a lantern.

In order to give accurately timed exposures, I use a pendulum consisting of a wooden rod with sliding weights above and below the point of suspension, and having an arm at right angles to it. At the extremity of this arm is a screen of card or ferrotype plate, which, when the pendulum is swinging, plays up and down in front of the camera tube. Matters are so arranged that, when the pendulum is at rest, the lower edge of the little screen lies across the horizontal diameter of the tube. After the negative is adjusted, the screen is held down so as to cover the end of the tube, while the slide in front of the sensitive plate is drawn, and then released and allowed to make a double vibration. The time of exposure is that of a single vibration of the pendulum, and this is regulated by adjustment of the sliding weights.

I find, as others have doubtless found, that the best composites are obtained from very dense negatives. Those from which the composites in this number were taken were made for me by Mr. Lovell, of Northampton, who succeeded admirably in obtaining strong negatives of very uniform density.

SALTS OF IRON PRINTING PROCESSES.

BY W. B. WOODBURY.

Notwithstanding the great intrinsic merits of iron printing processes, comparatively little of the attention they deserve has been bestowed upon them in this country. On the Continent of Europe, however, they are much better known, and in civil engineers' and architects' offices, these processes are largely used for obtaining copies of plans, &c. Not only for plans are these printing methods useful, but also for quickly obtaining a print from a negative without all the trouble involved in suddenly undertaking the usual operations necessary to produce a silver print. From soft negatives very good prints can be obtained. The general principles involved in these processes are not new discoveries, the process called "Cyanotype" being described by Sir John Herschel during the very earliest days of photographic invention. Since that time, however, many improvements have been effected. The probability that the attention of experimentalists in England may be directed to these methods, and the hope that further improvement may be the result, have together led me to undertake to bring before you a review of the methods already discovered and in use.

Certain ferric salts are sensitive to light, in consequence of the exposure which reduces them to ferrous salts. Upon those properties are based all the methods under consideration.

White Lines upon a Blue Ground first claims our attention as being the simplest, and therefore the most-used, method. In 1842, Sir John Herschel first made public a process under the name of "cyanotype" with ammonio-ferric-citrate and ferrid-cyanide of potassium. Two solutions are made—12 parts of red prussiate are dissolved in 100 parts of water; and 10 parts of iron salt in 60 parts of water. These two solutions should be mixed immediately before using, and the operation must be performed in the dark. Paper is floated on this solution, or applied with a broad camel's-hair brush, and then hung up to dry. If it is well dried and carefully preserved from light, moisture, and air, this paper will keep for some considerable time. After printing—which, when sufficient, should show the lines copied of a yellow colour upon a blue ground—the prints should be washed in several waters; and if a few drops of chlorine water or dilute hydrochloric acid be added to the washing water, the blue ground will appear much darker, and the lines rendered clearer and whiter. By this method the commercial paper is mostly prepared. The prints so obtained can, if desired, be changed from a blue to a beautiful black by being immersed in a four per cent. solution of caustic potash, until the blue is changed to yellow; after being well washed, they are laid in a four per cent. solution of tannin.

Dr. Vogel gives as an improvement on the above recipe the following:—10 parts of potassio-ferric oxalate in 100 parts of water, and 10 parts of ferrid-cyanide of potassium in another 100 of water; the remainder as before. With the above methods, the red prussiate, instead of being added to the mixture, can be used in dilute form as a developer after exposure. Paper that is prepared without it can also be developed after printing in the usual way with a one per cent. silver bath. Prints so developed are of a deep sepia tone.

It often happens, especially in summer, that pictures printed on these ferro-prussiate papers become over-printed, the blue colour assuming a dirty dark greenish tint. Herr Himly recently published a method of effectually saving such prints. He prepares a weak solution of caustic potash, and places the over-printed picture in it until the lines become clear, and the ground of a grey colour. The print is then immersed into a weak solution of hydrochloric acid, when it once more appears of a fresh blue colour. It is then washed and dried in the usual way.

Blue Lines upon a White Ground.—To obtain this effect, it is necessary that the action of the light should be to convert the iron compound into one that can be discharged from, instead of being fixed in, the paper, as in the other methods.

Pellet's Method (1877).—Paper is coated with boiled starch, so that the solution will remain upon the surface, and not sink into the paper. This is then floated upon a solution of 10 parts chloride of iron, 5 parts citric acid, and 100 parts of water. After drying, the paper is pressed flat, and kept from light and air. As in printing, the visible change is very slight; a few strips of the paper should be placed under a piece similar to the paper upon which the tracing or other design from which you are printing from is. One of these strips should be from time to time taken and placed in the developer, which is composed of a 24 per cent. solution of yellow prussiate. When these strips develop perfectly white, the print has been sufficiently exposed. In direct sunlight, one minute may possibly be sufficient; but on a dark day, from ten minutes to an hour may be required. After developing, the prints are rinsed with water, washed with a dilute solution of hydrochloric acid, and again washed and hung up to dry.

Blue spots, which sometimes appear upon the white ground, can be afterwards removed by touching with a solution of potash. This solution can also be effectually used for removing stains from the hands, &c.

Pizzighelli's method requires three solutions:—

A.—Water	...	50 parts
Gum-arabic	...	10 ,,
B.—Water	...	50 ,,
Ammonio-citrate of iron	...	25 ,,
C.—Water	...	50 ,,
Perchloride of iron	...	25 ,,

The solution A becomes useless in a very short time. B and C, however, remain good for weeks if kept in closely stoppered bottles. For use, 20 parts A, 8 parts B, and 6 parts of C are mixed together in the order named, otherwise the gum will coagulate. This mixture after a short time becomes thick and tenacious, but in a few hours will be found to flow quite freely. When in this state it can be applied by means of a brush to paper that must be well sized. It must then be dried quickly in a well-warmed room from which both light and damp are excluded, and after drying must be pressed flat. Development is effected with a solution of 2 parts of ferrocyanide of potassium in 9 parts of water, which is either applied with a brush, or the print floated upon the surface. In either case care must be taken that no portion of the developing fluid touches the back, as it would cause a stain. If floated, the exposed side of the paper should be carefully laid upon the developer, and the hand passed lightly over the back to remove the air-bubbles. After a few seconds the paper should be quickly drawn from the solution, and held in a vertical position till sufficient density is obtained; it is then rinsed with water, and immersed in an 8 per cent. solution of hydrochloric acid, and finally well washed and hung up to dry.

Dark Violet-Black Lines upon a White Ground.—The sensitizing solution required is composed of the following:—

Water ...	16 ounces
Gelatine ...	4 drachms
Perchloride of iron in a syrupy condition	1 ounce
Tartaric acid ...	1 ,,
Sulphate of iron ...	4 drachms

The necessary exposure is about the same as the others. When sufficient, the greenish-yellow colour will become white, excepting the lines, which should be somewhat dark. The developing solution is composed of one part of gallic acid in ten parts of alcohol and fifty of water. When immersed in this solution, the lines will be found to immediately turn blacker. The print is then finished by being well washed in water.

In conclusion, I see no reason why we should not, by improving upon these methods, be able to obtain a printing process equal to platinotype in the results, and at far less the cost and trouble of working.

ON FOCUSSING SAILING SHIPS AND OTHER MOVING OBJECTS.

BY J. TRAILL TAYLOR.*

The importance of being able to focus a moving object, under circumstances that admit of the exposure of the plate simultaneously with such focussing, has long been recognized, and several devices to admit of its being done have been introduced. I do not here refer to the placing of the object in its best position on the sensitive plate, for this is easily effected by a supplementary finder, or by sights placed upon the camera itself. One of the simplest and most elegant of the latter is the little folding square frame, with cross wires erected on the front of the camera, with a folding eye-hole piece for observation fixed on the posterior end. This is a French invention, and will be found illustrated in Monckhoven's "Optics," published twenty years ago.

But what I specially allude to is a means of ensuring a sharp focus of an object that is more or less constantly varying its distance from the camera—such as figures in a street or park, a restless wild animal in its yard in the Zoological Gardens, a ship or boat in rapid motion, or objects seen under like conditions of alteration of distance, and the effective photographing of which precludes the possibility of obtaining the focus on the ground glass screen of the camera in the usual way. The condition for photographing objects of this class is, that the plate shall be kept uncovered save by the exposing shutter, and that the focussing shall be effected through the agency of a separate lens of similar focus, or one which, for the time being, is relegated to this duty, a touch of the trigger effecting the exposure, when sharpness and correct position are obtained.

Sutton's reflecting camera, introduced in 1861, fulfilled this condition in an admirable manner. A mirror placed inside the camera at an angle of 45° intercepted the rays from the lens, and served the twofold purpose of preventing them from falling upon the sensitive plate at the back, and of projecting them upwards upon the focussing screen, which was fitted in the top of the camera, and upon which the operator watched the image, now in a non-reversed position. Touching a trigger at the fitting moment, the mirror, which was hinged upon a pivoted axis, flew upwards, covering the ground glass, and permitting the light to fall upon the sensitive plate, the lens being capped by an automatic movement or otherwise. Cameras constructed on this principle are being made in the United States as detective cameras. In this, only one lens was employed.

When photographing the animals in the London Zoological Gardens in 1873, Mr. Frederick York employed a supplementary camera having a lens identical with the working lens. This was erected on the top of the working camera, the mechanical parts being such that the focussing of both was effected by one motion, so that what he saw focussed on the ground-glass of the upper camera, he knew to be in equally sharp focus on the sensitive plate in that below. I remarked to Mr. York, when I examined it, with a view to writing the account of it which was published soon after, that it was a considerable expenditure of optical means to have such a costly lens as the focussing finder, and soon afterwards I simplified it in my own camera to the extent that the costly lens in Mr. York's case was superseded in mine by one of similar focus, costing less than two shillings. The ground-glass of the finder—a circle of an inch and a half in diameter—was erected on the top of the camera on the plane of the sensitive plate, and was connected with its lens at first by two tubes of brown cardboard, and subsequently by a tube of black calico distended by four strips of elastic rubber attached at each end. This answered so well that I can recommend it as something that may entirely supersede a large focussing screen, a great boon under many circumstances, especially when the camera is fitted with a roll holder for paper.

On one occasion, in the summer of 1881, when dashing through Boston (Mass., U.S.A.) Bay in the steam-launch of Ernest Edwards, and rushing under full steam up to first one and then another and another ship or yacht which was coming in or going out under sail, although with the small camera I was then using —an 8 by 5 with a lens of eight inches focus—I got them all quite sharp in virtue of an optical law to which I shall presently refer; yet I realized that with a large camera and a lens of large aperture and long focus, absolute sharpness could only be obtained by a fluke, unless the distance of the ship from the camera were known with a fair degree of accuracy; I conceived the idea which I am now going to submit to you, and which, I venture to think, will not only meet with your approval, but your adoption. It costs but little; it is worth much. But previous to doing so, let me, as cognate to this subject, recognise what has lately been done by some others in this direction.

The Jumelle opera-glass camera is doubtless familiar to many of you, as it has been before the public for nearly twenty years. In it one barrel is the focussing and the other the working camera. The small size of the plates (1⅝in. sq.) limits its utility.

More ingenious is the system adopted by Marc Ferrez, and described by him at the January meeting of the Photographic Society of France. Premising that he employed a large camera for plates eighteen inches square for obtaining instantaneous views of shipping, and that, after having got the image upon the ground glass perfectly focussed, by the time he got in the dark slide and opened it to take his shot, the image of the object was no longer in the camera, or, if it was, it was imperfect and out of focus; he eventually mounted on it a small camera, the lens of which was connected with the larger one by a lever, which acted on the principle of the proportional compasses. Both lenses working thus in harmony, a great advantage is gained by the operator. I quote Professor Stebbing, who wrote at the time, "He can have his dark slide ready open, and his instantaneous shutter set ready for a shot. He follows all the movements of the object he wishes to photograph with the greatest ease on the ground-glass of the little camera, and when the object presents itself to the taste of the operator, he has only to press the pneumatic ball, and the sensitive plate receives the lightning-like impression."

I now submit my own camera and the system of focussing I have adopted. The camera, as you perceive, is an American one, to which I have added a lens of sixteen inches focus. Being fond of carrying with me a pocket telescope, I selected one the object glass of which is of precisely the same focus as the camera lens; and when I wish to focus the camera on a moving object I take the little telescope (a cheap French one) from my pocket, draw out the slides, the second one of which moves very loosely, and by means of a pin projecting from the top of the lens board or front of the camera, I instantly attach the object-glass end of the telescope, doing the same with one of the sliding-tubes to the ground-glass end of the camera. Careful adjustment is necessary when determining the position for the pin, and as both telescope and camera are now controlled by the rack and pinion of the latter, it is only requisite that you look at the object to be photographed through the telescope, and render the image sharp by the rack and pinion, to ensure the image formed by the camera lens being more perfectly focussed on the sensitive plate than it could have been by focussing on the ground-glass in the usual way. When done with, the telescope is lifted from its position on the camera, and returned to the pocket.

Although no trouble will be experienced in obtaining French telescopes of every focus suited for this purpose, at prices ranging from five shillings upwards according to size, yet may it be well to observe that an accurate assimilation of its focus to that of the lens may be made by any one possessing mechanical knowledge. The object glasses of such telescopes are but rarely cemented, and, by separating the components by a greater or less space, its focus is lengthened. It is quite true that this will disturb its correction for the highest class of definition, but will not affect its working for the special purpose now being advocated. Such is the latitude permissible in this class of correction, that two common spectacle lenses, each approximately of twice the focus of the of the camera lens, may be made to serve as the objective of the finder, by noting, first, that their shortest focus is obtained by mounting them close together, whereas by separating them their focus is lengthened. With lenses of this class it is necessary to reduce their aperture by a diaphragm. Bear in mind that if the extemporized object glass of the finder be composed of a concave and a convex lens, the separation of the two lenses shortens the focus, whereas if both lenses are convex, the focus is lengthened by such separation. It is quite possible to obtain, at a cost of less than sixpence, a round, unedged spectacle lens, an inch and a half in diameter, of any required focus; but for those who desire absolute accuracy, I recommend the employment of two such lenses.

* Read at the Photographic Convention of the United Kingdom.

The rule by which any definite focus may be accurately obtained is this :—Knowing the focus of each of the two lenses, add them together, and subtract the distance of their separation ; then multiply the two foci together, and divide this last quantity by the first, which gives the precise focus of the two lenses when combined. As I have previously said, the focus is lengthened by increasing the separation, and by the above rule this can be done with unerring accuracy. A rude object glass for a finder of this class must have a diaphragm, but it answers its purpose admirably, notwithstanding the prismatic fringes.

Notes.

The Convention at Derby passed away quite pleasantly, and, apart from a little inconvenience from the wet weather, an agreeable time was spent by the eighty or hundred photographers assembled. Papers, and some further account of the meetings, will be found in this number of the News.

From Dr. Eder we learn that he will edit and issue a Year-Book of Photography for German readers ; and when Dr. Eder undertakes anything he is in the habit of doing it well, so we need not doubt that this will be a valuable addition to photographic literature.

The photographs exhibited by Dr. Heneage Gibes at the annual meeting of the British Medical Association merit some notice on account of their great practical value to the student. Photographs of normal and morbid tissues were shown as lantern slides, and so perfect is their definition that one can quite understand their value in class teaching ; while some of the photographs of bacteria—enlarged 2,000 diameters—are quite surprising.

Colonel Hooper, the Provost-Marshal in Burmah who made himself notorious by photographing criminals at the moment of execution, has been found to be guilty of the various charges brought against him. The severity of the sentence is appalling. He is to be reprimanded !

The success of a portrait, like that of a joke, lies not in him who makes it, but in him who takes it. That is to say, if you please the sitter, the end is achieved. Chatting with a photographer from the Cape of Good Hope the other day, he told us that the Dutch Boers would not look at their portraits unless their faces were made perfectly white. The consequence is that, being a wise man, he intensifies until he can intensify no more. The Boer, who thinks he is the salt of the earth, must not be mistaken for a Kaffir or Zulu, and the difference in kind must be emphatically proclaimed by photography. To comply with this demand may not satisfy the canons of art, but it shows commercial sense.

It would be difficult to imagine that when the House of Commons, in the time of that most religious monarch, Charles II., passed what is now known as the Sunday Trading Act, they had photographers in view. The justices of Wakefield have, however, come to this opinion, and in consequence have fined an unfortunate professor of the black art fourpence, and twelve shillings and eightpence costs, for "doing worldly labour which was not a work of necessity." Of course we bow in submission to such transcendent wisdom, but we would humbly urge, in extenuation of the offence of this reprobate, that supposing, as is too often the case with the cheap photographer, the Sunday is the only day on which he can safely reckon to pay his rent, whether his labour may not be justly considered a work of necessity? It might also be contended, on behalf of Phyllis and Corydon, whose only day of happiness is that "which comes betwixt the Saturday and Monday," that on no other day but the Sabbath could they be photographed together ; and if this is not a "necessity" in the eyes of young lovers, we do not know what is. But it is to be feared that such a plea would be totally lost on the adamantine hearts of the Sheffield Solons.

A too flattering portrait may be made to be as offensive as a caricature. Thus, the illustrated life of General Boulanger which has been hawked about on the Boulevards has caused him the greatest annoyance. One of the portraits represents the General on a curvetting horse, gracefully taking off his plumed hat to perform a military salute. Another pourtrays him with his three-cornered hat on, his hand on the hilt of his sword, and his face with an expression superbly heroic. In another he is supposed to be in Cochin China, and defending himself against swarms of natives. In fact, the portraits are in the style of Skelt's "penny plain, twopence coloured ;" but done with such artfulness that anybody who could not see through the intention of the draughtsman might easily be deceived. It is as though a designing photographer had enticed a man against whom he had a grudge into his studio, and had posed him purposely in a ridiculous position. But a photographer who could perpetrate so fiendish a revenge must be deeply injured indeed.

A good deal of instructive information is being furnished by the correspondence which has for some time past been going on in the *Telegraph* respecting foreign competition in trade. For instance, we are told that one reason of the success of Germany in regard to electro-plated goods is the enterprise shown in placing before buyers catalogues of new patterns. The expenditure incurred in producing these catalogues forms a very considerable item in the year's outlay, while, in addition, to the principal customers large photographs are forwarded of the newest designs. This kind of thing may of course be new, so far as the English electro-plating trade is concerned, but we believe that other manufacturers in England have for some time past made use of photography in a similar manner. It is, however, pretty certain that the camera is only employed in respect to very special samples, and its assistance might be extended with advantage. In the present ultra-realistic age, drawings, however exact, may be received with caution, but photographs are supposed to be beyond suspicion.

It will be no consolation to photographers, in the present depressed state of things, to know that out of fifteen hundred pictures exhibited in the Royal Academy, only a hundred and sixty three have been sold. This, we are inclined to think, exhibits more the lack of superfluous cash rather than a waning of interest in art. Painting shares with photography the honour of being a luxury, and, if money be scarce, both must suffer. But this, we repeat, is not consoling to photographers.

We alluded incidentally last week to the fact that, take as many photographs as you please of the same person, they will all differ, of course in varying degrees. The Protean variety of the human countenance must be held to be the reason, and not photography. Here is a case in point. Miss Violet Cameron, the well-known *Opera Bouffe* actress, has features of a statuesque cast, and her powers of facial expression are consequently limited. Yet we have an American paper, in informing its readers that a theatrical business manager has returned from Europe with a large collection of the lady's pictures, saying that, "according to the photographs, she is likely to suit all tastes in the way of beauty, for no two of the likenesses resemble each other." One would like to know whether this infinite variety is pleasing to the actress, and which of the photographs she likes best. Perhaps it would sound cynical to say that the one she would choose would probably be the least truthful.

NOTES ON PHOTOGRAPHY IN GERMANY.

BY W. E. WOODBURY.

Lichtdruck (Collotype) Printing—Meeting of Berlin Society — Orthochromatic Plates — Printing on Silk.

Lichtdruck.—In no country is the process of lichtdruck (collotype) printing worked to such perfection as in Germany. In common with most of the methods of permanent printing, the lichtdruck process is indebted to the discovery of Mungo Ponton of the sensibility to light of bichromate of potassium when combined with organic substances. For the benefit of those unacquainted with the working of this process I will give it.

A sheet of glass about a quarter of an inch thick is the material used for the printing block. This glass plate, after being thoroughly cleaned, is ready to receive the preliminary coating of :—

Soluble glass	6½ parts
White of eggs	20 "
Water	36 "

This solution is always made fresh about an hour or so before using. Care must be taken that the soluble glass does not contain caustic potash. After having been filtered, this mixture is applied to the glass as evenly as possible. This operation is done in a warm room, and the film is very soon dry, when it is thoroughly rinsed with water. This film is exceedingly thin, and will be observed to bear an open, porous, and slightly opalescent surface. The next operation is the coating of the plate with a bichromated gelatine solution, the formula mostly in use being the following :—

Bichromate of potash	15 grains
Gelatine	2½ ounces
Water	22 "

The plate having been placed on a levelling stand, the warm bichromate gelatine solution is poured on, and when set, is placed in the drying chamber. It is well-known that in any process of photographic engraving in half-tones it is absolutely necessary to produce what is termed a "grain," so as to obtain an ink-holding surface, and giving detail in the shadows. To do this, the uniform photographic gradation must be broken up into a series of points, dots, or other small masses. In the lichdruck process this broken surface is obtained by the manner in which it is dried, which should on no account take longer than three hours. The drying chamber is usually kept at a temperature of about 55° C. The object is to obtain this already-mentioned fine grain over the whole surface of the printing block, and unless this grain is satisfactory the film is of no use whatever. Should the film be too thick, then the grain will be of a coarse nature ; or should the temperature in drying be too high, no grain at all will be obtained. When the film has a fine even grain extending over the whole surface, it can be considered fit for use, and is ready for printing upon. In printing, a stripped negative is generally used, so as to ensure perfect contact all over ; where fine detail exists, this is absolutely necessary. If a glass negative be used, it is necessary that it should be upon patent plate-glass, as the sensitive film is itself upon a thick glass plate. The exposure is, of course, very rapid. The only way of measuring it is by experience and a photometer. After being taken from the printing-frame, the plate is placed into a dish containing cold water, for the purpose of thoroughly eliminating the soluble bichromate. About an hour's washing is generally sufficient to do this. It is then taken out and dried. When dry, the plate has the appearance of a design ground on polished glass.

Next comes the etching process. The plate is placed upon a levelling stand, and the following etching fluid poured over it—

Glycerine...	300 parts
Ammonia...	100 "
Nitrate of potash	10 "
Water	50 "

This etching fluid is allowed to remain upon the surface of the image for about half an hour, when it is poured off, and a piece of blotting-paper placed over the whole, so as to absorb any of the superfluous etching fluid that may be upon the surface. This etching is only resorted to when the block is to be printed from by machinery (schnell-press). When it is to be more carefully handled in a hand-press, it is moistened only with a little glycerine and water. By this means the printing block becomes thoroughly impregnated with glycerine and water. After etching, and without washing, the block goes straight to the printing press. The printing is done both by hand and by machinery. In cases where a large quantity of prints are required, the schnellpress (quick press) is used. This press is very similar to the ordinary lithographic press, and is usually worked by a small gas engine. Each press requires about a half horse-power. The manipulations are generally carried out by two persons—usually a girl and a skilled mechanic. A man who has been accustomed to lithographic work is the best for this purpose. It requires, as we know, a practised and skilled hand to produce a good lithographic print, but in the collotype process, where a gelatine printing block is used instead of a stone one, as may be imagined, practice and skill are still more necessary. The only way to obtain good prints from a block is by coaxing judiciously with roller and sponge ; but no amount of theoretical teaching will make a good printer. When in the machine, the plate lies upon a large steel bed. This bed, with the glass block, moves horizontally to and fro, and in so doing passes under about a dozen ink-rollers, some of leather and some of glue, which not only apply the ink to the gelatine plate, but disperse it; the surface of the block being touched by every one as it passes underneath. Whenever the printing block passes from underneath, immediately an inked slab takes its place, and imparts more colour to the rollers. The duty of the man is to see that the ink is applied regularly to the printing block, and in sufficient quantity. The girl's duty is to stand at some height above the machine, and place the sheets of paper around the huge cylinder, which, in revolving, presses against the block, and in this manner receives an impression upon it. It is necessary for the printer to stop the press every few minutes in order to damp the block. This is done with glycerine and water, by means of a small sponge. Before again resuming work, a leather roller is passed over, in order to remove all superfluous moisture; and the block is once more ready for printing from. In order to see how skilful the printer must be, one has only to watch the number of useless proofs that are at first obtained, and to see how gradually improvement takes place by dint of cleaning, rubbing, rolling, etching, &c. In many establishments two kinds of ink are used—*i.e.*, a dark ink and a light one—for producing the half-tones; but it is quite possible to secure delicate and vigorous impressions by employing one ink, and the two already-mentioned kinds of rollers. About one to two thousand impressions can be taken off in a day with these quick presses, but they are obviously not quite so fine as those which can be produced by a careful printer with a hand-press. These hand-presses, which are known under the name of Stern or Star press, are used mostly for printing of negatives from nature, rather than for copies of pictures or engravings, for which the machine-press is the most useful. They are nothing more than the ordinary lithographic hand-press, one man being sufficient to work it.

Lichtdruck prints, especially portraits, are usually varnished, but are first coated with a dilute solution of gelatine to act as a sizing, to prevent the varnish from soaking into the paper. This varnish, composed of a solution of shellac or spirit, is generally applied with a broad camel's hair brush, and dried quickly. Some prints are made upon thick paper (these are usually for book illustrations, and are ready for binding without further treatment); others are printed upon fine tone paper, known as "Kreide" paper, varnished and pressed, in order to impart a highly glossy surface. Prints so treated are often sold as silver prints, to which, indeed, they bear a great resemblance. A lichtdruck printer will furnish you with five hundred copies of your carte portrait for 25 marks, or the same number of shillings; for a thousand copies £2 is demanded, cabinets £3. The prints you get for this price are only made upon ordinary paper; for better paper and glazing, 30 per cent. more is charged. The printing of such things as pictures for catalogues offers a wider field than for portraits; as for the latter, not only must the negative be suitable, but the object also. Merchants and tradesmen are beginning to find out the immense value of photographic illustrations for advertising, and no mechanical process renders greater service in enabling them to place before the public, at a comparatively small cost, correct representations of objects for sale in a most novel and satisfactory manner.

In the last number of the *Photographische Correspondenz* a handsome coloured lichtdruck was sent as a supplement. These coloured lichtdrucks are at present mostly made with the aid of draughtsmen and retouchers. The process as executed by Löwe, of Vienna, is about the best, and approaches nearest to that of a genuine photographic picture. A number of printing blocks are made, according to the number of colours to be used. The negative is first stopped out by retouching, leaving open only those parts which are intended to print blue, for instance. A plate is made from it, and in a similar manner it is again retouched for yellow, &c. The coloured picture obtained by this means lacks softness, but this softness is finally obtained by printing over the colours from an ordinary lichtdruck plate in half-tones, thereby giving the picture its finish. The only book published upon this process is that admirable and useful little treatise "*Das Lichtdruck und di Photo-Lithographie*," written by Dr. Julius Schnauss, and published by Liesegang, of Düsseldorf.

Meeting of the Berlin Society.—The last meeting of the Berlin Society for the Advancement of Photography was held on the 9th of July last, President, Dr. H. W. Vogel. Herr Richard Weber, of Leipsic, exhibited a set of his new photographic apparatus, specially constructed for wheel riders. The apparatus received universal approbation, and appears cheap at £3 5s. Herr Stenglein then produced a number of micro-photographs, among which were some highly interesting organisms—for example, the Rommabacillus. The exhibitor offered explanations of his methods of taking and mounting mineralogical and other photographs. Especially he dwelt at length and with considerable emphasis on the micro-photographs of different classes of bacteria, the study of which has attained such importance within the last few years. Herr Stenglein hopes very soon to have still more perfect specimens of these minute germs. At present he recommends a process of colouring the objects, and particularly the use of aniline dyes. Herr Schultz-Hencke was of opinion that photography could not reproduce such objects with the exactitude of the microscope, and suggested a means of retouching which Herr Stenglein announced he had already taken into consideration. The President displayed several lightning photographs by Feldmann, in Bockenheim, near Frankfurt-on-the-Maine. Some of these created great interest, particularly one in which the electric fluid appeared to have retraced its own course from its apparent starting point. Herr Goedicke related his experiences of iron and pyrogallic developers, and exhibited his sensitometer plates. Herr Stenglein believed that one developer was not to be preferred to the other. A general discussion then took place as to the relative merits of the developers, in which Dr. Zenker said he preferred the English landscapes to the German, and he believed solely owing to the influence of the pyrogallic development; and Herr Jahr stated that in America the pyrogallic developer was almost exclusively in use. Herr Miethe then read a report of the recent experiments made by Herr Wallroth in portrait taking by the magnesium light. The experiments were conducted in the studio of Herr Halerlandt, and partly at the suggestion of Professor Vogel. Besides the gentlemen already named, Herr Gädicke and Herr Goety, of New York, were present. Some portraits were almost as well lighted and executed as if taken by day, and particular stress was laid in the report upon the cheapness of the magnesium light, which cost only a trifle under twopence for these experiments. But, on the whole, the trials were not considered decisive, and further communications are promised to the Club on the subject. A short discussion followed the reading of Herr Miethe's report, in the course of which the President promised to reproduce the sample pictures exhibited, and to issue them as a supplement to the number of the *Photographische Mittheilungen* for September 1st. The President showed also two photographs by Obernetter of the same landscape, one taken upon an ordinary plate, the other upon a colour-sensitive plate. The difference was very striking; not only was the relative value of the colours more correctly represented on the sensitive plate, but many details were perfectly clear and distinct, which in the picture from the ordinary plate were altogether wanting. Herr Schultz-Hencke and Herr C. Quidde (Secretary to the Club) exhibited photographs which were received with great applause; and Herr Comod Stapelfeld, of Frankenberg, contributed to the Club for its forthcoming excursion a most excellently planned map with portraits, for which a vote of thanks was granted him. The next ordinary meeting of the Club is postponed to the 17th September on account of the holidays, but interim meetings will take place on the first and third Friday in each month at Schaper's establishment, Leipsic Street, No. 136.

Orthochromatic Plates.—According to the *Photographische Mitarbeiter*, the following is the recipe for orthochromatic gelatine plates as given by Dr. Mallmann and Ch. Scolik.

The plates are first dusted with a soft camel's hair brush, and placed in a bath containing—

Water	... ...	200 c.cm.
Ammonia	... ...	2 „

in which they are allowed to remain for two minutes. They are then taken out, and after draining are immersed in the following solution:—

Erythrosin solution (1 to 1000)	...	25 c.cm.
Ammonia	... ...	4 „
Water	... ...	175 „

for 1 to 1½ minutes, the dish to be kept covered and in motion. Both baths can be used for a dozen plates, but after the seventh or eighth 1 c.cm. ammonia should be added to both solutions. The plates are then taken out, and allowed to dry in a perfectly dark room. This is accomplished in about three hours. Care should be taken against over-heating. With these plates the alkaline pyrogallic developer should be used. If the oxalate of iron developer be employed, veiling is the result.

Printing on Silk.—In the same paper, the following recipe for preparing silk for printing from is given:—

1.—Tannin	... ...	40 grammes
Water	... ...	1000 c.cm.
2.—Salt	... ...	40 grammes
Arrowroot	... ...	40 „
Acetic acid	... ...	150 c.cm.
Water	... ...	1000 „

No. 1 is mixed with No. 2, well shaken, and filtered. The older the mixture, the better it is for use. In this bath the silk is thoroughly immersed, and allowed to remain for three minutes, when it is taken out and hung up to dry.

Sensitizing solution is composed of a silver one to ten, acidified with nitric acid.

Toning Bath.

1.—Chloride of gold	... ...	1 gramme
Water	... ...	200 c.cm.
2.—Sulphocyanide of ammonium	...	20 grammes
Water	... ...	500 c.cm.

No. 1, after shaking, is mixed with No. 2. In a few days the mixture will become clear, when it is ready for use. It is preferable to dilute with from two to four times the quantity of water. Fixing and washing as usual.

NOTES ON EMULSION MAKING AND PLATE COATING

BY W. K. BURTON.*

I propose to say a few words on my favourite subject, namely, emulsion work. I am not going to give a new formula, or to write anything startlingly—or even, I fear at all—new; but to draw attention to a certain number of matters of detail, the real importance of which is frequently overlooked, even if the bearing of the matter has been taken into consideration at all.

Taking first of all the formula. It may seem strange when I state my belief that the factor of this, which usually receives the least attention—namely, the water—is the one, a variation in the quantity of which has the greatest influence of any on the time taken to gain sensitiveness by the process of boiling or stewing, which is to immediately follow. I presume, of course, that the quantities of the soluble bromide and iodide, and of the nitrate of silver, are not such as to permit an excess of silver nitrate.

If there be no such excess, then I say that the quantity of the water used will have more influence on the time or temperature, or both, required to gain sensitiveness, than will either the excess of bromide or the quantity of the gelatine, provided always that there be enough of the latter to hold the bromide of silver in suspension.

To take an example: a boiling formula is used with 400 grains of silver nitrate, and only 10 ounces of water, to both solutions. This is very nearly as concentrated as the emulsion can be made without a very considerable loss by precipitation of the bromide of silver in a granular form.

By boiling, sensitiveness will be gained in a certain number of minutes.

Now suppose the experiment be repeated with all quantities the same but that of the water, and that doubled. It will be found that much more than double the time is required to gain sensitiveness, being likely four or five times as long—a result which would certainly not arise from doubling or halving the excess of soluble bromide or the amount of the gelatine.

If this applies in the case of an emulsion, neutral or acid, intended to be boiled, it applies still more strongly in the case of an ammonia nitrate emulsion, for, as first pointed out by Eder, it is not according to the quantity of ammonia used, but according to the percentage, that there is a gain in rapidity with a certain time of stewing at a certain temperature. Now, in an ammonia nitrate emulsion, the quantity of ammonia is regulated by the weight of silver used, entirely independently of the amount of water, so that the *smaller* the quantity of water, the *larger* the percentage of ammonia.

I have adopted, for all formulas, whether boiling or with ammonia, as a mean between the very smallest quantity of water that can be used, and a very large quantity, which introduces difficulties of various kinds, a total quantity of 12 ounces to each 400 grains of silver nitrate used.

I do not think it makes much difference whether the water be equally divided between the two solutions, or unequally, or whether the method of Davis of adding the silver nitrate in crystals to the solution of soluble bromide and gelatine be adopted. If, however, either solution is to be more concentrated than the other, I prefer that it be the silver nitrate solution.

On the vexed question of iodide, I am almost afraid to say a word; there is so great divergence in the experience of different workers. I will therefore protect myself by saying that I refer only to the experience of my own working, and do not attempt to lay down a general rule, when I say that the highest sensitiveness is to be gained with tolerable certainty only when a very considerable percentage of iodide is used. I mean by a considerable percentage, say $\frac{1}{10}$ as much iodide of potassium as nitrate of silver.

I now come to what is, I consider, a most important part of the process of plate making, namely, that which lies between the termination of the boiling or stewing process and the coating of the plates. There appears to be a common impression that, at the end of the stewing process, a certain fixed amount of sensitiveness is gained, and that it is of but little consequence, so far as sensitiveness is concerned, what further action takes place.

Now there can be few greater mistakes than this. I think it is no exaggeration to say that even supposing washing to be so performed that all excess of bromide is removed, the emulsion may be so treated that plates representing a sensitiveness of anything between 1 and 10 may be produced; that is to say, the sensitiveness may be degraded, by ill-judged manipulation, to one-tenth what it might possibly be. And in this connection it should be borne in mind that it is always that emulsion which is capable of giving the rapidest plates that is most liable to be damaged in the matter of sensitiveness.

I will take, first of all, the mere freeing of the emulsions from the soluble salts, &c. A certain trace of these left in the emulsion does not appear to damage sensitiveness, but it appears to be liable—and especially in the case of an ammonia emulsion—to produce a peculiar surface fog during drying. It was W. Cobb who first pointed out to me that lack of sufficient washing was the cause of a surface fog that probably most workers in emulsion are familiar with, and my thanks, at any rate, are due to him. It is not generally known how difficult it is to remove the last trace of ammonia (and presumably of other soluble constituents of an emulsion), but the difficulty was brought forcibly home to me not long ago.

An emulsion had been precipitated in alcohol, had afterwards been cut into pieces and allowed to soak in water for forty-eight hours, after which it had turned out unsatisfactory. It was all melted up, was allowed to set, and was broken up into pieces to dry, so as to be sent to the refiner. Whilst it was drying some hydrochloric acid happened to be used in the room for cleaning plates, whereupon a very distinct vapour was seen to rise from the drying emulsion, indicating, I have no doubt, the presence of ammonia.

That the method of getting rid of the soluble salts and ammonia must be thorough in the sense of its being capable in ridding the

* A paper read before the Derby Convention.

emulsion of the last trace of them, probably everyone will admit; but there is another point I wish to draw particular attention to, and that is, that it must not be such a process as will give rise to an undue increase in the bulk of the emulsion. This brings me to a point on which I wish to lay much stress. It is the keeping down of the quantity of water in the finished emulsion. I think few matters are of much greater importance in emulsion work than this.

There are two reasons for keeping down the quantity of water. One is the mere fact that the less water there is in the film the less there will be to dry out, and that therefore the dangers of possible fog, &c., during drying, which are always present, but which increase with the sensitiveness of the emulsion, will be reduced. But another is of still greater importance, I think. It has its origin in the fact that the bromide of silver in a liquid emulsion inclines to sink from the surface, and that the more dilute is the emulsion, the more rapid is the sinking.

With bromide of silver in the very finest state of division, such as we have it in a very slow emulsion, this depositing action may not be so rapid that the bromide will perceptibly fall away from the surface of the films in, say, five or ten minutes, even in a fairly dilute emulsion; but just as the size of the particles of silver bromide increases, so does the rapidity of deposition, until, when we get to the size of particle common in the more rapid emulsions, the deposition is so rapid that at ordinary temperatures it has a perceptible effect before the emulsion can set on the plate. The result on the dried plate, if the bromide has perceptibly settled from the surface of the film, is that the sensitiveness of the emulsion is greatly decreased, whilst the quality also suffers. If the settling have gone on to any considerable extent, the result is actual fog.

These facts have been published over and over again, but I think I am right in saying that there is not even yet a due appreciation, by most, of the amount of deterioration that is liable to be brought about by a slight amount of settlement; nor do they bear thoroughly in mind the fact that the more sensitive the emulsion, the more chance is there of deterioration, and the greater is it likely to be in quantity.

I will state as a general rule that, except where ice is used to hasten setting (and probably even then), it is well to have at least as much as 30 grains of quick-setting gelatine to each ounce of emulsion.

Where great sensitiveness is not required, it may be sufficient simply to add as much gelatine as may be required to the washed emulsion; but I will state that, in my experience, there is always liability to a reduction in sensitiveness from pursuing such a course. Sometimes this is but slight, but often I have found the reduction to be very appreciable, and to be greater in the case of a very sensitive emulsion, than in that of one less sensitive. Probably the nature of the gelatine has a good deal to do with this, but I have been unable to find any rule.

Unfortunately, I am not practically acquainted with the centrifugal method of depositing the bromide of silver from an emulsion, and therefore cannot give an opinion of the efficiency of this method as a means of concentrating the emulsion, but from a purely theoretical point of view it looks the most perfect, if a gelatine which, when added after sensitiveness is gained, does not reduce, this gelatine can be obtained. In this connection, I think it only fair to say that I have had from my friend W. Cobb a sample of gelatine which is remarkable in as much as it does not appear to reduce sensitiveness appreciably, at whatever stage of the process it is added.

Leaving on one side the centrifugal method as one on which I am not competent to express an opinion, I come to others which require no particular appliance.

I shall first take the spontaneous precipitation method, as I am personally in part responsible for its introduction. And in connection with this I would say at once that although I have got by its means the very best emulsion that I have ever made, and although for a considerable time I worked it with uniform success, there is some factor of uncertainty not yet explained, since the operations may be performed in apparently precisely similar manner with the result that a very fine emulsion of splendid quality will be produced in one case, a thin, granular, useless emulsion in the other. I know several operators who have worked and do work the process with uniform success, but as I cannot do so myself, I do not recommend it to others.

Another means of ridding the emulsion of excessive water is the well-known one of precipitation with alcohol. This requires no description here, but I may mention a few details in connection with it. In the first place, of course, it is of advantage for economic reasons to keep down the quantity of methylated spirit to be used as much as possible. The quantity of this needed seems to depend entirely, or almost so, on the quantity of water present in the emulsion, about two and a-half times as much methylated spirit as water being required. There is no need to add any water to the emulsion after stewing, as the bulk of the gelatine may be added dry, the solution being allowed to get cool first, and the gelatine being allowed to soak in the cool solution till it is quite soft before an attempt is made to melt it.

By keeping to the quantities of water that I gave above, and by adding none after stewing, it is quite easy to manage with two pints of methylated spirit to each ounce of silver nitrate used, a quantity which is by no means enormous.

I need scarcely say that methylated spirit is a substance of very uncertain constitution, and that a sample should be well tried before it is adopted for general use.

One point must not be overlooked in connection with this process, and that is, that a very thorough washing is required after precipitation. The stiffened emulsion must be broken up into *very small* pieces, and must be allowed to soak in frequent changes of water for at least twenty-four hours. It will swell considerably during this soaking, but will not take up more than one-half or one-third the amount of water that it would were it washed in the usual manner.

The washing after precipitation is very much facilitated by keeping the quantity of the gelatine very much down, adding (say) only about one-third or one-quarter of the bulk. There is of course a smaller mass to wash, and it is in a much more porous state; but then, as already stated, there is a possibility of lowering the sensitiveness by adding the remaining bulk of the gelatine afterwards, which addition is of course quite necessary.

The emulsion got by simply melting the swelled gelatine will probably be too thick for coating at a moderate temperature. It will very likely set on the plates before it has thoroughly spread; but a trial should always be made before diluting it. In any case, great care should be taken not to secure even coating by excessive raising of the temperature of the emulsion just before coating. If it will not flow at a maximum temperature of about 110° Fahr., it should be diluted; the temperature should not be raised.

This matter of keeping the emulsion at such a state of concentration that it will set quickly—only just giving time to let the film spread itself evenly on the glass, with the temperature of the emulsion at from 90° to 110°—is one of the very greatest importance if the highest sensitiveness is required in the plates.

I have little else to say, except that it is necessary to exert the extremest caution in the matter of additions made to the emulsion after it is complete. Thus I have known some samples of methylated spirit that would cause an enormous reduction in sensitiveness when added only to the extent of five per cent. There are others I know which do not; still it is well to be on the safe side, and to add nothing but pure alcohol, and of this not too much. Ten per cent. even of pure alcohol is enough at times to produce an appreciable reduction in sensitiveness. Then, again, caution is necessary in the matter of adding antiseptics. In fact, I believe that in the case of emulsions of extreme sensitiveness—such, for example as will give a strong 25, after fixing, on Warnerke's sensitometer, and will show figure 10 of sufficient density to serve as the maximum density of a negative—the safest course is to coat the emulsion without any addition whatever; that is, if it be desired to retain the full sensitiveness.

SOME NOTES ON DERBYSHIRE: FOR THE PHOTOGRAPHIC CONVENTION.

BY RICHARD KEENE.*

There are few counties possessing so much food for the camera as Derbyshire, and but few so much photographed, yet the subjects are exhaustless. It is true we have no beautiful lakes or lofty mountains, but we have rivers and streams in abundonce winding through the most picturesque and lovely scenery, and rocks and hills of no mean height penetrated by charming dales. We have no cathedral in the county, but fine old churches abound; while castles and halls, some in ruins "amid their tall ancestral trees," are dotted all over the neighbourhood. We have also antiquities not a few. More beautiful in decay than in their prime, perhaps, are some of these old ruins, touched lovingly by the hand of nature and mellowed by time.

* Abstract of a paper prepared for the use of those attending the Convention.

The Derbyshire dales have long been famous for their beauty. The principal are Dovedale, Monsal Dale, Miller's Dale, Chee Dale, and Middleton Dale. The most noted, perhaps, is Dovedale. I shall not attempt to describe it, for it is indescribable, though many have attempted it in high-flown and exaggerated language. Let these two words suffice: "Perfectly beautiful!" A day may be well spent here with the camera, for a fresh picture presents itself at every turn. For above two miles—that is, from the inn to the "Dove Holes"—a constant succession of subjects suitable for the camera come into view as you wander up the lovely stream where old Izaak Walton and Charles Cotton angled for trout and grayling above two hundred years ago. The river is here and there diversified by little cascades, and the hill-sides by jutting rocks, tors, and caverns, mingled in wild confusion with trees and undergrowth. Had you time, it would be well to trace the stream upwards, beyond the "Dove Holes," as far as Beresford and Hartington, some seven or eight miles further; for at Beresford is the celebrated Fishing House of Walton and Cotton, "sacred to fishermen," as its Latin inscription over the door informs you. The old hall, alas! was destroyed some thirty years ago, but Beresford Dale is still as beautiful as ever, and "Pike Pool," with its rustic bridge and pike of rock rising out of the water, with many another pretty picture, may be got. Dovedale, distant from Derby eighteen miles, is best reached by brake, which will set you down at one of the hotels near the entrance to the Dale; or you may take train to Ashbourne, and walk or post the remaining four miles. In either case I would advise a short stay at Ashbourne to see the church, which is a fine example of Early English and Fourteenth Century work, containing among other interesting monuments one of a lovely child asleep, the daughter of Sir Brooke Boothby, executed by Banks. There is the neat little Swiss like village of Ilam, about a mile from the hotel at Dovedale, which has many pretty views, including an Eleanor cross and fountain, with sculptures by Westmacott, and a fine hall, with charming grounds through which flows the river Manifold, and in the church one of Chantrey's best works.

Monsal Dale has been called the "Arcadia of the Peak." A railway runs through the upper part, on its way to Buxton and Manchester, and has made it easily accessible from Derby. There is an ancient church at Ashford and another at Bakewell, and at the latter place a Saxon cross. Miller's Dale and Chee Dale are both easily got at from Miller's Dale Station. Miller's Dale is somewhat spoilt pictorially by the huge lime-works started there some years ago, but many pleasing views may still be had. Chee Dale is as secluded and lovely as ever, and its grand tor, washed at the base by the rapid Wye, makes a fine study. Middleton Dale is situated beyond Stoney Middleton village, and boasts of some fine rocks, such as the "Castle Rock" and "Lover's Leap."

Let us now take rail to Buxton, and resisting the temptation to stray down Ashwood Dale, get places on the coach for Castleton. Here we are in the heart of the Peak country, surrounded by high hills. The entrance to the Great Peak Cavern, the Norman Keep of Peveril Castle, the views in Cave Dale and in the rocky pass of the Winnats, whence are obtained lovely views of the Vale of Hope, will find you plenty of work for a long day. The Burbage brook, in its rapid descent through the Yarncliffe woods, on its way to the Derwent at Grindleford Bridge, yields a series of the most charming pictures conceivable. The village of Eyam lies among the hills two or three miles hence. Its grand old Saxon cross, with interlaced knotwork and rude sculptures, said to be the finest in England, and the scenery round about, render it a desirable place for a day's ramble with the camera. At Matlock you may get some nice river bits, and a good view of the High Tor. At Rowsley is a good river view with Gothic bridge, and the far-famed "Peacock" Hotel. South Winfield Manor is easily got at by a railway ride of fourteen miles from Derby. One mile from Wingfield Station, on a picturesque eminence, stands the extensive ruins of the Manor House, the most beautiful in the county, dating from the time of Henry VI. Hardwick Hall is a fine example of Elizabethan architecture, and with the ruins of an older Hall close by would furnish a good day's work; so also would Bolsover Castle, partly in ruins, some four miles off. These places are historically interesting, picturesque, and finely situated on the eastern side of the county. Tideswell and Wirksworth are both famous for their grand old churches, and both are in hilly districts. Repton is a place of some note. Amongst the best subjects for the camera are the ancient brick tower at the back of the Hall, with the old Trent and its waterlilies in the foreground, and the elegant church spire beyond; the street view showing the Cross, the Priory Arch and Church, and some nice wood and water subjects at the other end of the village. Dale Abbey, in another direction, has a hermitage cut in the sandstone, on a wooded hill-side, a quaint and curious little church, and remains of an extensive abbey. Still nearer are some pretty bits about Darley Abbey, on the River Derwent; and again on the Markeaton Brook; and on to Mackworth, an easy walk, where is a castle gateway, a good church, and picturesque cottages and lane scenes. But perhaps one of the best lane scenes is at Littleover, two miles off. Everybody in Derby who handles the pencil and brush, and everybody who photographs, makes a point of doing Littleover Lane. In our old town itself there is not much left you will care for, I fear, many of its best features having been improved off the face of the earth; but I may point out the views from Exeter and St. Mary's Bridges as the best still left to us, and the grand old tower of All Saints' Church is well worth a plate.

Patent Intelligence.

Applications for Letters Patent.

10,191. William Middlemiss, Lumb Lane, Bradford, Yorkshire, for "Improvements in camera slides."—10th August, 1886.

10,256. Samuel Henry Crocker, 52, Huntley Street, London, for "Improvements in photographic colour printing."—11th August, 1886.

10,439. John Henry Buxton, Hugh Haswell Shanks, and Charles Henry Evans, 28, Southampton Buildings, Chancery Lane, London, for "A process for obtaining from photographic negatives formes for lithographic or letter-press printing."—14th August, 1886.

10,483. Johann Conrad Hosch, 55 and 56, Chancery Lane, London, for "A photographic process for printing in colours." 16th August, 1886.

Specification Published during the Week.

7963. Hermann Wilhelm Vogel, of 124a, Kurfürsten Strasse, in the city of Berlin, Prussia, Germany, chemist, for "An improved process for manufacturing colour sensitive (isochromatic or orthochromatic) photographic emulsions or plates by dyeing the same with dyes highly sensitive to light."—15th June, 1886.

My invention relates to an improved process for manufacturing colour sensitive isochromatic or orthochromatic photographic emulsions or plates by dyeing the same with dyes highly sensitive to light. In the year 1873 I discovered that the sensitiveness of the haloid salts of silver for green, yellow, and red rays of light which is very feeble can be augmented by the addition of bodies which absorb such said rays. As such bodies I recognized at first coralline, picrate of methyl rosaniline, cyanine, fuchsine or aniline red, naphthaline red, aldehyde green, methyl violet, &c. These researches were continued by Waterhouse, Becquerel, Ducos du Hauron, Eder, Schumann, and others, and in this manner a large number of such light-absorbing bodies were discovered, which I denominate optical sensitizers. This discovery is the basis of the isochromatic or orthochromatic process now in use. The first isochromatic—*i.e.*, colour sensitive—collodion process was published by me in the May 1884 number of the *Photographische Mittheilungen*, Berlin.

Continuing my researches and experiments, I observed that some dyes which absorb coloured rays are not sensitizers for such rays, and ascertained that only those dyes are optical sensitizers which are not only powerful absorbents of certain rays, but which are themselves readily decomposed by light. The more readily coloured bodies fade under the influence of light, the better is the same adapted for rendering silver sensitive to light. When this fact has once been established, it will be an easy matter to determine whether any new dye or colour is a good medium for increasing the sensitiveness of the haloid salts of silver, it only being necessary to test its sensitiveness under exposure to light, and if it fades readily, it is a good medium for rendering such silver salts sensitive. In order to carry out this test, I prefer to prepare paper, gelatine, or collodion with the dye or colour in question, and expose the same to the light (preferably sunlight) under a perforated screen or photographic negative. In this manner I ascertained that cyanine is one of the best sensitizers or mediums for increasing the sensitiveness of the salts of silver employed in photography, and I furthermore discovered other valuable colours for achieving the same object.

I discovered further that all the red, violet, and blue chinoline and pyrodine dyes, which cannot be employed by dyers, on account of their fading so rapidly when exposed to light, are first class optical sensitizers for photographic plates.

The application of the aforementioned dyes is extremely easy; for instance, (a) the dye is either dissolved in alcohol in the proportion of about 1 : 1000 alone or mixed with other colours, and then mixed with the prepared emulsion, and with or without an addition of liquor of ammonia or carbonate of ammonia; or, (b) the dye is dissolved in water alone, or mixed with other dyes, with or without adding liquor of ammonia or carbonate of ammonia to the solution. The quantity of dye to be added to the emulsion varies according to the quality of the latter, and must be determined by an experiment. An excellent formula for many emulsions is:—2 to 4 cubic centimetres of a solution of chinoline red in alcohol (1 to 500), 5 drops of a solution of cyanine (1 to 500), 100 cubic centimetres of water, 1 cubic centimetre liquor of ammonia. The emulsion plates are dipped or steeped in this solution for one minute, and then dried. On the other hand, I have ascertained that the chemical stability of certain dyes—such, for instance, as cyanine—can be increased to a great extent by combining the same with certain other dyes, so that colours which produce plates which will keep only a short time can be used to advantage in combination with other dyes, whereby plates of good keeping quality are produced; for instance, cyanine is very much improved by an addition of chinoline red, and for the above-named reason I prefer in many cases to use mixed dyes instead of single dyes. What I claim is:—

1. The method of rendering photographic emulsions and plates sensitive to coloured rays of light by treating the same with a dye or colour which readily fades when exposed to light.

2. The method of rendering the haloid salts of silver more sensitive to coloured rays of light, by treating the photographic emulsions or photographic plates containing the same with a solution of chinoline dyes in alcohol.

3. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, by treating the same with a solution of chinoline in water.

4. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, with a solution of colours made from chinoldine.

5. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, with a combination of two or more dyes or colours which readily fade when exposed to light.

6. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, with a solution of one dye, and subsequently with the solution of a second dye for wet or dry plates.

7. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, with a solution of colours made from pyrodine.

8. The method of rendering the haloid salts of silver in photographic emulsions and photographic plates sensitive to coloured rays, by treating the same with a solution of colours made from chinoldine.

ON MEN'S HEADS.

BY WILLIAM ADCOCK.*

In addressing professional gentlemen who are present, I feel as a layman may be supposed to feel who pushes under the notice of a bishop, saturated with Greek and Hebrew, his interpretation of a difficult passage, or as an ordinary medical student should feel if advising a distinguished local oculist how to treat a case of threatened blindness. In photography I am a mere amateur. Important business occupations claim me, especially in summer, as their own; and yet I am presuming to offer advice to those whose daily study is the production of portraiture of a high class, which shall meet and satisfy the demands made upon them. On these grounds I ask your forbearance, and indulgent interpretation of my address to-day.

It has happened that an onlooker of a combat has seen where a defensive movement or an onslaught would, at a given moment, have changed the fortunes of a day. Is it possible that an onlooker of the struggle going on on all sides for more and more sitters, may see a chance for some, at least, getting fame and profit by adopting his suggestions? I have an idea about men's heads which may, in your opinion, be worthless; but this is the foundation of it: that I should wish to purchase from some of you the thing I recommend, were I not able to supply myself with it, and I assume many others have the same desire, who are not able to take their own portraits. This paper is on "Men's Heads" only.

By what I say, do not think I am unmindful of, or underrate, the beautiful work you do. Portraiture is daily better done than formerly. It is artistic, refined, polished, and charming; but is not the almost universality of it apt to pall? Should we not value more much of this delicate and refined work if we saw some in contrast to it? For heads suitable I am about to suggest more size, more ruggedness, more abrupt lighting, more vigour, more character; less *finesse*, less prettiness, less of the pencil—more of the lens.

Painting is many-sided: why should not photography have more sides than we see? The beautiful work of the miniature painter is rivalled by the beautiful retouching, or overwork, of your artists; but the subjects of the miniature painter are chiefly women and children, not strong, massive-faced men. Again there are artists who work with big hog's-hair tools. Who amongst you gentlemen imitate these? Who tries to do in photography what is done by the sweeping brush of Millais, or Frank Holl? You take large heads—that is, you enlarge to them; but here again comes the overwork, which makes them drawings. I suggest five-inch direct heads—strongly, not delicately lighted—with every scar or wrinkle left on them. A negative a retoucher is never allowed to see; a print nought beyond a mere spotter is ever allowed to handle. Rough, rugged, demonstrative, truth-telling photography!

Tell men who have heads what pictures they would make, and show them what you can do. Have two styles of heads, a masher's, and a man's. Let the former be beautiful as Rachel's enamel once was, let no egg-shell beat the skin in smoothness, let no wrinkle or marking be unobliterated; but when you get a man with a character in his head, make a man of him. Make two portraits, if you like, but let one be the big, direct, untouched one. If untaken, that is, unbought, show it as a specimen. Let artists see it. Grist will come to the mill. In saying this I am asking you to employ your best powers, your artistic taste; study old masters and imitate them; aim at grand effects of light and shadow. *For a change*, under-expose and over-develop. You will get a Spagnoletto. Who remembers the Duke of Cleveland in the Academy just closed? Was this head smooth, and polished, and wrinkleless? Indeed no; it was wondrously painted rough, old, corrugated skin, with all those marks and discolourations which belong to advanced life. Now, am I wrong in saying an ordinary portrait, and an ordinary enlargement from it, of that man's head would be smooth as the cheek of a girl, and in that respect a fiction? I have advised direct heads, and shall probably be met by the inquiry, Why not enlarge? Well, this is reasonable to ask, and all I can reply is, If, as a rule, one copy only would be likely to be wanted, and you can get as fine results, by all means consider the difference of cost between buying a large lens and enlarging. When I asked a well-known maker to supply to me a large lens, the facilities for enlarging effectively were not what exists to-day. I am not unmindful of what may be done on the specially prepared papers offered to us. I have seen fine things as enlargements, but I remember others, in days gone by, where the hair was thatch, and where, without over-work, the thing could not be accepted. This brings me again to the point I would insist upon. Produce them as you like, but give us five-inch heads that look pictures in themselves, that have never been retouched, and never worked upon.

I will take no more of your time; I do not expect my words to pass unchallenged. From my point of view, and my hope that some here trace the rut I have pointed to, it is scarcely desirable they should.

* A communication read at the Convention.

Correspondence.

THE BRITISH ASSOCIATION AT BIRMINGHAM.

Sir,—In connection with the meeting of the British Association at Birmingham (September 1st to 8th), it is the intention of the Birmingham Photographic Society to invite photographers attending the meeting to a special

conference to be held at some convenient time during the course of the meeting, of which due notice will be given. Messrs. A. L. Henderson, Prestwich, and W. England, have already signified their willingness to attend, and we hope also to be favoured with the company of Messrs. J. Traill Taylor, F. York, and many others. Will all photographers who intend to be present kindly send their names to our Hon. Secretary, Mr. B. Karleese, 87, Wilson Road, Birmingham, or to yours truly, W. Jerome Harrison.
Science Laboratory, Board Schools, Icknield St., Birmingham.

Proceedings of Societies.

London and Provincial Photographic Association.

A meeting of the Society was held on Thursday, the 12th inst., Alexander Cowan in the chair.

"Which is the best wood for making camera stands, having in view portability and rigidity?" was a question from the box, which was discussed.

The Chairman thought light ash was the best.

W. M. Ashman had used American ash—split, and pegged with hickory—under the most trying conditions, and he thought hickory might well be used, seeing that it was almost as hard as metal.

The Chairman did not think any folding stand was so firm as the split form of rigid leg.

A. Mackie referred to certain commercial stands possessing a large degree of portability.

The Chairman, however, deprecated the system of aiming at extreme portability, thereby sacrificing other qualities.

R. Offord considered that the chief value of a sliding leg consisted in the facility of securing a position at any point, either up or down.

H. D. Atkinson spoke in favour of the bamboo stand.

The Chairman said that upon one occasion he found it necessary to increase one leg of his tripod stand five feet longer than the others; he also referred to the old plan of drawing the front leg beneath the camera, when it was necessary to incline the camera very much. In alluding to some silver prints of the Niagara Falls, now on sale in this country, he remarked that in many cases the clouds were darker than the principal object, and in some instances upside down.

Another question from the box was then discussed as follows: "Is there any easy way of printing stereo pictures in the proper position for the stereoscope on one piece of paper, when taken with twin lenses, without cutting the negative?"

The Chairman remarked that the neatest plan he had ever seen was to be found in an early volume of the Photographic News. A piece of paper was cut twice the length of the negative, folded, black paper placed between, and then printed. When cut in two, the pairs would be in their proper order.

R. Offord explained his plan of producing stereoscopic pictures with one lens. The sitter was placed upon a music stool with head-rest thereon, and one half the plate exposed; then by means of a cord the plate was moved a given distance in the dark slide, and the sitter revolved a previously determined distance, when the second exposure took place. He thought few people were aware what grotesque effects could be produced by modifications of the above plan.

A. Mackie said many pictures were too stereoscopic, which was doubtless due to the employment of very short focus lenses.

R. Offord replied that one of the greatest mistakes in making stereoscopic pictures was the use of a lens of less than cabinet size, and he should prefer a lens of 5D type, rather than 2B.

H. D. Atkinson inquired how statuesque pictures were made.

The Chairman said the model leaned against a dummy bust.

R. Offord suggested the use of a vignetted negative, and superimposing a transparency of the design.

The Chairman said his frame would register transparencies over any portion of the plate.

A. Mackie thought it was more difficult to register negatives than prints.

R. Offord observed that it was still more difficult to make a carbon print from three or four subjects.

H. D. Atkinson spoke of the non-photographic effect of a surface previously painted with quinine di-sulphate.

In the discussion which followed, it was mentioned that Dr. Gladstone had brought this fact prominently before the British Association about fourteen years ago, and the late G. Wharton Simpson had suggested its application to silver prints to prevent piracy.

T. Waltenberg inquired the best means to remove silver stains from an unvarnished gelatine negative?

A. Mackie recommended friction with turpentine if the stains had recently appeared. Potassium cyanide in alcohol was also good, and so was bleaching with mercury.

R. Offord was of opinion that chromic acid would act in the same way, and could easily be removed by washing in dilute ammonia. He then went on to point out the value of chromic acid in producing reversed positives direct from negatives by this method of Obernetter, and their artistic effect when coloured by Wood's plan. In reply to a question regarding matt varnish giving an indifferent surface, he said that ether evaporates more easily than benzole; hence, when these solvents are not equal, a perfectly matt condition cannot be fulfilled; and the Chairman also advocated making a fresh quantity, rather than additions, when a fine grain was not obtained.

Manchester Amateur Photographic Society.

The monthly meeting was held at the Masonic Hall, Cooper Street, on August 10th, Thomas Widdop in the chair.

A communication was read from the Corporation of Oldham, announcing that it is intended to hold an exhibition of photographs in the Art Gallery, Oldham, to be opened in September for three months.

The Honorary Secretary (Mr. Parrott) reported that during the past month rambles had taken place to Ingleton, Worsley, Whalley Abbey, and Warburton. At Worsley, by permission of the Hon. Algernon Egerton, the members were allowed to photograph Worsley Old Hall, a fine sample of magpie architecture. The members were also allowed to photograph the interior of Whalley Abbey by the kindness of Colonel Hargreaves.

Samples of a new kind of printing paper, called aristotype, were exhibited by Mr. Chapman. It is claimed for this new paper that it will print in one-third the time necessary for the ordinary albumenized paper, and that being prepared with gelatine instead of albumen, the resulting pictures will be more permanent.

An exhibit of prints from negatives taken on the Society's excursions by the Secretary caused an interesting discussion on the practice of backing plates used for interior and for landscape work, in order to prevent halation of the high lights. Plates that had been backed with burnt sienna ground in water showed a marked superiority over similar plates used unbacked.

At the conversazione held after the meeting, prints were exhibited by Messrs. Graham, Wheeler, Smith, Enriquez, Furnival, and Parrott.

Sheffield Photographic Society.

The ordinary monthly meeting was held on the 10th inst. at the Masonic Hall, Surrey Street, Mr. Barber in the chair.

The principal business of the evening was the adjudication of the July prize competition, the subject being landscape. T. G. Hibbert was the successful exhibitor, with a half-plate view in Endcliffe Wood, near Sheffield.

The Chairman announced that A. S. Platts had promised to read a paper at the next monthly meeting.

Cardiff Amateur Photographic Society.

The usual monthly meeting was held on the 13th inst., the President, S. R. Allen, in the chair.

B. J. Edwards was elected an ordinary member, and W. Furley, P. R. W. Williamson, and H. Dyer were added to the Council.

Several prints were exhibited—the result of the Society's visit to Caerleon on Bank Holiday. Although the excursion was most enjoyable, the unanimous opinion expressed was that one visit to this ancient town, from a photographic point of view, was quite sufficient.

The Society was indebted to Dr. Boo'cott for his kindess in throwing open his grounds on the occasion.

Talk in the Studio.

Photographic Society of Great Britain.—The usual monthly technical meeting will take place on Tuesday, August 24th, at eight p.m., at the Gallery, 5a, Pall Mall East. Doors open at seven p.m. for reading journals, &c.

The Queen has presented the Indians and natives who recently visited Windsor Castle with photographic groups of themselves taken on the east terrace during their stay at the Palace. The pictures have been printed by Cartland, of Windsor, and Hills and Saunders, of Eton, the Royal photographers, in order that the visitors may possess lasting mementoes of their interview.

Photographs of the Photographers in Convention.—Of several groups taken at the Convention, that by Thos. Scotton deserves special notice. It was taken on a 26 by 21 plate, and the print size is 24 by 16. About half of those present at the Convention are included, and each person is distinctly recognizable—in fact, we have here about fifty really good portraits.

Extract from a Circular sent to us: A Study in Self-Laudation.—We have the pleasure to call your attention to a most exquisite series of instantaneous photographic studies of * * * * of the highest artistic excellence and idyllic beauty. They are printed by the Platinotype process, the beautiful grey tones of which give them all the appearance of the most charming mezzotints. The lighting, posing, and composition are most carefully studied, and the results are beyond criticism. This description may appear exaggerated, but we do not wish to obtain orders upon the strength of this, but simply to be favoured by an inspection, when we feel assured that you will admit that they fully bear out our eulogiums. We have accepted the sole publication of these, both at home and abroad, and are now booking orders from our samples which will be executed in rotation. As the demand for these studies promises to be excessive, we should advise an early visit of inspection. Selections, suitably mounted and bound, form an exquisite and artistic gift for any occasion, and we are certain that nothing will be more appreciated.

The Provost-Marshal.—The *Times* of the 13th inst. has the following, and states it to have been received from the India Office:—A general order has been issued to the Army in India, announcing that the Viceroy is satisfied that the charges brought against Colonel Hooper, late Provost-Marshal at Mandalay, of photographing condemned criminals at the moment of execution, and of causing a prisoner to confess under threat of death, have been established. The order adds that Colonel Hooper's conduct reflects discredit upon the British Army, and that the Viceroy would have been justified in recommending his dismissal from the service; but, having regard for his past career, thinks that a public reprimand will be sufficient.

Velocity of Light in Quartz—By K. Exner (*Jahrb. f. Min.* 1886, i, Ref., 388).—If v_1 and v_2 represent the velocities of two plane waves propagated in the same direction in quartz, and v'_1 and v'_2 the velocities of two plane waves propagated in the same direction in a crystal which does not possess the power of optical rotation, but which, in directions perpendicular to the optic axis, has the same velocity of light as quartz, then it follows from the theories of Cauchy and V. v. Lang that—

$$\tfrac{1}{2}(v_1 + v_2) = \tfrac{1}{2}(v'_1 + v'_2),$$

that is to say, for any direction of propagation in quartz, the arithmetical mean of the two velocities of propagation is equal to the arithmetical mean of the velocities which would correspond with the same direction of propagation in a crystal without the power of optical rotation, but with the same refraction. From this may be deduced Cornu's law that in the direction of the optic axis of quartz, the arithmetical mean of the two velocities of propagation of light is equal to the velocity of propagation of the ordinary wave in directions perpendicular to the optic axis.

Gold Washing in Italy.—Washing for gold has been practised from time immemorial in Piedmont, in the beds of some of the torrents which flow from the Alps to the Po. According to Pliny and other ancient writers, upwards of 5,000 persons were engaged in this occupation at one time. In modern times, however, it has only been practised on a small scale, and principally in the beds of the torrents Orco, Malone, Dora Baltea, and Ticino. Of late years the existence of these auriferous sands has been more fully investigated, and have been found to extend at the foot of the Alps from Legin and St. Maurizo on the West to the Dora Baltea on the East, and bounded on the South by the Po, covering an area of 100,000 hectares, or about 250,000 acres. The depth of this gold-bearing deposit varies from 5 to 8 metres, and although the amount of gold these sands contained cannot be said to have been ascertained with any degree of accuracy, there appears to be every reason to believe that the estimate of 0·40 grams per cubic metre is not an exaggerated one :0·01286 Troy ounces (0·2572). A company, the "Società dei Giacimenti Auriferi di Piemonte," have recently commenced operations in the bed of the torrent Orco, near San Benigno, and a few weeks ago inaugurated a powerful steam dredger, named the "Regina Marghousa," which has been constructed especially for the excavation and washing of these sands, by M. Perrin, of Lyons; it is of 50 horse-power, and is capable of raising from 2,000 to 2,500 cubic metres of stuff per day of twenty-two hours. The buckets are twenty-two in number, and are capable of excavation to a maximum depth of 8 metres.—*Journal of the Society of Arts.*

Photographic Club.—The subject for discussion on August 25 will be "Single Lenses." Saturday outing at Earlsfield; train leaves Waterloo at 1.50.

To Correspondents.

*** We cannot undertake to return rejected communications.

Pyro.—Our advice is that you should shade the more transparent half of the negative by fastening one thickness or more of the finest tissue paper at the back. The so-called *Papier Mineral* will answer.

"Rembrandt" writes from Kidderminster as follows:—"Would you allow me, through the medium of your paper, to caution photographers against a man who is going about the country, stating that he is a background painter; his *modus operandi* is to obtain a small sum either for his dinner, or for the colours, &c., he says that he requires, after which he is not seen again, nor the amount advanced."

A Constant Reader.—They probably arise from insufficient washing.

Basil Christian.—You can get it done by Wratten and Wainwright, 38, Great Queen Street, Long Acre.

R. P. G.—See a series of articles that appeared in the News during 1884, pages 177, 210, 226, 276.

Zinc.—1. An article on the subject will appear shortly. There is, as far as we know, no book devoted altogether to the subject, but articles will be found in various technical publications.

Foreign Subscriber.—As far as we can ascertain, they are not made commercially; but it is very easy to fold up a sheet of the material in the form of a dish, and to fasten the corners. 2. Very fine silk stretched on the frame answers admirably.

A Tasmanian Subscriber.—All the matters you refer to are fully treated of in Abney's "Instruction in Photography" (see notice of the new edition, in another part of the News.)

P. M.—1. They are ordinarily made in moulds of pasteboard, and the whole process of moulding and casting need not occupy more than twenty minutes or so. A book on stereotyping, &c., is published by Wyman, of Great Queen Street, London, W.C. 2. For the purpose, a very soft gelatine should be used; that sold by Nelson and Co. as "transparent sheet," is very suitable. 3. More bichromate should be employed; In fact, as much as double the proportion you have been using will not be too much.

Cambridge.—1. Dissolve it in cold water, as hot water partially decomposes it. 2. The effect is due to the absorption of oxygen, and the old solution is not worth troubling about. Keep the next making in a well-closed bottle.

E. C. Waring.—The method is one which is capable of giving good results, and if you will send us a specimen of your work we may possibly be able to suggest the cause of your failure.

Convention Papers Standing Over.—"The Treatment of Negatives after Development: A Mystery Explained," by W. B. Bolton; "Development: Another Word for Oxalate," by John Crosby; and "Gelatine Emulsions," by A. L. Henderson, are in hand, but must stand over till next week.

The Photographic News.

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THE PHOTOGRAPHIC NEWS.

Vol. XXX. No. 1450.—*June* 18, 1886.

CONTENTS.

PHOTOGRAPHY AND THE ELECTRIC LIGHT.

The present seems an opportune time to make a few remarks on the subject of photographing by the electric light, since we see various artifices put forward not only for generating light by electricity, but also for its adaptation to photography. The question at present to discuss, to my mind, is not how electricity will be generated, but as to the value of the light for the latter purpose. It may be necessary incidentally to touch on the mode of generation, but it will, if it may so be said, be kept in the background. There are two modes in which electric lighting may be satisfactorily employed: one in which a current is used to heat a thread (or filament, as it is technically called) of carbon, inclosed in a glass globe (known as the incandescent light system) which is in a state of high vacuum; and the other, in which a current is maintained between two carbon rods separated by an interval varying from one-sixteenth of an inch to half an inch or more (known as the arc light). The question, then, is, as to which form is the most economical and useful to employ in photography. Let us take the case of the incandescent, or glow lamp, first. It is very well known that a body may be hot, and yet not luminous; and in the matter of a carbon filament through which a current of electricity is passing, the same fact holds good: it may be hot, and yet not luminous. To fully comprehend how the heat is generated touches on a domain in physical science which can only be dealt with very slightly in the present paper. Suffice it to say, that if an electrical current, generated from, say, a battery, meets with any obstruction to its free passage, part of the energy expends itself in doing work upon the obstructing body, causing the ultimate particles or molecules to vibrate with greater vigour than they do at ordinary temperatures, such increased vibration is shown by an increase of temperature in that body. The less obstruction offered to the passage of the current, the less heat there is which shows itself. For instance, taking unit lengths and sections, copper offers less resistance to the passage of the electrical current than does platinum, and platinum than carbon; hence if the same current is caused to flow through different filaments of the same section and length, the carbon filament will become hotter than the platinum, and the platinum than the copper.

If, also, through the same filament, which, with a certain current passing through it, is only black hot, a larger current be caused to pass, the filament will become red hot, and therefore luminous; if larger still, yellow hot; and if still more, white hot. Applying a pocket spectroscope to view the filament at three different stages, it will be seen that only when the filament becomes red hot does any light appear, and that is red; that as it is gradually heated up to yellow heat, the red of the spectrum increases in intensity, and at the same time yellow and green rays begin to show; whilst at white heat the red becomes still further intense, and the yellow and green become much more luminous, and blue also appears, and a dim violet. If we take the ordinary bromide plates, such as are at present in vogue, we know that the parts of the visible spectrum which are most photographically effective lie in the violet and in the green, whilst the yellow has but a trifling effect, and the red almost none. Beyond the violet it is also well known there are invisible rays which also exert a photographic action. Hence we arrive at the conclusion that the filament at a white heat is more photographically efficient than one at a yellow heat, and a great deal more so than one at a red heat.

Having arrived at this conclusion, we can deduce certain others from it. Suppose we have at our command a certain quantity of electrical energy as given by (say) twenty Groves' cells, and desire to utilise it most economically, how should we proceed? The resistance of a thread at the same temperature varies inversely as its section, and directly as its length—that is to say, if there are two threads each one inch long, one having a cross section of $\frac{1}{100}$ of a square inch, and another a cross section of $\frac{1}{200}$ of a square inch, the latter has a resistance which is twice as great as that of the former; but if the length of the first thread be two inches, the resistances will then become equal.

Now the heat (not temperature, which is quite a different matter) caused by the passage of the same amount of current, varies as the resistance; therefore, in the cases of the two filaments, each an inch long, but the one filament $\frac{1}{100}$ of an inch, and the other $\frac{1}{200}$ of an inch in section, the heating effect produced by the current will be double in the latter to that of the former (supposing the heat had no effect on altering the resistances); but in the case where the length of the thickest filament is doubled, the total energy converted into heat will be the same. Now suppose we had two glow lamps made with these filaments—that is to say, one with a cross section of $\frac{1}{200}$ of an inch, and one inch long, and another with a cross section of $\frac{1}{100}$ of an inch and two inches long: which one should be the most economical to use for photographic purposes? The energy converted into heat would be the same as already said in the two cases. Now as fast as the thread is heated, so fast does it lose a part of its heat by radiation, which may be dark radiation, or dark radiation together with visible radiation; and finally, an equilibrium is established, so that the quantity of energy converted into radiation at any instant is replenished, as it were, by the electrical energy converted into heat. Now the amount of radiation depends on the surface from which such radiation takes place.

In the case of the two filaments, the area of radiation is the length multiplied by the girth. It will be found that if the radiating area of the shortest filament, which has the smallest girth, be called 1, the area of the other is $\sqrt{2}\times 2=2{\cdot}8$, or nearly three times of that of the first (supposing that they are similar in section—say, square or circular). Radiation can therefore take place more freely from the latter than from the former, and consequently the long filament will be kept permanently at a lower temperature than the short one, or to the eye the former, if the radiation be visible, will be less white than the latter; that is, the shorter and thinner filament will be heated by the same expenditure of energy to such an extent as to emit more photographically effective rays than the longer and thicker filament.

[No note here is taken of the slight decrease in resistance which takes place by the increased temperature of the former, since it would only complicate matters.]

We have supposed the currents in the two cases to be the same, and also the resistances, therefore the total quantity of energy expended by the battery will be the same (*i.e.*, the amount of zinc dissolved in the battery will be the same in the two cases); and although, as measured by a thermopile or other measurer of radiation, the total amount of radiation will be the same, yet the quality of that radiation will be very different. To take a homely simile. We may heat a long bar of iron black hot, and cool it in a quart of water; but we may heat another quart of water to the same temperature by plunging into it the end of a white hot poker. The quantity of heat in the two is the same in both cases, but the quality of the radiation is very dissimilar. The conclusion, then, to be derived is, that a short fine filament is more economical for photographic work than a longer and thicker one which has an equal resistance.

Another point to which we may call attention is the effect of nature of the radiating surface on the quality of radiation.

If we take a filament of carbon which has been rendered of a steel like appearance by proper treatment, and over one-half brush a very fine layer of lamp-black, and then form it into a lamp, and pass a current through it, we shall find that the half which has been dulled in surface emits less light, and is of a redder character, than the other half. The fine coating of powder does not alter the resistance of the filament to any praticably measurable extent, and as *increase of heat* in carbon *lowers* its resistance, the steel-like part of the carbon, therefore, offers *less* resistance to the passage of the current than the other part. But, as we have said already, the greater the resistance the higher the temperature should be; in this case it is part of the filament of *lower resistance* which has the *higher temperature*, hence it must be the difference in the kind of radiating surface which causes the loss of light. In other words, the total radiation from each part is practically the same, though the lamp-black causes the invisible radiations below the red to be more rapidly expended than on the part where the lampblack is absent, and has, consequently, a lower temperature, and does not, as a consequence, emit so many rays which are photographically effective. The deduction from this to be drawn is, that with a certain amount of energy to be expended, a carbon filament which is steel-like and bright in appearance is better than one which is dull. This matter was investigated some time ago, but the results seem not to have been generally recognized. We arrive, then, at two important points in regard to the generation of electricity for photographic purposes under the conditions named. It must not be imagined that with an unlimited supply of electricity there is economy in this way of choosing a lamp. With the longer and thicker filament already spoken of, the same temperature and, therefore, the same quality of light can be obtained, as with the shorter and thinner filament, by using up more electrical energy. When the same temperature is attained, the quantity of light emitted in the two cases will be exactly proportional to the energy used up. The same argument holds good in the case of a dull filament as against a bright one. When the same temperature is obtained in the two, the former emits more light than the latter, but uses up a proportionally larger quantity of electrical energy.

In the case of a battery, the electrical energy may be measured by the zinc consumed, and in a dynamo by the effective horse-power employed. Electrical energy has two components. You may have the same work done on a water-wheel by a large quantity of water falling on it from a slight height, as you can by a less quantity of water falling on it from a higher level. So if you have a small current of electricity which is, may we say, pushed by a high "head," it will do the same amount of work as a larger current pushed by a smaller head. Thus you may have 10 grains of zinc consumed in one cell of a battery which does a certain amount of work, the current of which we will say is represented by 10, and the pushing force 1, or we may have 10 grains consumed in 10 cells in the same time, the current will then be only 1, and the pushing force 10. The current multiplied by the pushing force will in both cases be equal, and this is a measure of the electrical energy. In electrical parlance, current in "ampères" × electro motive force in "volts," is equal to "watts" of energy, and the watts is practically a measure of the total radiation, visible and invisible combined. There is further a connection between the current, the electro-motive force, and the resistance of the lamp, leads, and battery. The last two may be neglected for our purpose, and the connection between the three is that the current can be found by dividing the electro-motive force by the resistance of the lamp. Thus, suppose that the resistance of a red hot filament does not differ very much from a white hot lamp—which it does not do in many filaments—the current obtainable is measured by the electro-motive force, and this is roughly measured by the number of cells of the battery employed. Now, as the energy is given by the electromotive force, multiplied by the current, we may compare the energy employed, when using different number of cells, by squaring such number. Thus, if five cells make a filament red hot, and ten cells white hot, we can roughly say that the energy employed in the latter case is four times that in the former, or four times more zinc is consumed. It will be at once apparent that you have to use a much larger quantity of energy to produce a fair photographic light than you have to produce a fair light for illuminating purposes.

(To be continued.)

THE "ARTISTIC PHOTOGRAPH" CASE.

IN another page we give a full report of the hearing of the summons against Messrs. Erdmann and McIntosh for having "unlawfully sold obscene prints or pictures." Although Mr. Chance has not yet given his judgment, we have no hesitation in commenting on the case so far as it has gone, because the decision of the magistrate cannot in any way affect the dictum we have already laid down; that is to say, to pronounce whether a photograph is obscene because it represents a nude figure is not a matter of law, but of individual opinion.

We think we shall have the feeling of most unprejudiced persons with us when we say that a weaker case has rarely been brought into court, nor supported by more childish arguments. The prosecutor is a John Southward, described as a "journalist," who, having seen the defendant's advertisement that art photographs and studies from the nude would be sent to any address "on approbation," wrote for samples, bought a quantity, and subsequently made a second purchase. Then his modesty appears to have been shocked, and he made a communication to Sir Charles Warren, which led to the present prosecution. At the outset it will be seen that the case differs *in toto* from an ordinary police prosecution of the

Holywell Street class. Messrs. Erdmann advertised openly; their advertisement was not couched in those insidious terms which persons of prurient minds never fail to understand; and samples could be had "on approbation," certainly a condition which the Holywell Street dealer would never dream of offering. It may be fairly argued that Mr. Southward desired "photographs from the nude," or he would not have written for them; and why, having got what he wanted, he communicated with the police, we leave him to explain. Had the police been anxious to act in the public interest, they could have proceeded on their own responsibility without the slightest difficulty. However, they have preferred to shelter themselves behind the sensitiveness of Mr. Southward, "journalist," and whether they are seeking to protect Mr. Southward's morals, or the morals of the public, it is impossible to say.

So much for the method of prosecution. We now come to the arguments by which the prosecution was supported. Mr. Powell's contention with regard to certain of the photographs was, that as they fully disclosed the body, they ought to be destroyed. He did not say they were suggestive of immodesty; he did not complain that they were inartistic; their sole crime was that they represented the human body as it is. If this theory is to be accepted, the sale of a study made in a life school will render the seller liable to fine or imprisonment. However one may differ from the learned counsel in his construction, there was a show of reason in his argument; but as he proceeded, common sense seems to have departed. It is scarcely possible to comprehend a man arguing in this fashion:—"It was obvious," said this learned counsel, "that there was a great distinction between pictures in a gallery, and photographs of these pictures. First of all, there might be one picture, and there might be any number of photographs seen by any number of persons, old and young. It was not usual to take young persons, and young females especially, into galleries where such pictures were to be seen." Prodigious! One is tempted to ask Mr. Powell whether he has been kept at home all his life under the eye of some elderly female relation. Has he never seen the crowds in the National Gallery? Did he visit the Royal Academy last year when there were at least a dozen nudities at which young ladies gazed without a blush? Has he never heard of Mr. Goodall's "Susannah" in this year's Academy; or of Mr. Whistler's Harmony in Blue and Gold in Suffolk Street?

No wonder the shrewd magistrate refused to accept such an obvious absurdity. Nor did Mr. Powell strengthen his case as he went on, for we have him gravely contending that because certain pieces of statuary were objectionable in the eyes of some persons, therefore photographs of them should not be circulated. One has hardly patience to follow such reasoning—if reasoning it can be termed—especially when the climax was reached by the remark that "it was because there were prurient-minded persons who would pay high prices, in order that they might have their pruriency gratified, that those who instructed him asked for a conviction in this matter." In other words, the law is put in action on behalf of the low and vile, for whose protection, if Mr. Powell's argument is sound, all our picture galleries should be closed, and Shakespeare and the Bible be burnt!

The reply of Mr. Besley—who, we may remark, in passing, has had a large experience in these cases—may be left to speak for itself, and we have devoted more attention to the arguments for the prosecution, because it is upon the prosecution that the onus lies. It is gratifying to see that the magistrate is disposed to deal with the case in a dispassionate spirit. His remarks during the progress of Mr. Powell's speech indicated an accurate appreciation of the points at issue, and whatever decision he may give will, we believe, be arrived at without prejudice. As a test, the case is regarded as a most important one, and the defendants are well advised in their determination to appeal, should the judgment be adverse. But supposing they are victorious at every step, a valuable precedent is all that will have been settled. What is wanted in the future is a body of experts competent to decide what comes fairly within the range of art, and by whose opinion the magistrate shall be guided. It is significant of the flimsy character of the present prosecution, that no witness of known artistic ability has been called to support it. One word from Mr. Poynter would have been of far more value than all Mr. Powell's so-called arguments.

STEALERS OF SPECIMENS.

A Caution to Assistants.

We are sorry to have to recognize the fact that there exists a class of photographers who, when they want to furnish their show-cases with specimens of better work than they can do, are not content with merely cheating the public and degrading themselves by purchasing specimens in the open market and showing them as their own, but even go farther than this—even so far as to advertise for assistants, in order to obtain their specimens.

Here is the substance of a typical letter of complaint, a letter dated June 15th:—

"Sir,—On May 31st I answered an advertisement which appears in your issue of ———, in which an Operator is advertised for, and it is further requested that specimens be sent, the return of these being promised. I sent cabinet and carte specimens, also a photo of myself, coupled with a request that if I did not suit, they would kindly return them by the next post. Not hearing anything further, I wrote on June 4th, enclosing stamps for their return—no answer. I wrote again on June 8th—no answer. On June 11th I wrote again, threatening them with legal proceedings; again no answer."

At the present stage we cannot publish the initials and address of the advertiser to whom our correspondent sent his specimens, as there is so far no evidence that he really belongs to the group of specimen stealers. Indeed, it may be assumed that by some rare chance our correspondent's package containing the photographs did not reach its destination.

Now, without regard to the special complaint made by our correspondent, we have abundant evidence that specimen stealing by advertisement does go on to a great extent, and we need not remark that thefts perpetrated upon those who are unemployed are especially cruel and deserving of punishment. In such cases the victim should go to the police-station nearest his residence and state the facts of the case, when the inspector on duty will give him information as to the police-station nearest the residence of the advertiser. A communication in the clearest and most concise language should then be addressed to the inspector on duty at that station, which, for convenience, we will call the advertiser's station, with a request that he obtain what information he can regarding the matter. Sometimes, in such a case, the inspector at the victim's police station will himself write the communication to the advertiser's police-station.

The correspondent referred to above, authorises us to give his name and address to parties interested in punishing those who steal specimens.

COMPOSITE PORTRAITS OF AMERICAN INDIANS.

BY ALICE C. FLETCHER.

On the plate accompanying this number is given, so far as known, the first presentation of composite portraits taken of North American Indians.

No. 1 is of three full-blood Dakota or Sioux young women belonging to the band commonly known as the Brulé, and living at the Crow Creek agency, Dakota terri-

Fig. 1.—Composite from photographs.

Fig. 2—Composite from direct sittings.

Fig. 3.—Ruling face in fig. 1

Fig. 4.—Ruling face in fig. 2.

tory. Their ages range from nineteen to twenty-three years. Their average height is five feet six inches and a half; their average weight, a hundred and forty-one pounds. This composite is made from photographs taken on the same day and in rapid succession. On the same afternoon, composite No. 2 was taken from the same persons, each one sitting her allotted seconds before the camera. In No. 1 and No. 2 the order of the faces is identical, and care was exercised to try and procure similar results in the portrait; but, as will be observed, the composites are different. The controlling face in No. 1 is given in picture No. 3, which was the first photograph to be exposed in making up composite No. 1. The dominant face in No. 2 is given in picture No. 4. It belonged to the last sitter, and her photograph was the last one exposed in making composite No. 1. In two composites similarly made, of Omaha women, the one from sitters varies in a like manner from the one made up from photographs, only in a different order. In the one from life the broad face of the last sitter controls the composite, and in the other the long face of the first photograph influences the picture. This variation of composites made from the same faces—one taken from life, the other from photographs—is mentioned for what it may be worth.

A composite of Omaha men, a cognate tribe, differs but little from a Dakota composite, except in the eyes. In the Omaha composite the eyes are larger and fuller. The height and breadth of the head, the strong but not unduly heavy lower face, are noticeable in both Omahas and Dakotas. A composite of Omaha women does not differ in any marked manner from the Dakota portrait. In both the pictures of the women, there is to be observed a similar variation between the female and the male of the same tribe, notably in the shape of the head, and the greater prominence, proportionally, of the cheek-bones in the women's faces.

It is premature to judge of the value of composite portraits. They are certainly curious and interesting, and many points will occur to the observer of these Indian faces. In a general way, they seem to confirm the results of a close study of the home life and the various customs, including the most savage rites of war and religion, made by the writer among this family of Indian tribes, by showing them to be a people intellectual rather than brutal, unawakened rather than degraded. The portraits indicate the stamp of tribal fixity, and reveal the unconsciousness within the individual of the analytical powers of mind by which man masters nature—a peculiarity which is the key to much in Indian sociology and religion.

The writer is indebted to Mr. Jenness Richardson, of Washington, D.C., for the making of the composites.—*Science.*

AN IRISH TRIP

With Wheel and Lens in the East and West.

BY HENRY STURMEY, EDITOR OF "THE CYCLIST."*

My first and only night spent in Limerick was anything but an enjoyable one to remember, for a most acute bilious attack troubled me the whole night through, and by the morning I was fit for nothing, and, moreover, had not the ghost of an appetite for breakfast, so ate none.

Our portmanteaux had come on in the night, so we were able to get a fresh supply of plates, and replenish our double-backs, and were not long in being once again ready for the field.

By previous arrangements we had planned to be in Lisdoonvarna on Saturday night, and as we had duly made our appointment for that night, we were bound to go ahead. Our original plan was to have spent two clear days at Limerick, visiting Adare, the seat of the Earl of Dunraven, with its celebrated antiquarian ruins of the Augustinian monastery, and Franciscan Friary, which afford splendid scope for the camera. This was to have been one day's work, and our Lisdoonvarna friend—Dr. Stacpoole-Westropp—had very kindly arranged with a relative of his to look after us there. The second day was to have been devoted to "doing" Castle Connell, with the falls of Doona; and if time permitted, O'Brien's Bridge, and other picturesque spots in the vicinity; but the delay at starting quite upset our plans, and we were forced to forego our two days around Limerick, and move onwards for Kilrush. We found the steamer left at 3 p.m., so decided on making a dash for Castle-Connell, as being the nearest, in the morning, and accordingly got the tandem out for its first actual run, much to the astonishment of the natives, who, although accustomed to the sight of single cycles, had never before set eyes on a double one, and we were, during the time occupied in fixing our kits in front of the hotel, the centre of a very respectable crowd, which remained gaping after us as we mounted and slid away down the main street. Through the town the roads were abominably heavy, and ploughing was nothing to it; but once clear, though somewhat rough and muddy, they certainly improved, and we made fine progress. Some four or five miles out a castle is passed on the right, standing out boldly on a hill by the side of the road. As time was precious, we did not stop to take a view of it, though we afterwards wished we had, as the light just then was fair, it being bright and sunny. A peep at some falls a few miles further on called for another stoppage, but the cameras were not unpacked. We now thought the eight miles we understood to lay between Limerick and Castle Connell had been nearly completed, so enquired of an old fellow with a donkey and cart how much farther we had to go. "Shure, it's about a moile and a quarther," said he; and we grew merry at the near approach of our destination, and pegged away with a will. A full mile and a half having been covered, and no sign of the castle, we pulled up at a snug little constabulary barracks, at the gates of which three or four members of the R. I. C., in their soldierly uniforms, were standing, and again enquired the distance. The answer—"three good English miles"—did *not* tend to our gratification, but we found it true, nevertheless, and in due course found ourselves there. The ruins are situated on the top of a solitary rock on the banks of the Shannon, and would make a good view from the river; but we could not succeed in getting very happy points of sight, and, to make matters worse, the light not only got poor in the extreme, but we had barely tipped the old lady in charge of the ruins, gained admission, and focussed our object, than the rain came down pretty smartly, and we were fain to shelter for awhile under the bushes. A second shot was taken of a portion of the ruins from the top, whilst S. exposed a plate on the river as viewed from the top of the rock. This made but a poor picture, but proved infinitely better than the other two, which, although given four seconds by me, with the full aperture of the Lancaster lens, was woefully under-exposed, so the quality of the light may be imagined. Packing our traps, and refusing the invitation of a lame waterman to take a boat to the falls of Doona close by, we made the best of our way through several showers back to town, the run back occupying just an hour, though my indisposition of the previous night, and want of food, gave S. extra work, as for the last three or four miles I was little better than dead weight. A good feed, however, soon set matters to rights, and after getting one of the carriers of my changing-box (which I found broken) repaired at a silversmith's, we made the best of our way to the quays, where the good ship *Vandeleur* lay in readiness to take us aboard for our trip down the Shannon. This gave us a better opportunity of observing the shipping of the town, which is said to be fourth in importance in the whole of Ireland. Our impression of it, however, was one of desolation and decay more than thriving trade, for although there were a few small ships in the harbours and docks, there seemed no life about the place, and trade

* Continued from page 244.

was evidently in a very stagnant condition. A general view of the shipping and river from the bridge of the steamer gave us both but poor results, and a plate I exposed on the steamer herself was no better. The getting of our tricycle on board was a matter of much pushing and shouting, for although, knowing how to manage it, we could easily have run it on board ourselves, it proved almost more than a match for a dozen lusty vagabonds, who seized it by the handiest parts, and eventually, after nearly toppling it over into the river, landed it in safety on the broad bridge, where it reposed in a corner, and, with a number of flour barrels, was covered with a tarpaulin. Then came the demand for what in Egypt would be "backsheesh"; each individual helper professed to be *the* one entrusted with the work, and after I thought I had settled the crew with a shilling amongst them, S. was tackled by an old buffer, who had been conspicuous by laying hold of the little wheel, because, I suppose, it was smallest, and who had to be settled with because "he had done all the work," and the others had left him out of the division. The charge for the machine was 3s., and for ourselves, 4s. each. The vessel had barely commenced to swing round in mid-stream, preparatory to starting, when it commenced to rain, and this it did more or less for an hour, obscuring the vision, and keeping us within the cabin.

The trip down the Shannon on a fine day in summer must be really magnificent, but our luck was against us. However, after a while it cleared, and we even had glimpses of the sun at times. We found the captain a genial, jolly old fellow, whose chief joke appeared to be at the expense of the Home Rule party, for did we remark on the desolate appearance of the magnificent river on which scarce a sign of life was visible, on the stagnation of trade in the West, on the poorness of the light for photographic purposes, or on the vagaries of the weather in giving us so bad a day for our trip, his dry and sarcastic reply was, "Ah! there! that'll *all* be put right *when we've got Home Rule.*" He, however, was very entertaining, and after we had "wetted his other eye," retailed to us legends of the coast, and gave us much information on many points. Soon after leaving Limerick our attention was attracted by a ruin in the distance, and by the help of S.'s glass we got a distant peep at Carrig-o-Gunnel, a high rock on the top of which the ruins of a castle form a most picturesque feature in the landscape. From what we could judge, these ruins would give rare work for the camera. As we progressed down stream we appeared to come in sight of nothing but ruined castles, there being one or more always in view on one or other of the banks.

As in the morning, the light remained horribly poor, and consequently it was no wonder a few "forlorn hopes" we tried in the shape of instantaneous exposures on such objects as we passed close to, including the Scarlet Tower, and Beagh Castle—navigation guides in mid-stream—and a waterlogged timber ship, gave us little or nothing of anything on our plates, S. being the most successful, using Paget 60-time plates for the occasion. At times, when we passed through the loughs, the expanse of water was splendid; and when the river banks were more closely skirted, we had an opportunity of inspecting the system of stake netting adopted by the fishermen along shore.

After one or two stoppages, the *Vandeleur* hove to off of Tarbert, a dilapidated pier preventing a landing by a more legitimate manner, and a few passengers were brought off in a boat from a barge, which was warped in and out as required. Several of the newcomers proved to be enterprising car drivers, who had come on board to solicit passengers from Kilrush to Kilkee, Tarbert being the last calling place of the boat before reaching the former place, from which to Kilkee is nine miles, and has to be traversed by car.

These car-men proved to be well-spoken, intelligent fellows, with a keen eye to business, and ready enough to impart any information required of them, even if they *did* suit their answers to the most probable wishes of the questioner. They told us they made a regular practice of meeting business thus half way, and securing fares before landing.

The little jetty at Kilrush was one mass of whips and out-stretched arms, and a perfect Babel, as the crowd of jarveys eagerly sought fares from amongst our passengers. We, however, sought out the boots of the "Vandeleur Arms," who had come down to meet the boat, and giving the portmanteaux into his charge, after a struggle with the volunteer porters who would persist in grabbing each article as it came handy, and then requiring payment for their services, we kept an eye to directing the landing of the tandem, which underwent a trying ordeal in the operation. The astonishment of the natives was great, and whilst all collected and followed us as we wheeled it over the villainous paving of the quay to the roadway, the jaunting car men prepared to show us the way into the town, which lay a mile away. When all was fixed up, however, we started, and although the leading car kept within distance of us up the first rise, we astonished them afterwards, for all the rest of the way being down hill, we piled it on, and "let her go," despite the mud, and were soon lost to sight round the bend. This was about the fastest piece of travelling the tandem did, and it shook up our plates tremendously, covering them with dust—my changing-box being the chief delinquent in this respect—and causing the only breakage of a plate which fell to my lot on the journey. However, we showed the cars how to move, and impressed the onlookers visibly. What more could we want?

The Vandeleur Arms is not a very extensive establishment, but large enough for the requirements of the place; and although the house was in the hands of the plasterers and paperhangers, the landlady made us very comfortable, and we found her nephew, a young man who had been to America and was pretty well informed on many things, most ready to assist us to the utmost in folk lore of the neighbourhood, and a description and direction to the objects of interest.

(*To be continued.*)

THE ART PHOTOGRAPH PROSECUTION.

On Saturday, at the Lambeth Police Court, the adjourned hearing of the summonses against Mr. Erdmann, of Salcott Road, New Wandsworth, and Mr. McIntosh, his manager, for having unlawfully sold obscene prints or pictures, came on before Mr. Chance. Mr. Arthur Powell, barrister, prosecuted, and the defendants were represented by Mr. Besley.

It will be remembered that Mr. John Southward, journalist, of 86, Loughborough Road, Brixton, is the complainant. Mr. Southward saw an advertisement in a trade paper that art photographs and studies from the nude would be sent to any address, on approbation, on application to Messrs. Erdmann and Schanz, Salcott Road, Wandsworth Common. He wrote to them, and received from them a large parcel of photographs, some of which were nude, and some of which were photographs of animals and copies of foreign pictures. He kept some, and sent a cheque to Mr. Erdmann for them, subsequently making a second purchase. He then communicated with the new Chief Commissioner of Police, Sir Charles Warren, who submitted some of the photographs to Sir James Ingham, the Bow Street magistrate. From the opinion expressed by Sir James Ingham, Mr. Southward applied to Mr. Chance, the magistrate at the Lambeth Police Court, submitting to him also specimens of the photographs. Mr. Chance issued a search warrant and a summons against Erdmann and McIntosh. The search warrant was executed by Inspector Detective Jarvis (of Scotland Yard) and Inspector Shaw (of the V Division), who seized at the house of the defendants upwards of 2,000 photographs of nude figures, animals, and other descriptions.

At the hearing on Saturday last,

Mr. Powell said the charge was one of misdemeanour for publishing, and there was also a summons to show cause why certain photographs seized should not be destroyed. The court had proceeded on the summons, and he proposed to continue the case until it was decided to go on with the other part of it.

Mr. Chance.—The only question I can deal with summarily is as to the destruction of the photographs. As to that you may appeal, and in such a case the photographs have to await the decision of the higher tribunal.

Mr. Besley.—It is not a question of destroying by fire or otherwise, or postponing that destruction until the appeal is heard, but it is that the misdemeanour shall not be sent for trial against two persons, this being a summons against only one. I thought the arrangement was that the summons for misdemeanour was to stand adjourned until the appeal was heard.

Mr. Chance.—I was not aware there was such an understanding. Supposing I condemn the photographs, and that decision is appealed against, and the Court holds I was wrong, in that case, of course, you would not consider it a misdemeanour.

Mr. Powell.—The desire of the prosecution is that there should be a decision of the Central Criminal Court upon the matter, and it can only go there upon a summons for misdemeanour.

Mr. Chance.—Is it confined to the Central Court?

Mr. Powell.—You could, of course, send it to the Sessions if you like?

Mr. Chance.—In a matter of this kind it is desirable to get things to the higher Court.

Mr. Besley.—There is no reason for not sending the case to the Surrey Sessions. I am quite content to go there, and upon their decision, with regard to the appeal against your order for destruction, I shall make no contest. If the decision is against me, well and good; and if in my favour, there is an end of all proceedings. There is no case that is so free from any aggravating circumstances as this.

Mr. Chance.—I agree with that.

Mr. Powell proceeded to contend that there were eight different classes of photographs in the case, and consequently that the matter before the magistrates at the Surrey Sessions would not be the same as before a judge and jury in respect of misdemeanour. What he wanted, in the interests of justice and morals, was, that there should be a proper report of the proceedings to refer to. It was desirable to know what photographs should be seized and destroyed, and the sale of which was a misdemeanour.

Mr. Chance.—Do you propose to proceed by way of misdemeanour in respect of any photographs which don't come before me for the purpose of being destroyed?

Mr. Powell.—No, I do not.

Mr. Chance.—Then we shall put them out of the case.

Mr. Powell.—There is no innocent part about these photographs (showing a bundle). My learned friends have eliminated those concerning which we have no objection.

Mr. Chance (taking up the bundle).—Then those remain, and are the only photographs about which my opinion is asked?

Mr. Powell.—That is a bundle containing objectionable photographs. They are duplicates of the photographs sold to Mr. Southward, concerning which the summons was issued.

Mr. Chance.—They come before me to be condemned. Then you do not proceed for misdemeanour, except as regards those which you ask me to destroy?

Mr. Powell.—That is the case. If you think the summons for misdemeanour should stand over, well and good.

Mr. Chance.—I think so. The best plan would be to proceed upon that before me, in respect to which the appeal should go to the Sessions, and afterwards determine whether the misdemeanour should go to the Sessions or the Central Criminal Court.

It was then agreed that the summons for misdemeanour should stand over until after the appeal upon the first part of the case could be heard.

Inspector E. Shaw, of the Criminal Investigation Department, was called, and gave formal evidence that he accompanied Inspector Jarvis when the seizure was made. The witness generally confirmed the evidence of Inspector Jarvis.

Mr. Powell then put in the eight classes of male and female figures into which the photographs seized had been divided. The complaint against some was that they were naked and disclosed certain parts of the body, and as regards others, that they were only slightly draped. One class contained photographs of pictures and studies of nude female pictures, and these the learned counsel submitted ought to be destroyed in common with the other specimens. It was frequently contended in such cases, he proceeded to say, that inasmuch as the pictures were allowed to remain in public galleries, therefore it was permissible to sell photographs of them. It was obvious there was a great distinction between pictures in a gallery and photographs of these pictures. First of all, there was but one picture; and there might be any number of photographs seen by any number of persons, old and young. It was not usual to take young persons—and young females especially—into galleries where such pictures were to be seen.

Mr. Chance.—Is that so? Do you think people who go to public galleries do not take young people with them?

Mr. Powell did not think that people who had a knowledge of what was to be seen in such galleries, or of what it was desirable for young people to see, would take young persons to visit them.

Mr. Chance.—If that were so, there would be many galleries in various cities of Europe that would not be visited.

Mr. Powell submitted that there were certain things that could be published in medical works, for the benefit of medical students, that would not be allowed to be published in the streets. He quoted a judgment of Mr. Justice Lush, in which it was held that it was not because a picture was to be seen in a gallery that anybody would be allowed to sell photographs of it. There were (continued the learned counsel) sculptures which were objectionable in the eyes of a great many, and it seemed to him it was within the purview of the law to hold that photographs of these statues should not be allowed to be disseminated. By the reproduction the statue was converted, as it were, into a picture, and publishing that which was presented only for one purpose.

Mr. Chance.—Would you contend, with regard to photographs of this character, that in the cases of all to whom they were sold it would be a wrong act?

Mr. Powell.—It is difficult to say.

Mr. Chance.—There would be a difference between selling them to an artist or selling them to the public.

Mr. Powell.—I am given to understand by artists of great repute that these photographs are of no use to artists.

Mr. Besley.—We have no evidence of that.

Mr. Powell proceeded to say that in this case, at all events, they were sold to a journalist who had nothing to do with art. Mr. Justice Stephen held that the justification ceased for the publication of certain matter when it was made in such a manner, to such an extent, or under such circumstances as exceeded what the public good required. It was because there were prurient-minded persons who would pay high prices, which were paid in this case, in order that they might have their pruriency gratified, that those who instructed him asked for a conviction in this matter.

Mr. Besley then addressed the court on behalf of the defendants. It could not but be observable, he said, that there was no public authority interested in this case to say that the public interests were damaged by the publication of these photographs. It was obvious that the public authority, namely, the Public Prosecutor, declined altogether to further a crusade which might end disastrously in putting a stop to the development of art—art not in the sense of the man who used his pencil, but in the knowledge which the public acquired of the beauties to be found in the representation of lady figures. He pressed upon the court the view that it was a prudish and unjustifiable thing to talk about children and women being offended at any of these photographs, when it was perfectly well known that sights utterly offensive met the eye in show-yards and the public streets. The persons who instigated this prosecution, whom he could not characterize in too strong terms, asked the learned magistrate to condemn pictures in none of which were contained the slightest suggestion of bestiality or immodesty, which contained nothing but the absolute representation of nature as it existed. What interest Mr. Southward could have in this prosecution, except to make money, he (the learned counsel) could not understand. He had an utter contempt for a person who went out of his trade for the purpose of proceeding in this way. He (the learned counsel) could go to the Mansion House and see a representation of Ida in marble, but it was suggested that he was a miscreant if he saw the picture of an entire female figure. The real question was whether the photographs were suggestive, by reason of another figure being introduced, or by reason of an immodest expression or attitude, and he denied entirely that either of these faults could be found with these photographs, which were chaste works of art. In Shakespeare certain lines were struck out; but because there were indecencies in Shakespeare, would it be for the good of the world that there should be no original Shakespeare?

Mr. Chance.—You need not go so far back as Shakespeare. There are publications you might take at the present day.

Mr. Besley agreed that that was so, and went on to observe that the covering up of the pages of Shakespeare or Chaucer would mean the knuckling down to unreasonable, squeamish, prudish notions which he hoped would not find expression in the judgment of the learned magistrate. He reminded the court that these photographs were sold in a private house on application, and proceeded to contend that, whereas there were well-known instances, such as the case of the "Confessional Unmasked," in which public decency was outraged, the same argument could not apply to art studies.

Mr. Chance.—I have a strong opinion upon two or three samples, but my mind is not altogether made up with regard to others. It is very difficult to draw the line, and if I am to give a decision from which the defendants would not appeal, I think it is better I should take time as to which I should condemn or not. I shall give my decision this day three weeks.

The defendants gave an undertaking not to sell any of the photographs pending the magistrate's decision.

Notes.

The Photographic Exhibition at Glasgow will probably be the best and most instructive exhibition which we have had since that held in the House of the Society of Arts, under the superintendence of H. Trueman Wood.

In the first place, there are to be no medals or awards of any kind, so we may expect to see nothing of the works of those enterprising traders who look upon medals as a means of making the untrained public regard them as the "salt of the earth," as far as matters photographic are concerned.

There will, however, be a thoroughly representative collection of the finest pictorial results obtainable by the manipulator who directs the recording eye of the camera—portrait, group-study, landscape, oppidan, and marine. Next may be mentioned the collection illustrating the early history and gradual progress of photography, after which we may refer to the crowd of processes and appliances to be illustrated or exhibited. Those readers who can send suitable exhibits should write at once to The Secretary, Glasgow Photographic Exhibition, Corporation Galleries of Art, Glasgow.

The question of the fading of water-colour drawings has, thanks to J. C. Robinson, been much talked about by artists during the week. Sir J. Linton has been interviewed on the subject, and repudiates indignantly the views held by Robinson, and by Professor Church, the chemist to the Royal Academy. One point at issue may be of interest to photographers. Professor Church says indigo is always a fugitive colour, and the admixture of Indian red does not affect it more than any other colour. Sir J. Linton, on the contrary, says that in every old drawing where indigo and Indian red has been used in combination, the former has left the latter absolute master of the field; but where indigo and Venetian red are mixed, the colours remain in perfect harmony without a sign of disagreement. Sir J. Linton continues:—"Mr. Church's chemistry says this is impossible; if so, all I can say is, that Mr. Church's chemistry knows nothing about the matter." But in this controversy, has not the action of light been left out? A chemist who had only seen chloride of silver freshly prepared, and unexposed to light, could not know that a chemical change would take place directly it was placed in the sun's rays. Is it not possible, therefore, that light brings about a reaction between the indigo and Indian red, which it fails to produce with indigo and Venetian red?

The late King of Bavaria had peculiar ideas about photography. In fact, he had a strong objection to sitting for his portrait; and it is said when he began to get stout, as he did during the later years of his life, and it was represented to him that his existing photographs did not accurately pourtray him, he had the photographs altered with the brush rather than sit afresh.

"Gathering Water Lilies" is the title of an autogravure from an original by P. H. Emerson. As regards the original, we can hardly speak too highly, that is to say, if the reproduction enables us to rightly judge of it. It has much of the character of a picture, the pose and motives being natural and unstrained. An old man rows the boat over the leaf-decked water, while a young woman gathers the lilies. We would much like to have an ordinary silver print to compare with the engraving, in order to better judge how far certain high-lights and certain deep blacks are likely to be due to accidents which may have happened to the plate after its production. As far as the whites are concerned, we allude more especially to wedge-shaped patches of very high-light which radiate from circumference to centre of most of the floating leaves. They look like scraper-marks on the plate, and some of them seem to be strangely at variance with what we should have expected under the conditions of lighting.

Any assistants who have been robbed of specimens through the medium of advertisements should read that which is on page 387. We invite correspondence regarding this matter, also suggestions for practical action.

The capture of a supposed swindling photographer has followed closely upon the complaints which appeared last Tuesday week in the *Daily News*. On the following Thursday a man was charged at Highgate with obtaining, by fraud, fifteen shillings from a resident of Brixton, and five shillings from a resident of Highgate. The Highgate resident deposed, that on the second Saturday in May the prisoner came to her house and asked her if she would mind putting the front blinds of her house straight, as he was going to photograph the house. She asked him what he was going to photograph it for, and he said for architectural purposes. She put the blinds straight, and he took the photograph, showed her the negative, and asked her if she would like any copies. She agreed to pay five shillings for them, but had never received any photographs at all, and the prisoner had left the address where he was staying at the time. Whether the charge of fraud be substantiated or not, the method of proceeding certainly shows ingenuity and knowledge of human nature. To ask a lady bluntly if she wanted her house photographed, would in all probability result in a refusal; but to lead her on by the guileless request "to put the front blinds straight," is a species of art to which nine ladies out of ten would yield.

Photographic copyright bills are destined to have the fate of Tantalus. The dissolution of Parliament has swallowed up Mr. Agnew's measure, and it is scarcely likely to see the light of day during the present year. So far as the ordinary photographer is concerned, he will regard the prospect with perfect equanimity.

It is interesting to notice the ever increasing way in which photography is becoming mixed up with well-nigh every social "function"—to use the word now in vogue with society journalists—and event of local or national interest. Take up a newspaper, London or provincial, and one's eye is sure to be caught by some such sentences as these:—"The county eleven then partook of a cold collation at the invitation of the Earl of Timbershire; and, having been subsequently photographed in the pavilion, resumed their places in the field." "At the wish of the happy bride, the guests then inspected the wedding presents (which had been photographed with much success by our respected townsman, Mr. E. Mulsion, Junr., of the Market Place), and then proceeded to the Terrace, where a camera was brought to bear with much success on the wedding party." "The men were then drawn up in line and, photographic reminiscences of the interesting ceremony having been secured, his Royal highness proceeded, amidst cheers, to address them." "A break in the proceedings was then utilised by the photographer in attendance, who, having focussed his camera, was successful in obtaining several excellent negatives of the distinguished guests assembled round the stone." "An adjournment was then made to the park, where the excursionists, having been taken in several groups by Mr. A. Lens (himself a Knight Harbinger of the Mangel Wurzelton Habitation) gave three cheers for the marquis, and made at once for the tea-tents." "Whilst waiting for the Grand Old Man to appear, a Chester artist secured a successful 'cabinet' of the deputation and their illuminated address, copies of which have since been sent to Hawarden Castle." "Having been photographed in their Swiss peasant dresses, the ladies took up their positions at their *chalet*-like stalls, and the bazaar operations at once commenced." "The camera that dominated the fairy-like scene was then put in requisition, and without further delay the flower show was declared open." But we need scarcely multiply instances which any reader of the newspapers can so easily recall for himself. The facility with which photographs can now be taken has doubtless had much to do with the satisfactory state of affairs we refer to. In fact, as an irrepressible correspondent lately put it to us, the general use of dry "plates" has made photography more than ever a matter of "course." In other words, a photographic item is now to be found in nearly every "bill of fare."

We alluded lately to the rumour as to the real reason which induced the Russian police to summarily close a photographic studio on the Nevski Prospect some time since. It was discovered (so it is asserted) that the intention of the "artists" was to take, not the Czar's portrait so much as his life. Since then many more curious details have reached this country, some of which have reference to the seizure of an infernal machine shaped exactly like a photographic camera. This diabolical apparatus was so constructed, it is said, that bombs could be fired through the tube, which could have been aimed at its victim on the pretext that the operator was focussing the so-called camera. The story, if true, is indeed a most unpleasant one, and it is to be hoped that the details are, after all, only the outcome of an ingeniously inventive correspondent's imagination. Once let it be understood that cameras posed on their tripods may be infernal machines in disguise, and the lot of the open-air photographer will certainly be far from a happy one, especially in Russia.

The prison authorities in France are not contented with simply photographing criminals. To make identification absolutely certain, they now adopt in addition an anthropometric system. What measurements are considered as of vital importance in regard to comparison we are not told; but it is said the method is being found satisfactory, and probably the Amsterdam plan is adopted. This comprehends accurate measurements of the middle finger, the foot, and the head. It appears that the middle finger varies in males from 17 to 20 centimetres, the head from 16 to 21 centimetres, and with the foot, the variations are still greater.

It is hard to say whether photographers should be gratified or the reverse at the shortcomings of the portraits in the Academy, as pointed out by the *Athenæum* last week. One of Mr. Pettie's efforts "has all the defects of a florid and showy, not to say coarse, reading of the superficial aspect of the face," while each of the painter's examples of portraiture "is three times as large as its merits entitled it to be." Mr. Frank Holl "takes less pains than ever," and all his portraits come in for some severe handling, the critic winding up with the opinion that "the mode of painting Mr. Holl has pursued, till probably he cannot avoid its snares, has brought disaster upon him."

J. S. Sargent's portrait of Mrs. Harrison is "decidedly unpleasant as an household companion, and for the owner's sake," the critic hopes, "unjust to the lady." Yet "it is suavity and grace itself compared with the group of the Misses Vickers." We can scarcely imagine Mr. Sargent being pleased when he is told that "the fortitude of his sitters who submit to be painted in this uncommon manner—a manner which is totally devoid of elegance and elevation—is almost as worthy of admiration as the courage of the artist." Mr. P. R. Morris "shows how even a curtain may be vulgarised, and a handsome boy made to look like papier mache;" while "among many portraits by Mr. Morris which we remember, this (Mrs.

J. Parker) is the only one too good for a public-house parlour." Time will doubtless improve Sir J. E. Millais' portrait of Mr. Barlow, "but we are not satisfied the result will be all we desire." Mr. E. Long's portrait of Lady Robartes is "flat and unsound in painting, the arms are badly drawn; it is hard to say why the nostrils should not be delineated." In fact, except in the case of Mr. Ouless and Mr. Herkomer, the *Athenæum* has not a good word for the portraitists of the first rank, and is compelled to say that portraiture, as a whole, "is very much below the average." A photographic critic could scarcely go further.

The fact that their visitors now occasionally arrive with an ingeniously-packed photographic apparatus amongst their luggage, certainly tends, in not infrequent instances, to add to the trials which the modern host and hostess have to undergo in exercising their hospitable purpose. It is not so much that the guest with a turn for photography dabbles in his art in the spare bedroom, and ruins the best quilt with chemical stains in the pursuit of his hobby—the introduction of dry plates has worked a revolution in this direction—it is rather in his irrepressible desire to be for ever "taking" something, or somebody, that the photographic visitor of the period becomes too often a terrible bore. He is for ever prowling about the house seeking whom he may de-velop, and stopping at nothing in his eager desire for obtaining negatives.

It was such a guest as this that lately arrived in the heyday of youth and photographic avidity at a quiet house in a western country town. The young man had only "taken to photography" lately, and his eagerness to use his new apparatus was so great that, even on his way up from the station, he had attempted to photograph the interior of the one-horse 'bus which bore him and his baggage to his destination. In the course of three days he had nearly driven his host—a kind, but rather prim old gentleman—crazy by his insatiable desire to be "taking" something. How he had photographed his host and hostess, their sons and daughters, their dog and their cat, their man-servant and their house-maid, and, in a way, the stranger within their gates, seeing that he had promptly taken flying shots at nearly everyone who came to the front door, need not be described. He had wasted dry plates by dozens, but his eagerness to waste dozens more seemed unquenchable, when, one morning, instigated by his artistic yearnings, he made his way to the kitchen and found in a plain cook of vain imaginings a sitter after his own heart.

So engrossed did he become in reproducing in endless positions the buxom features of this new subject, and so delighted was she to find her charms appreciated at last, that they both forgot the flight of time, and, as a consequence, luncheon that day was not only late, but uneatable. This was the last straw, and it utterly broke the back of Paterfamilias' patience. Informed of the cause of the breakdown of the commissariat arrangements, he without delay gave his guest a piece of his mind. "Look here, my young friend," he said; "when I asked you to visit me, I did not know that you meant to 'carte-de-visit' me also. But I have not objected, as you must admit, to your photographic fad. You have taken me, and my house, and my family, times without number. You have taken every piece of furniture in the place, and every tree in the garden, and I have not objected. But now you are going a little too far, and in taking my cook you have taken a liberty I cannot but resent. No more photographing in the kitchen, if you please, or I shall have to reluctantly ask you to take the only thing that you have not taken up to the present time—I mean your departure."

The sequel is very brief. Paterfamilias did not have to proceed to the threatened extremity. The ardent young amateur "took" the hint instead.

Patent Intelligence.

Patent on which the Fifth Year's Renewal Fee of £10 has been Paid.

2527. W. B. Woodbury. "Printing surfaces."—1881.
2800. W. Willis, junr. "Photo-chemical printing."—1878.

Specifications Published during the Week.

1365. Thomas Forrest, 14, Market Street, Pontypridd, in the county of Glamorgan, Photographer, for "An instantaneous photographic drop shutter."—27th March, 1886.

The claims are—

1. A vertical frame having two pairs of grooves, which are divided by a central partition having an aperture near its lower edge.

2. A pair of plates, sliding in two pairs of vertical grooves divided by a central partition, such plates being connected by cords or other flexible material passing over the central partition, or roller affixed above same.

3917. Benjamin Joseph Edwards, The Grove, Hackney, in the county of Middlesex, Photographer, for "A new or improved apparatus for coating photographic plates and paper."—6th April, 1886.

The claims are—

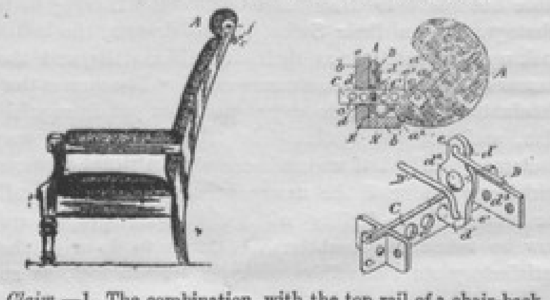
1. In an apparatus for coating plates or paper with gelatine emulsion or other fluid, the perforated distributor so arranged that the flow of the liquid can be exactly adjusted or stopped entirely.

2. In an apparatus for coating plates or paper with gelatine emulsion or other fluid, the method of adjusting the width of flow of the material by means of pistons or stops.

3. In an apparatus for coating plates or paper with gelatine emulsion or other fluid, the use of a hot water tank in contact with the distributor.

Patents Granted in America.

342,830. John Hogan, St. Louis, Mo., "Adjustable head-rest for chairs."—Filed November 20th, 1885. (No model.)



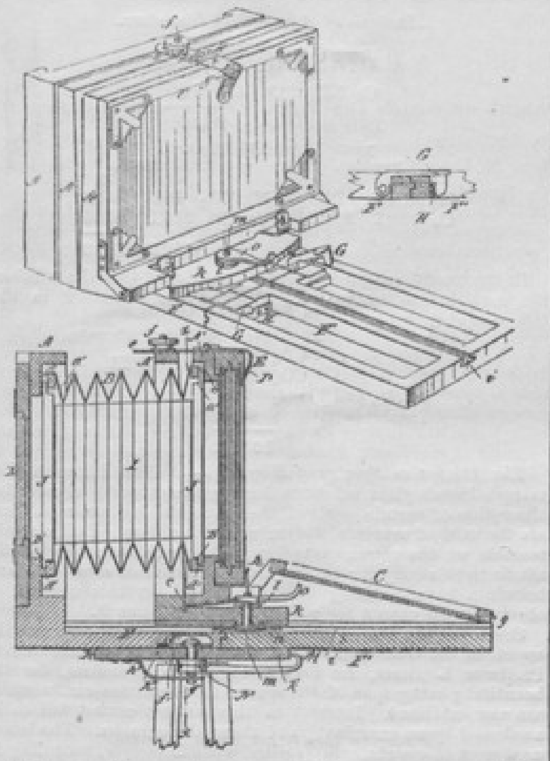
Claim.—1. The combination, with the top rail of a chair-back, of a movable head-rest, a spring for actuating the movable head-rest, and a graded or variable locking mechanism for securing the head-rest in different positions, whereby the head-rest will adjust itself to the head of the occupant of the chair.

2. The combination, with a chair-back having an L-shaped top rail, of an inverted L-shaped rest-frame pivoted thereto at the lower forward angle to form a box for the locking mechanism of the movable head-rest, and the locking mechanism concealed therein.

3. The combination, with the top rail of a chair-back, of a movable head-rest pivoted thereon, a locking mechanism for securing the movable head rest, and one or more transverse rods for actuating the locking device, said rods arranged in the axial line of the movable head-rest, so as to be in reach of the hand of the occupant of the chair.

4. The combination, with the top rail of a chair-back, of a pivoted head-rest, a spring for actuating the same, and locking mechanism composed of a bar having pin-holes, said bar pivoted on the head-rest, a hook or locking pin, pivoted on the chair-back, and a rod for actuating the pivoted locking-pin.

342,211. William H. Lewis and Erastus B. Barker, New York, N.Y., assignors to E. & H. T. Anthony and Co., same place, for "Photographic camera."—Filed Aug. 20, 1885. (No model).



Claim.—1. The combination, with the rear portion of the frame of the camera, of the upper spring holding-hook, E, adapted to hold with an elastic pressure the plate-holder at or near its top to its place in or against the camera.

2. The combination, with the permanent bed-section F and the removable bed-section F', constructed to match or engage by tongue and groove with each other at their meeting ends or edges, of the hooks G, for securing said removable section to the permanent bed of the camera.

3. The spring take-ups H, in combination with the hooks G, the permanent bed portion of the camera, and the removable bed-section F'.

4. The combination, with the camera and its slotted bed, of the cam-lever *o*, the headed screw *m*, and the fixed cam *l*.

5. The detachable dividing flexible diaphragm I, having uprights or posts J, provided with shouldered ends *a' b'*, in combination with the camera-frame having recesses or apertures *c' d'*, for the reception of said shouldered ends.

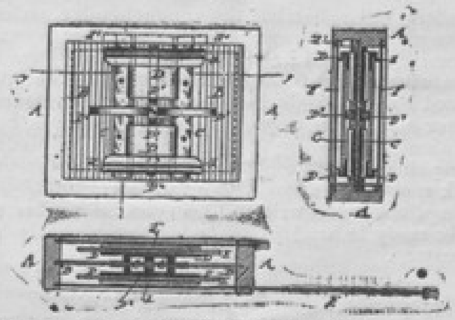
6. The bottom of the camera provided with a locking-recess, in combination with a headed bolt for connecting the camera with its stand, and a cam mechanism for operating said bolt.

7. The combination, with the top board or table portion of the camera-stand, of the headed bolt *g'*, and the fixed cam N, and the cam-lever M.

8. The combination, with the top board or table portion of the camera-stand, of the headed bolt *g'*, for locking hold or engagement with the camera, the fixed cam M, a spring for raising said bolt and the cam lever M for drawing down or locking said bolt with the camera.

9. The locking-plate K, applied to the under side of the bed of the camera, and having an irregular-shaped aperture, *f'*, in combination with the cam lever M, the fixed cam N, the top board, *k'*, of the camera-stand, and the bolt *g'*, having a head adapted to engage with and disengage from the locking-plate.

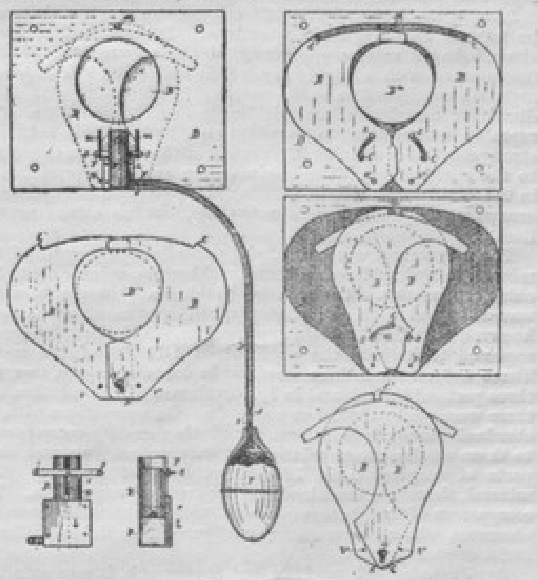
342,914. Ludwig Koss, New York, N.Y., for "Plate-holder for cameras."—Filed Dec. 16, 1885. (No model.)



Claim.—1. The combination of a supporting-frame, transverse guide-rails, adjustable plate-holding clamps guided on said rails, and band-springs pressing on the clamps and plate.

2. The combination of the supporting-frame having a recess in one edge thereof, transverse guide-rails, adjustable plate-holding clamps guided on said rails and having outwardly-bent ends, and band-springs pressing on the shanks of the clamps and the plate.

342,693. George F. Green, Kalamazoo, Mich. "Photographic shutter."—Filed June 6, 1885. (No model.)



Claim.—1. In combination, in a shutter for a photographic camera, the pivoted wings B B, having holes or slots *a'*, with enlarged or elongated ends *c*, to receive the actuating-pin at the end of the stroke to lock said wings in an open or closed position.

2. In combination, in a shutter for a photographic camera, the pivoted wings B B, a pneumatic engine to operate them, and the stop-pin *n*, or its equivalent.

3. In combination with a shutter for a photographic camera, having pivoted wings B B, and a pneumatic engine to operate them, the tube *f*, with its hole *z*, and sliding bulb T.

4. In combination, in a shutter for a photographic camera, the pivoted wings B B, the pneumatic cylinder P, and the pin *s*, rigidly attached to and carried by said cylinder, and directly connected with the wings B B, thereby dispensing with the aid of joints, levers, or links intermediate as to the cylinder, and its connection with the wings.

Review.

PHOTO-MICROGRAPHY, OR HOW TO PHOTOGRAPH MICROSCOPIC OBJECTS. By I. H. Jennings. Price 3s. (*London: Piper and Carter, 5, Furnival Street, E.C.*, 1886.)

OUR readers will remember the comprehensive series of articles on photo-micrography contributed to the NEWS by I. H. Jennings in 1884; and as many readers have expressed a wish to have them in a separate form, the author has revised them, brought them up to date, and arranged with Piper and Carter to issue them as a separate book. An additional chapter on "Bacteria, and the Mode of Photographing Them," contributed by Dr. Maddox, gives the work special value.

Jennings' manual is written by a practical worker, and should be ready to hand in every histological or biological laboratory.

PHOTOGRAPHY AND THE SPECTROSCOPE IN THEIR APPLICATIONS TO CHEMICAL ANALYSIS.

BY W. N. HARTLEY, F.R.S.*
Royal College of Science, Dublin.

Pyrites.—Examples of analyses of pyrites are the following. The mineral is powdered and dissolved in nitric acid, evaporated to dryness, with addition of hydrochloric acid. The salts are treated with ammonia, and afterwards submitted to the spectroscope. In this way the iron is separated, and the silver and copper are detected or estimated.

Limestone.—A remarkable mineral was examined, which may be termed an amygdaloid limestone. It consisted of small almond-shaped masses, apparently of the nature of a zeolite, interspersed with a highly crystalline and almost transparent material, considered to be the matrix. It effervesced with acids, dissolving completely, and yielding no residue of silica after repeated evaporation to dryness with hydrochloric acid. A strong solution containing 20 per cent. of the solid was submitted to the spectroscope. The calcium lines came out prominently in the photograph, and, in addition, the quadruple and quintuple groups of magnesium were noticeable, but no other metallic lines.

The magnesium was estimated by dissolving one grain of the mineral in hydrochloric acid, and making the volume up to 100 cubic centimeters. The solution yielded a photograph, which was compared with the photographed spectra of solutions of known quantities of metallic magnesium. This first photograph appeared to indicate the presence of 1-10,000 of the metal. Three separate solutions were made containing one, two, and three parts of the mineral in 1,000 volumes of the solution, and these were photographed on one plate. On comparison with the standard photographs, it was found they exactly corresponded to those obtained from solutions containing one, two, and three parts of magnesium in 100,000 volumes of solution. The mineral, therefore, contained one per cent. of magnesium. The comparison of the photographs was made by three independent observers, who each gave the same figures from the two different series of photographs.

By simple inspection of the first photograph, it was seen that the calcium amounted to something between 30 and 40 per cent. of the mineral. Special precautions are necessary in estimating calcium, on account of the dust flying about in the air, always showing the most prominent lines of this metal to a greater or less extent. Gold electrodes were used, and a short exposure in this special case. There appeared to be 37 per cent. of calcium present, because a solution containing 1-10,000th of the mineral yielded a similar spectrum to a solution containing 37 parts of calcium in 10,000.

* Continued from page 382.

Five photographs were then taken of each solution; the results may be stated as follows:—

The Mineral.	The Standard Calcium Solution.
1. Five seconds' exposure.	1. Five seconds' exposure.
2. Fifteen " "	2. Fifteen " "
3. Thirty " "	3. Thirty " "
4. Five " "	4. Five " "
5. Fifteen " "	5. Fifteen " "

It was not quite clear whether there was any difference between the length and strength of the calcium lines in the first three pairs of photographs, but in the fourth and fifth pairs it was certain that there was no difference, and hence it was concluded that there was 37 per cent. of calcium in the mineral. The mineral was very carefully analysed by the ordinary process, and two or three different portions were examined, which showed slight differences in composition. The separation of the magnesia was made with all possible care, a correction being made according to the directions of Fresenius for the slight solubility of the ammonia-magnesian phosphate in the filtrate and wash-water. The results are as follows:—

Analysis of Amygdaloid Limestone.

By the Spectroscope.

Per cent.			Per cent.
Mg 1	=	$Mg\,CO_3$	3·5
Ca 37	=	$Ca\,CO_3$	92·5
			96·0

By the Gravimetric Method.

	Per cent. (1)	(2)		Per cent. (1)	(2)
Mg	1·17	1·38	$Mg\,CO_3$	4·08	4·83
Ca	36·45	36·98	$Ca\,CO_3$	91·11	92·45
				95·19	97·28

In the second analysis, it may be mentioned that the whole of the constituents were found to be those contained in the following statement:—

(2)	Per cent.	Total carbonates.
$Mg\,CO_3$	4·83	97·28
$Ca\,CO_3$	92·45	
$Al_2\,O_3$ and $Fr_2\,O_3$	2·24	
Insoluble residue	0·82	
	100·34	

The Absorption Spectra of Minerals.—It is well known that many minerals yield solutions having the property of selective absorption of certain parts of the spectrum, and amongst these are the salts of uranium, didymium, and erbium. It is scarcely possible, on the present occasion, to do more than very briefly allude to this subject; but as the discoveries of samarium and holmium have certainly been established by this method of observation, I cannot altogether omit to mention it.

Several of the absorption bands belonging to the rare earths appear in the violet and ultra-violet region. I am indebted to Professor L. Soret, the first discoverer of holmium, for the beautiful photographs of the spectra of these rare earths which are now exhibited. Interest in this subject cannot fail to be awakened by an examination of these photographs. The lenses used were of quartz, achromatized with fluor-spar, according to the method of M. Cornu.

Solutions of the chlorides of the rare metals show the following characters:—

Erbium.—Four absorption bands lying between L, and extending to just beyond N.

Holmium.—Three bands between M, and midway between Q and R.

Samarium.—Six bands between G and O, the last band being at O. The chief bands are between G and H.

Didymium.—Two strong bands between N and O.

THE EXAMINATION OF ORGANIC SUBSTANCES.

Dr. Miller failed to trace any connection between the chemical complexity of a substance and its actinic absorption. In January, 1878, M. L. Soret published his "Recherches sur l'Absorption des Rayons Ultra-Violet par diverses Substances" ("Archives des Sciences Physiques et Naturelles, Genève," [2] lxi., 322.) This work included the examination of many inorganic and some organic compounds. In 1879, a paper was published in the *Philosophical Transactions* (vol. clxx, p. 257, Part I.), dealing with connection between the absorption spectra and the chemical constitution of organic compounds. Later results have from time to time been presented to the Royal Society and the Chemical Society, a brief notice of which may prove to be of interest.

The ultra-violet rays are exceedingly sensitive to the action of carbon compounds, so much so that the photographic absorption can be employed as a means of identifying organic substances, and as a most delicate test of their purity. The curve obtained by co-ordinating the extent of dilution with the position of the rays of the spectrum absorbed by the solution of a compound forms a strongly marked and often its most highly characteristic physical property.

Organic substances are of these classes :—

1. Those which transmit continuous spectra and are highly diactinic. Examples—The alcohols, acids, ethereal and haloid salts, and carbohydrates.

2. Those which transmit continuous spectra, but yet possess strong absorptive power. Examples—Most essential oils and camphor.

3. Those which exhibit absorption bands. This class includes benzene, naphthelene, anthracene, and all their derivatives, nearly all the natural alkaloids, and many substances in which nitrogen and oxygen are united. Cymene, which is a derivative of benzine, has been detected, and even the amount estimated in many essential oils.

All these substances contain a nucleus with the same constitution as that of benzene. The curve obtained from benzene is exhibited. By the process of diluting with alcohol the presence of bodies of the aromatic series have been detected in essential oils, and even in some cases the amount of these substances has been estimated.

The greatest interest attaches to the examination of the alkaloids. Many of these substances are highly poisonous, they give no distinctive chemical reactions by which they may be identified, and the only means of recognising them are their crystalline form and physiological action. Some of the alkaloids have never been crystallised, and even such as are usually obtained in crystals are not always recognisable; moreover, the form and grouping of crystals is occasionally modified by such reactions or treatment as is necessary in the extraction of an organic base. No absolute reliance can be placed upon the mere appearance of crystals which are microscopic; they must be submitted to recrystallisation by sublimation or some other process. The physiological action of certain alkaloids is remarkable enough to prove a means of identifying when the effect on the human subject is under observation; but it is to some extent capable of being modified by the extent of the dose, the administration of other drugs, or the idiosyncrasy of the patient. These are well known and grave objections to experiments of a physiological character which I have not time to discuss at present. The whole subject of the modification of alkaloids by the reagents used in their extraction, variations in their crystalline character, and in their physiological action, can be well illustrated by reference to the researches of Dr. C. R. A. Wright, F.R.S., on the various preparations known as aconitine. The evidence given at the trial of George Henry Lamson, a surgeon, at the Central Criminal Court, in 1882, for poisoning by the administration of aconitine, rendered of great importance any method of absolute physical measurement which might take the place of ordinary physiological tests in the identification of the dangerous alkaloids. The forthcoming volume of the *Philosophical Transactions* for 1886 contains an account of work on this subject, abstracts of which have already been published in the *Proceedings Royal Society* (vol. xxxviii, pp. 1 and 191). About forty authentic specimens of the alkaloids have been examined; I propose to show the absorption curves of many of these substances.

Alkaloids and Derivatives Exhibiting Spectra with Absorption Bands.

Aconitine	Diacetylcodëine
Pseudaconitine	Quinine
Japaconitine	Quinine sulphate
Morphine	Cinchonine sulphate
Narcotine	Quinidine sulphate
Codëine	Cinchonidine sulphate
Papaverine	Veratrine
Oxynarcotine	Piperine
Apomorphine hydrochloride	Brucine
Tetracetylmorphine	Strychnine

The absorption spectra offer so ready and valuable a means of ascertaining the purity and of establishing the identity of the alkaloids, that drugs of such potency as aconitine, morphine quinine, strychnine, &c., should be submitted to spectroscopic examination, so that their exact nature and degree of purity may be guaranteed before they are prescribed. The difference in character of the various specimens of aconotine are remarkable; the comparatively harmless base is easily distinguished, and of those which are physiologically active, each has its distinctive absorption curve.

The cinchona alkaloids show strikingly distinct curves; so in like manner do those of the papaveraceæ. Two specimens of morphine exhibit the same curve, and so do two of codëine. There is a difference, but yet a similarity, between the morphine and the codëine, which arises from the constitution of the two bodies being only slightly different, codëine being a methyl-morphine.

PHOTOGRAPHIC CABINET-MAKING.

BY C. R. KING.*

CARE must be taken to lay the finished frame on a true surface to prevent its twisting. When ready, smooth over the sides and level the joints. If the work has been carried out nicely, the back-frame will be so near the size of the front frame as to resemble a box sawn into halves. Any slight difference in the sizes can be remedied by planing the two frames together while held in the bench-screw, and afterwards working a little mould or bead on the inner edge of the back frame as shown at B, on full size sketch (fig. 19), which will give a finished appearance to the work, and render any difference in the sizes of the

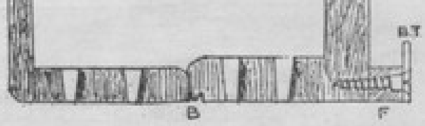


FIG. 19

frames less noticeable than if left with plain edges. A bead plane is not necessary to do this; the guage is set to $\frac{1}{16}$ inch, run round the frame edges rather deeply, and the groove thus made enlarged a little with the point of a file; then, with a piece of sand-paper held between the thumb and forefinger, the projecting tongue can be rounded over as nicely as if "stuck" on with a bead plane.

The two frames being now finished (fig. 14), the rising fronts might be taken in hand, but as it economises stuff to prepare large work first, leaving the short and odd pieces to come in handy for smaller jobs, I will next proceed with the base- or tail-board; one that will be more within the joinery capabilities of a beginner than the ordinary extension tail-board for long-focus cameras, besides being specially adapted to the camera I am describing, which is on the same system as one I contrived and made some years ago, and found to answer admirably for both landscapes and interiors, while I know it to be the most easily made apparatus that it is possible for an amateur to construct.

First saw out all the pieces required, from a $\frac{3}{8}$ or $\frac{7}{16}$ inch board, the following being the exact size of the pieces when finished (the letters refer to the parts on figs. 20 and 21, which are one quarter actual size). Two strips, 1 inch wide, $2\frac{1}{2}$ inches long, A A; four strips, 1 inch wide, $6\frac{3}{4}$ inches long, A A and C C; one piece, $2\frac{1}{2}$ inches wide, 5 inches long, B (note the way of the grain on sketch); one piece, $6\frac{3}{4}$ inches wide, $3\frac{1}{2}$ inches long, D.

If a good length of stuff is available, the six pieces first mentioned may be ripped out in one length of 32 inches long, which would be easier to shoot straight than so many short pieces. By having the grain in middle of the tail-

* Continued from page 260.

board running at right angles to that of the clamps, the board is prevented from warping. Plane one side only of

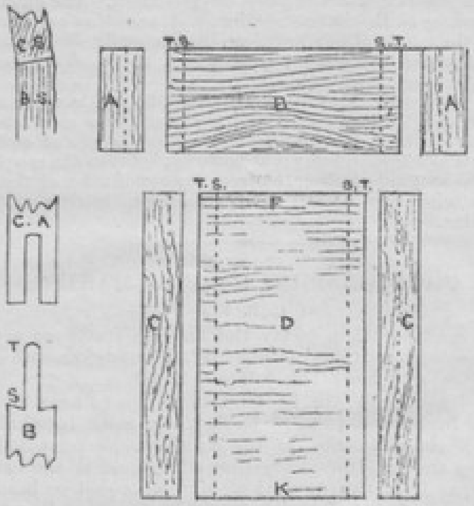


FIG. 20.

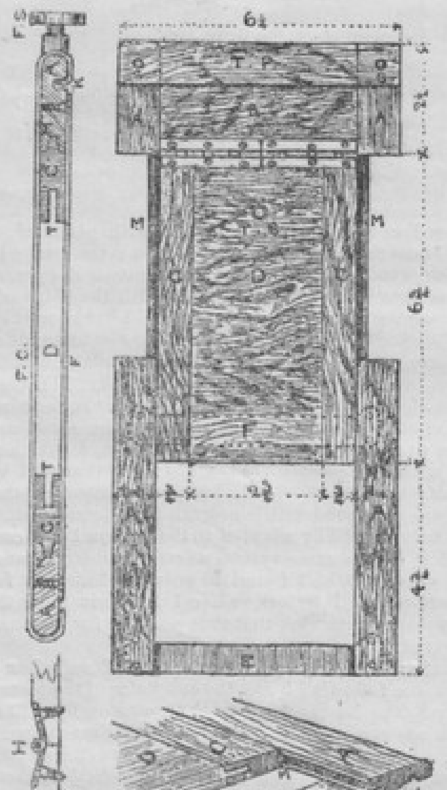


FIG. 21.

the narrow strips straight and free from twist, taking care not to reduce it to ¼ inch thick in the operation, as that is the thickness to which the board must be guaged after it has been put together. Next plane the edges of D and B so as to make good joints with C C and A A, and as you are not likely to do this at the first try, D and B should be sawn about a ¼ inch larger than the sizes given. Do not attempt to plane these end-grain pieces in the same manner as you would when the grain runs lengthways, or piece after piece of the end would be split off until it became useless for the purpose. All beginners find this difficult, especially with a small piece like B, and to do it successfully the plane must be quite sharp, the back iron set very fine, and but little "bite" given to the plane. Put all the pressure on the "nose" of the plane at the commencement of the stroke, and transfer it to the "heel" at the finish. This prevents a rounding edge being made, and the wood being split off when the plane iron passes the end of the piece. Turn the wood end for end, shoot the edge again, try on the clamp until a close joint is obtained, and then put a distinctive mark on the two pieces so as to avoid confusing them. In jointing pieces like these, make good use of the try square, for want of truth in this direction will throw the pieces out of line, as at C S B S, fig. 20. The edges of B and D being straight, guage the two pieces to the sizes already given, and plane down to the gauge-marks, but taking care to have the edges form good joints with their respective clamps before the guage-marks are quite reached.

The dotted lines on the plan, D and B, show the depth for the tongue, as on the full-size section, T to S. Set the guage to ⅜-inch, and mark down the two pieces D and B on both sides for the shoulders, and for the thickness of the tongue, which is $\frac{1}{16}$-inch. First run a $\frac{3}{16}$-inch guage-mark round the edges of both pieces *from the face side*, then a ⅛-inch mark on the same edges, thus giving the thickness of the tongues. These are now to be sawn out from T to S; this may seem rather difficult for such a length as from F to K on the plan, but will be easily complished if sawn out in the manner described for rebating the back frame. After cutting out for a l the tongues cross-cut the shoulders at S. Commence the cut at F, and work backwards to K, and try to cut so close as to leave just a hair-line of the gauge-mark; hold the saw at a slight angle to cut the shoulder a little under as on section—this helps to make a better fitting joint.

The grooves in the clamps are next worked out, and as a set of match-planes would scarcely be found in an amateur's work-shop, a suitable tool must be made. This is done by converting a guage into a sort of adjustable plough. Bore a hole through the guage-stick with the archimedian drill at the end opposite to the marking point, pare the hole out square with the $\frac{1}{16}$-inch chisel until the

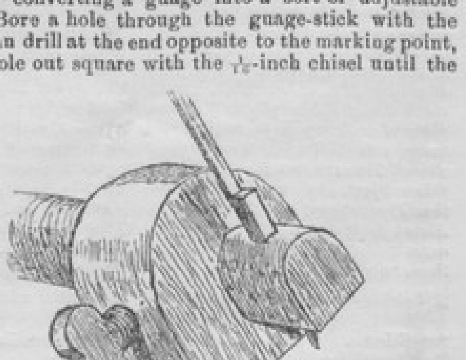


FIG. 22.

blade fits tightly in the mortise and projects about ⅛-inch through the stick, with which it must stand perfectly square as on fig. 22. To use the tool, knock off the handle of the chisel, so as to make it less top-heavy, set the blade to stand out $\frac{1}{16}$-inch, and the guage-head (say) $\frac{1}{4}$-inch back from it; take a piece of waste wood and commence grooving at the farthest end, holding the tool at an angle proportioned to the depth of the groove, or projection of the chisel-point through the guage-stick, fig. 23. As the

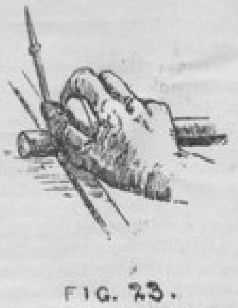


FIG. 23.

wood is scraped away, the chisel will become more upright, and requires tapping out to take more "hold;" at the same time the groove must be extended by working backwards to the nearest end of the wood, holding the tool so that the chisel scrapes at an acute angle at the commencement of the stroke, and becomes almost perpendicular at the finish. The groove is thus cleaned out to allow the free egress of the shavings caused by each succeeding stroke.

(*To be continued.*)

Correspondence.

WAS LORD BROUGHAM AN INVENTOR OF PHOTOGRAPHY?

DEAR SIR,—I must first thank Mr. Jerome Harrison for pointing out my mistake. I was led to interpret Brougham's "suggestion" as an accomplished fact by taking my information at second-hand. However, may we not credit Brougham with the suggestion to use a sensitive surface in a camera until it is well established that his suggestion was not new? I have till now imagined that, as far as we know, Schulze in 1727 was the first to do contact printing, and that Brougham, if we accept his own claim, was the first to associate the sensitive surface with the camera. Mr. Harrison perhaps misunderstands the word "permanent" as used by Brougham, because the print produced by mere exposure is permanent as compared with the picture on a white surface in a camera, the moving pictures on white tables in dark rooms that people pay pennies to see at holiday resorts. Permanency in photography is still a comparative matter; and, quoting Mr. Harrison's extract, Brougham says:—"I had suggested improvements in drawing." Now an unfixed picture would be permanent enough for some improvements in this direction that occur to one's imagination. Mr. Harrison says:—"Brougham appears to be ignorant that the action of light upon nitrate of silver, and its possible use for obtaining copies of objects, had been known perhaps for centuries before 1795." I do not see any reason for assuming this ignorance, but evidence which points in quite the opposite direction; however, this does not appear to me to be the point in Brougham's mind when he suggested the use of a sensitive surface, instead of a plain white screen, in a camera-obscura.

I have no desire, sir, to do anything in the direction of putting Lord Brougham in a position where he shall be immortalized as a pioneer in photographic matters, but as Mr. Harrison founded his discourse on a sentence of mine (only partially quoted, by the way), I have made a few observations from an opposite standpoint. The statement made by Mr. Harrison that I have represented Lord Brougham as "*the* inventor" of photography, if my "paragraph is to be literally construed," is wholly unintelligible to me, especially as the kind of work done by Schulze and the date of it are given in the same sentence.—I am, &c.,

CHAPMAN JONES.

THE PROVOST-MARSHAL.

DEAR SIR,—I was greatly annoyed at reading, in the "Notes" of your issue of 2nd April, the reference you make to my case. I consider it very uncalled for and unjust. It would have been bare justice on your part if you had waited until you had heard the result of the Enquiry before publishing such remarks as those I refer to. Other people and papers have spoken and written as they have, in ignorance, misled by the lies published in the *Times*; but you, at least, might have known that an instantaneous photograph could be taken unobtrusively without in the least affecting anyone. If you read the proceedings of the Court of Enquiry, which have, I hope, been made public before this, you will, I think, admit that I am justified in asking that you should express your regret at having spoken of me as you have done.

The public at home have blamed my act of photographing a cold-blooded murderer at the point of death. Your quotation from *Lloyd's* paper talks, in the most unconcerned manner, of "a large crowd" which had assembled to *watch the last dying struggles* of an unfortunate fellow-countrywoman, and it does not say that *one* of that crowd attempted to alleviate the sufferings of the poor creature. This occurred in the heart of the city in which many of those who have accused me of inhumanity reside. Further comment is unnecessary.—Yours truly, W. HOOPER.

Mandalay, May 14th. Lt.-Col. 1st M. Lancers.

[The following is the note which is referred to by our correspondent: "The Provost Marshal who so loves to depict the death struggles of the miserable by means of his camera need not despair, neither need he mourn that the horrors of the great Flavian Amphitheatre all took place long before the time of the camera. Colonel Hooper may still find something to do, as in this London of ours about one person dies each day in the streets—dies the slow death of starvation and untended disease. We quote from *Lloyd's* of last Sunday to show him how he has missed at least one opportunity:—'Yesterday afternoon a woman, about forty-five years of age, and apparently unknown, died while sitting on the step of a house in the Blackfriar's Road. She had been noticed sitting about on several steps in the neighbourhood, looking ill, since ten in the morning. Eventually she began to sway to and fro, from side to side, and then fell over and died about 3.30. The appearance of the woman indicated poverty, and seemed to speak of death from want. Before she finally expired, a large crowd had collected, and stood by watching her last death struggles." In the old time it was written:—

"Pallida mors æquo pulsat pede pauperum tabernas,
Regumque turres."

But our modern system has changed all that.]

Proceedings of Societies.

LONDON AND PROVINCIAL PHOTOGRAPHIC ASSOCIATION.

A MEETING of this Society was held on Thursday, the 10th inst., J. TRAILL TAYLOR in the chair.

HORACE W. GRIDLEY, New York, showed examples of portraiture taken in an ordinary room, also a shutter made in Geneva, the mechanical work of which the Chairman pronounced to be of the highest type of excellence. It was made wholly of steel, the length of exposure was under control, the shortest being calculated at 1-250th part of a second. Some negatives of Florence were shown by the same gentleman.

Coagulation of albumen by means of methylated alcohol then formed a subject of discussion, and several pieces of albumenised paper were dipped into that agent, followed by a brief immersion in hot water, with differing results. In some cases the albumen was removed, others partially so, and in one instance it was perfectly coagulated. After a long discussion, in which it was pointed out that under certain circumstances albumen may be coagulated with alcohol,

The CHAIRMAN said that perfectly dry albumen could not be coagulated. Many years ago an amateur in Edinburgh employed steam for coagulating albumen; it was afterwards salted and sensitised, and yielded prints of extreme brilliancy.

F. York remarked that double albumenised paper was made by means of steam coagulation. His objection to it was liability of cracking, when dry, which might be prevented, he thought, by the use of glycerine or sugar.

W. E. Debenham had used alcohol in the sensitizing bath, but found it occasioned a slight scum.

F. York used 25 per cent. of alcohol in his sensitizing bath, and was not troubled with scum in consequence, or discolouration.

The Chairman referred to a process of printing with the nitrates of uranium and silver, introduced by C. J. Burnet; 5 grain solutions were used, the paper being salted with nitrate of uranium, and developed with nitrate of silver; he remembered getting vivid pictures in this way.

A. L. Henderson found the prints from uranium rather yellow. He obtained better pictures with Worthly's process, in which paper was coated with uranium and silver in collodion; the prints were very good, but had not proved more permanent than those on albumen.

Leicester and Leicestershire Photographic Society.

A regular meeting was held in the Mayor's Parlour on June 9th, Geo. Bankart in the chair. Theo. Walker and A. Brown were elected members, and Mr. Proctor proposed for election.

The cards for Society's album were announced as having come to hand; members are desired to procure them from the hon. Secretary, and it was decided to have slips printed to accompany each card, to be filled in by contributor, denoting place, time, size of stop, lens, &c.

It was arranged to discontinue the usual indoor monthly meeting for the months of July and August, out-door excursions to take their place. The next excursion of the Society was arranged for Thursday, July 15th, to Charnwood Forest.

T. Smithies Taylor promised to open the next session with a paper on "Lenses.

The report of the last excursion to Wistow was brought up, and although, in consequence of the unfavourable state of the weather, the attendance of members was not numerous, some very excellent work was shown, that of Messrs. Tucker and Weatherhead being especially commended.

Manchester Amateur Photographic Society.

The monthly meeting was held on Tuesday, at the Masonic Hall, Cooper Street; the President, the Rev. H. J. Palmer, in the chair. G. M. Brierly, P. A. Estcourt, and W. J. Pollitt were elected members.

S. F. Flower read a paper on "Thiebaut's Pellicle Films." He gave a short history of the rise and progress of photography, showing the change from Fox Talbot's paper process to the gelatino-bromide plates of the present time, and how another revolution appears probable, the dispensation with the heavy and fragile glass. He then exhibited and described the 100-fold filmograph apparatus for holding sheets of sensitized gelatine, and Thiebaut's films. The latter are sensitized films attached to cardboard instead of glass plates. They are exposed, developed, and fixed in the ordinary manner, and after drying are stripped from the cardboard support to print. One hundred of these cards are said to be equal in weight and bulk to one dozen glass plates.

There was a good display of prints from negatives taken by the members on the Society's rambles. Amongst the apparatus exhibited was Lancaster's new patent adjustable diaphragm stop, and Billcliffe's new camera with patent revolving back.

Birkenhead Photographic Association.

The ordinary meeting of this Association was held on Thursday, June 10, at the Free Public Library, Hamilton Street, the President, Mr. J. Alexander Forrest, in the chair.

H. N. Atkins exhibited a panoramic picture of the river Mersey between Rock Ferry and Tranmere Ferry, composed of four consecutive views placed side by side on a bevelled cut mount. The mount had four openings separated from each other by narrow bars which coincided with and covered the juncture line of the various views, the whole producing a very charming and artistic effect. Mr. Atkins explained that the views were all taken from one spot, the camera having been first carefully levelled, and then moved round on its own axis for each successive exposure.

P. Lange exhibited an album of pictures from paper negatives taken on a recent trip in North Wales.

Mr. Atkins then read his monthly synopsis of photographic information, which contained a number of interesting formulæ published during the month, and other matters of special interest to photographers.

A very pleasant evening was spent in conversation on photographic subjects, and the meeting terminated after passing a vote of thanks to Mr. Atkins for his paper.

Talk in the Studio.

Photographic Society of Great Britain.—The usual monthly technical meeting will take place on Tuesday next, June 22nd, at 8 p.m., at 5a, Pall Mall East. Doors open at 7 p.m. for journals and conversation.

Transmitting and Recording Sounds by Photography.—Methods of doing this have been published in the News from time to time, and a new departure in this line, recently made by the cousins Bell, may be mentioned. A jet of water is made to vibrate by sound, and either by taking reflections from a definite part of the stream, or by making the stream opaque and letting it partially block out a source of light, a negative corresponding to the vibrations is obtained. By known methods a relief plate can be made from the negative, and this relief plate can be made to actuate a diaphragm which, by its action on the air, reproduces the original sound.

Mysterious Fire.—On Tuesday afternoon last, shortly before two o'clock, another fire broke out in the studio of Mr. Sage, amateur photographer, of Upton Lodge, Victoria Road. It is only about nine months ago that the same studio was almost entirely destroyed. We understand that a few weeks back Mr. Sage received an anonymous communication intimating that an attempt would be made to set fire to the building, and two days after the place was discovered to be alight, but fortunately the flames were extinguished before much damage had been done. By some unaccountable means a third fire broke out at the studio on Thursday afternoon, as before mentioned, Mr. Sage being off the premises at the time. He was quickly apprised of the occurrence, however, and lost no time in hastening back to Upton Lodge and assisting Inspector Milcham and others in throwing buckets of water on the flames until the arrival of several members of the Twickenham Volunteer Fire Brigade with standpipe and hose. The fire was extinguished with some difficulty, but not before the contents of the studio had either been destroyed or seriously damaged. Mr. Sage was insured in the Sun Office.—*Twickenham Times.*

Photographic Club.—The subject for discussion at the meeting on June 23rd will be "Dark Slides and Plate-carrying Contrivances." Saturday afternoon outing at Orpington; train leaves Cannon Street at 2.25 p.m.

To Correspondents.

*** We cannot undertake to return rejected communications.

Amateur.—It is probable that your gelatine contains traces of greasy matter. Try another sample.

X. X.—Fontayne's machine is described in our volume for 1860, p. 270, and is referred to on p. 2 of our volume for 1883. The drawing referred to hardly needs description.

T. P. Watson.—We can only assume that an incorrect address has been endorsed upon the specification. If so, you can have the error corrected by paying a small fee, and the correction will be announced in the official journal. Until this, or something equivalent has been done, we cannot do as you suggest.

W. H. Simperley.—See article in another part of the News. We shall be glad to have further particulars, and to know how the matter goes on.

M. F. Sherwill.—1. Probably many good portraits have been taken in the way you suggest, but the plan is better suited for the open air than for working in a studio. 2. Not quite in the present form. Perhaps some day you may treat generally of photographing children.

H. P. Robinson, M. T. Shaw, C. Goldsworthy.—Received.

Florence.—1. The metallic silver has been converted into iodide, and it is evident you used the mixture in a much too concentrated form. 2. We have very little faith in any such substitutes for a thorough washing.

W. Body.—All depends on the condition of the goods. They may be well worth £20, or dear at £5.

G. and W. Morgan.—You can obtain a ruled plate from Hughes and Kimber, East Harding Street, Fetter Lane. Thank you for the excellent specimens, and we shall be glad to receive a block.

Surprised.—1. Perhaps, as you suggest, he does not quite know what he is talking about, for the two words mean precisely the same thing. 2. Write to the person concerned, and ask him.

THE LEISURE HOUR.

BEHOLD IN THESE WHAT LEISURE HOURS DEMAND,
AMUSEMENT AND TRUE KNOWLEDGE HAND IN HAND.—*Cowper.*

POOR MADAME RONDA!

IDONEA.

CHAPTER XXI.

Oh, could I fly, I'd fly with thee!
We'd make, with joyful wing,
Our annual visit o'er the world,
Companions of the spring.

—*Logan.*

A CARD of invitation for the performance of Mozart's Requiem Mass was sent to Neville from Mr. and Mrs. Dooner, and on the appointed evening he found himself at Queen's Gate. It was blocked up by carriages, for six or seven hundred guests had been bidden, and all fashionable London was there. Hall and staircase were crowded when Neville entered, and he thought he should never reach the landing of the first floor for the trains of the ladies. As he trod inadvertently, now on one of white satin, anon of crimson velvet, he wished for the train-bearing pages of the olden time. However, he reached the top at last, where Mrs. Dooner was receiving her "six hundred." "Dee-lighted, Mr. Neville," was the triplet that greeted him as he touched her hand and passed on. Soon afterwards he was welcomed by Mr. Dooner, whose natural voice was refreshing as a city fountain.

"Very glad to see you again, Mr. Neville. Hadn't we a jolly evening at the Rectory? Got into a fine scrape, though, through Miss Umfreville and her ballads. Thought she would make a success in public, and offered to help her to a musical education, but her mother won't hear of it, and my wife is offended. Better keep to bachelorhood, for there's no being up to the ladies. How d'ye do, my lord?"

The last clause was for a great man who came up, and Neville's "I mean to keep a bachelor" was cut short.

As he made his way through anterooms and corridors he found himself, both literally and figuratively, in a garden of exotics, for many-coloured and perfume-laden flowers filled each space where richly-dressed, scented, and painted women were not. He passed through them with difficulty to the music-hall. He met Miss Emma Dooner, to whom either he or his reputed acres were not indifferent. Thanks to Idonea, she had learned that he had a place in the North. But if he had been amused by her conversation, he was not pleased with her dress; for not even the blaze of a dozen lockets that were suspended by a chain round her neck could reconcile him to what his Mentoria of the Strand called "the *décolleté* style."

"So glad you have come, Mr. Neville. So kind of you to victimise yourself by listening to our poor attempts. I am trying to make my way to the choir."

"Can I help you?" he asked, as the crowd opened for a daughter of the house, and she moved on to the orchestra while he went into the hall.

It was already full, though guests were still arriving. He stationed himself at the bottom to survey the scene. Opposite him, at the other end, was the orchestra, filled with its distinguished choir of amateurs, artistically arranged, and sparkling with colour and jewels. On either side of them were professional musicians with their stringed and wind instruments. The body of the room was crowded with expectant auditors, who were of the rich, noble, and even royal of the land. He was bewildered by the splendour and the brightness of the scene. The massive chandeliers and sconces were filled with a blaze of wax lights; the ceilings and walls were painted and gilded, the windows shrouded by curtains of rose-coloured silk and Indian muslin, and all the arrangements betokened wealth and taste.

When he had accustomed his eyes to the glare and glamour, he looked about him for his few acquaintances; but he saw no one he knew, and while still leaning against the wall, the performance began. At a stroke of the conductor's magic wand, the glittering choir rose, and he was soon lost in the beauty, grandeur, and solemnity of the music. The impression he had received at the practice was stereotyped by the finished performance, and his wonder and admiration increased and culminated as he listened. As chorus followed chorus and the volume of harmonious sound filled all space, he marvelled at the skill that could thus unite so many voices into one grand result.

The first solo recalled him from heaven to earth, for he was interested to know who would sing it. It was Miss Charlotte Dooner, who was too nervous to do herself justice, and who found that it was one thing to sing in a chorus, another to sing alone. However, she executed her part carefully, if feebly, and was only surpassed by one female soloist. This was Madame Ronda, who, at the last moment, had been compelled to take the part, owing to the sudden illness of one of the principal members of the choir. What she urged as a plea for Idonea's singing had occurred, and she was forced to undertake what she had intended for her pupil. Neville did not recognise her, but felt that she knew what she was about, and sang with the skill and voice of a professional artist. Although applause was, nominally, prohibited, an involuntary *brava* succeeded.

There was an interval during the performance, and while the listeners rose and talked or looked about them, Neville's attention was attracted by bursts of laughter close at hand. They proceeded from a group of young people on and about an ottoman in the anteroom, the centre of whom was Lina, who had apparently escaped from the ranks of closely-packed chairs to ease and noise. He was glad to see that Idonea was not amongst them. As he was on a line with Lina, he proceeded to speak to her, and found that Sir Richard Dyke was at her back, urging her on to vivacious repartee.

"Is Miss Umfreville here? I have a message from her brother," he said to Lina, when they had shaken hands.

"She is in that remote corner, with my unoccupied chair as a companion," laughed Lina. "It was so dull that I escaped, but she was too discreet to follow. As you have been standing all the evening you may as well fill my place."

Neville made his way to Idonea, who was looking anxiously towards Lina and her party.

"Will you kindly ask Lina to come back? We were placed here, and Mrs. Dooner will be so displeased," was her greeting.

"She seems too well amused, but I will try," replied Neville, returning to Lina with the message.

"Tell her to come here instead," laughed Lina. "I am not going to remain amongst the wall-flowers."

He went back to Idonea with this determination, and as the seats were refilling took Lina's place, but could not allay Idonea's anxiety.

"Let her be; she is very happy, and so am I," he said, coolly. "Percy bade me tell you that he is glad you did not join the choir, because he disapproves of this sort of performance of religious music, and also that he quite agrees with your mother in all that she says."

Mrs. Umfreville had written again and again concerning the proposal that Idonea should appear in public, and had urged her immediate return home.

"But he does not wish me to leave the Dooners?" asked she, alarmed.

"He did not allude to that."

"Mrs. Dooner is annoyed with me because I could not, even if mother would consent, sing in public, and I think she wants me to leave. Now she will be still more displeased, for she told me to keep Lina here until Madame Ronda comes, who is our chaperon."

"Why is Madame Ronda not here?"

"Because she was obliged to sing two solos. Did you not recognise her? that lovely soprano!"

"Was that Madame Ronda? I should not have known her again. I am glad you were not in her place. Your mother was right, and you are better in private life. She, poor lady, must live by her voice."

"So, probably, must I. Hush! they are beginning."

Again the choir rose, and there was silence in the room. The second part was, if possible, finer than the first, and as Idonea and Neville looked over the score together their whispered comments expressed delighted approval. Madame Ronda sang another solo, immediately after which she disappeared from the orchestra.

"She ought not to be poor with such a voice," remarked Neville.

"She has repaid me my loan," said Idonea.

When the performance was concluded, there was a momentary solemn silence, then a burst of applause, then a buzz of many voices and general movement. Idonea looked round for Lina, but she and her party had disappeared.

"What can I do? How shall I find her?" she exclaimed.

"You must trust yourself to me, and her to Sir Richard Dyke," said Neville.

She had, indeed, no choice, so she took his offered arm, and they tried to pierce the crowd together. He had more than he could do to guard her and her dress from being crushed, and was glad to perceive that both were equally simple. As they were swayed to and fro, however, by the fashionable assemblage they could not fail to be amused, for neither had ever been before in a London crush. They reached the staircase at last, and finally the ground floor, but they were no better off than before, for every inch of space, in hall, passages, and rooms, was pre-occupied. Neville, determined that Idonea should not go without her supper, managed to force a way to the large dining-room, when he placed her in a seat just vacated behind the door, while he proceeded, with considerable difficulty, to the table. He glanced down its length, and wondered whether Belshazzar's feast and the imperial Roman banquets had been more sumptuous. Every conceivable luxury was outspread, and waiters innumerable ministered to the guests. Champagne flowed like water, and hothouse and icehouse vied in their varied productions. The season had just begun, and winter was barely passed.

Neville secured a plate of cold chicken and other tempting fare, and bore them triumphantly to Idonea.

"Thank you. You know of my good Northern appetite," she said, laughing. "Now will you kindly look for Lina and Madame Ronda?"

"Needles in a bundle of hay, but I will try. Stay here till I come back," he replied, and was soon lost in the crowd.

He was immediately replaced by Sir Richard Dyke, who had been in search of Idonea. For the first time she was glad to see him.

"Where did you leave Lina? Will you bring her to me?" she asked.

"She has taken advantage of the absence of her beautiful duenna, and is making the most of her liberty by amusing and being amused," he answered, lightly. "And I must not lose my chance," he continued, in a whisper. "I have long sought a private word with you to ask you to forget our unlucky meeting in the train, and what you considered my freedom. Also to assure you that you need not remain in these gilded chains if you choose to cast them off."

Idonea felt, instinctively, that he had managed to drink more champagne than was good for him, and rose from her seat to see if there were any one near with whom she could take refuge. But all were strangers, and the crush was so great that she could not move from her corner.

"'Water, water everywhere, but not a drop to drink,'" laughed Sir Richard, pushing forward to her chair. "You must tell me if I have any hope?"

"Hope of what, Sir Richard?" she said, indignantly, and, to her great relief, his answer was prevented by the reappearance of Neville, accompanied by Madame Ronda.

He muttered scorn on that "meddling prig," but kept his place by her side. Neville perceived him, but took no notice of him.

"I cannot find Miss Lina, but I have brought Madame Ronda," he said, coldly, striving to make room for that lady in front of Idonea and Sir Richard.

"And I have been seeking you both everywhere," began madame, and paused.

Her eyes were suddenly fixed on Sir Richard Dyke, and her severe, pale face as suddenly flushed, and her dark eyes flashed.

"I have found you at last!" she cried, seizing his arm.

He looked at her, and his countenance changed for a moment. But if embarrassed, he instantly recovered.

"I beg your pardon. You have the advantage of me. I have not the pleasure of knowing you. Miss Umfreville, I will relieve your anxiety by routing out the sprite."

He said this and was gone, lost in the denselypacked, fashionable, good-humoured crowd.

"I cannot be mistaken. What is his name?" asked Madame Ronda, eagerly.

"Sir Richard Dyke," replied Idonea.

"That must be an *alias*. I must see him again," she cried, with strange impetuosity, and before Neville or Idonea was aware, she, too, disappeared in pursuit of him whom she fancied she had recognised.

CHAPTER XXII.

> Hence, vain deluding joys,
> The brood of folly without father bred!
> How little you bested,
> Or fill the fixed mind with all your toys.
>
> —*Milton.*

"Pray let me follow her, and seek for Lina," said Idonea, when Madame Ronda disappeared in search of Sir Richard Dyke.

She rose impulsively, and pushed through the company. This time it was Neville who followed, struck by her decision. She succeeded in reaching the crowded passage, closely pursued by Neville, and penetrated with difficulty into the rooms that he did not recognise. The cloak-room, where Idonea thought she might find Madame Ronda, was heaped with a confusion of wraps, into which ladies and gentlemen were peering with laughing desire to secure their property. Tickets were strewn about that ought to have marked the bundles, and maids stood helplessly by who were supposed to superintend them, but there was no Madame Ronda. Idonea asked the maids if they had seen Lina, and was answered in the negative. Servants and waiters were bearing refreshments to famishing guests in the hall, and there were shouts of laughter and cries of "Have you seen mamma?" "I had once two daughters, and can find neither;" "Where is so-and-so?" "You are treading on my dress;" "Ten thousand pardons;" "Lady ——'s carriage;" "Impossible to reach it;" "Come along, will you?" "Where have you been? I have been looking for you an hour," and similar sentences. Idonea could not help laughing at the fierce faces of some of the elder gentlemen on the look-out for their womankind, and the despairing inquiries of the deserted chaperons.

"This is pleasure, and it is Saturday night!" said Neville, struggling up to her as she stood against a wall near the door of one of the smaller supper-rooms.

"It would be very amusing if only I could find Lina," replied Idonea. "It is delightful to see the upper ten just like other people. Mother would be astonished."

"I should think so!" laughed Neville, recalling that majestic matron.

"Hush! That is Lina's laugh! Good night," cried Idonea, breaking away from Neville and vanishing he knew not where. He had lost her. She was the first woman he had ever taken so much trouble for, and a child's uproarious mirth had drawn her from him. He tried to follow her with his eyes as well as legs, but a dense group of growling husbands stood between them, and he saw her no more that night. He was conscious of an unusual feeling of anger, but nevertheless he turned to a waiter bearing a tray on his shoulder, and demanded a portion of the contents thereof.

He ruminated, while eating his sandwiches, on the lives of the "Jeameses and pampered menials," as they are called, and came to the conclusion that they were not, after all, quite so untroubled as they were said to be. For his own part, he decided that when he became a poor man himself, as Mrs. Keene prophesied, he would not earn his bread either by waiting on the tables of the rich within their dwellings till cock-crow, or by sitting on a coachbox, freezing, or drenched, or sun-stricken, without. He bethought himself that he would go North and turn day-labourer or anything independent by preference.

Wishing that he could have shaken hands with Idonea, he at last made his way to the hall door. There was such confusion of carriages and servants, and so much difficulty in getting at their owners, that he went off himself in search of a cab. Passing the long line of carriages and their aforementioned coachmen, chilling beneath a February moon, he suddenly encountered Madame Ronda. She was, like himself, in search of a cab, but the cabbies had cruelly resisted the appeal of a lady in black dress and scarlet hood, knowing that gentlemen were, as a rule, better fares, and not so likely to quarrel over the charge.

Poor Madame Ronda! It was wheel within wheel. Neville volunteered to procure the cab, but she stayed him by putting a question. She was evidently in agitation.

"Who was that man to whom Miss Umfreville was talking?" she asked, with imperative anxiety.

"I only know him as Sir Richard Dyke," he replied.

"He is not—he cannot be Sir Richard Dyke," she cried. "Could you add to the obligation I am already under to you by finding out his address, or history, or anything concerning him?"

"I am going abroad almost immediately," replied Neville, "and fear I cannot help you. But perhaps Miss Umfreville might—or—or her brother, who lives in London. I will mention it to him."

"No—no—I would rather not. I should not have asked you, had you not been so good to me. I now know to whom I am indebted for the anonymous five pounds, and I shall hope to return it. But, indeed, I have been in great straits."

She burst into tears, much to Neville's discomfiture. She was standing against the railing of a corner house, and her pale face looked almost startling in the moonlight beneath her scarlet hood.

"Make a friend of Miss Umfreville," he said. "Let her communicate with her brother. I can hear of you through them, or, if I hear of this man, I will write to you."

A cab appeared; Neville hailed it, and placed Madame Ronda in it. They shook hands warmly. He gave the driver his fare and her address, told her it was paid, and received in return a "Thank you—God bless you for your kindness to a stranger."

Meanwhile, Idonea had found Lina. She was in the midst of a group of fast young men and women, in the remotest corner of one of the smaller supper-rooms. Wise if not prudent in their generation, they had left the concert-room as soon as the applause began, hurried downstairs, and secured this "modest nook," as Lina called it, and maintained it. Indeed, they could not well have left it, for it was partly shut in by the supper-table, and wholly by the crowd. They had used their advantages, which is more than everybody does; but they had also somewhat abused them, which is what many people do when they are abundantly within reach. The excitement of the evening had betrayed them into almost riotous fun; and even the young ladies were in danger of overpassing the bounds of decorum.

When Idonea reached them, she saw that Duke Dooner was amongst them. His sullen temper had held him aloof from her, though Lina had kept him informed of her doings and sayings. Lina's voice and laugh were loudest where all were loud, and Idonea paused, astonished at her excitement. She soon heard the words, followed by a suppressed giggle, "Here is my little companion! She has caught me at last." Duke also saw Idonea, and made way for her.

"I am so glad I have found you," she said, quietly. "It is twelve o'clock, and we were only to remain till eleven."

"I am not going to bed till every soul has departed. It is so jolly!" exclaimed Lina, so resolutely, that the bystanders turned to look. "I maintain the liberty of this my castle for one night at least."

"You must come with me," whispered Idonea.

"I wish you may get her," laughed Duke.

Idonea had been so long in command at home, that she could be, as Neville had said, resolute; so, looking at Duke somewhat disdainfully, it must be confessed, she said,

"Perhaps, then, you will be answerable for her. Madame Ronda has left, and I have not sufficient authority."

Duke perceived that they were objects of attention, so he offered his arm to one of the ladies, and broke up the noisy coterie by saying,

"I believe Miss Umfreville is right. The carriages were ordered for eleven, and I heard yours called."

The rest paired off, two young men escorting Lina, and Idonea was left to follow. To her surprise, Sir Richard Dyke started up from she knew not where, and offered his arm. She did not take it—she disliked the man too much—but she could not prevent his keeping next to her.

"Can you tell me who that lady was who addressed me?" he said. "It is so awkward not to remember a face or name; yet I seem to have no recollection of hers."

"It was Madame Ronda, who sang two of the solos," replied Idonea.

"Then she certainly was mistaken, for I have never even heard the name," he said, carelessly, and Idonea supposed, from his natural and self-possessed manner, that it must have been a mistake.

When they reached the hall he bade her good night and once more disappeared.

Idonea joined Lina, whose hilarity and ridiculous jests were still audible, but it was not until they were all gone that Idonea prevailed upon her to withdraw. She did so, however, before any member of her family, save Duke, appeared.

BIRTH AND CHILDHOOD:

THEIR CUSTOMS AND SUPERSTITIONS.

As every period of human life has its peculiar rites and ceremonies, its customs and superstitions, so has that ever all-eventful hour which heralds the birth of a fresh actor upon the world's great stage. From the cradle to the grave, through all the successive epochs of man's existence, we find a series of traditional beliefs and popular notions which have been handed down to us from the far-off distant past. Although, indeed, these have lost much of their meaning in the lapse of years, yet in many cases they are survivals of primitive culture, and embody the conceptions of the ancestors of the human race.

Without, however, entering critically into their origin and growth, and tracing their transmigration from one country to another, it may be interesting to many readers to give a brief and general survey of that varied and extensive folk-lore which has interwoven itself round the life of man.

In commencing, then, with birth, we find that many influences are supposed to affect the future fortune and character of the infant. Thus in some places great attention is paid to the hour of birth, as children born at midnight are believed to have the power of seeing ghosts; whereas in Devonshire it is said that those born by daylight never see such things. Equally important, too, is the day of birth, as may be gathered from the following rhyme, current in Cornwall:—

"Sunday's child is full of grace,
Monday's child is full in the face,
Tuesday's child is solemn and sad,
Wednesday's child is merry and glad,
Thursday's child is inclined to thieving,
Friday's child is free in giving,
Saturday's child works hard for his living."

This piece of folk-lore varies, of course, in different localities. By general consent, however, Sunday is regarded as a lucky day for birth, both in this country and on the Continent. The "Universal Fortune Teller," a book which has had a wide circulation among the lower orders of our countrymen,* informs us that "great riches, long life, and happiness" are in store for children born on Sunday; and in Yorkshire, "Sunday children," as they are called, are said to be secure from the malice of evil spirits; while a Sussex belief considers them safe against drowning and hanging. In the same county, too, babies' caps must be left off on a Sunday for the first time, and then no cold will be taken.

In Denmark children born on Sundays have characteristics by no means enviable. Mr. Thorpe, in his "Northern Mythology" (ii. 203) tells us that in Fyen there was a woman who was born on a Sunday, and therefore had the faculty of seeing much that was hidden from others. Unfortunately, on this account, she could not pass by the church at night without seeing a hearse or a spectre; hence this gift became a perfect burden to her. She therefore sought the advice of a man skilled in such matters, who directed her, whenever she saw a spectre, to say, "Go to heaven," but when she met a hearse, "Hang on." Happening some time afterwards to meet a hearse, she, through forgetfulness, cried out, "Go to heaven," and straightway the hearse rose in the air and vanished. Soon after, meeting a spectre, she said to it, "Hang on," whereupon it clung round her neck, hung on her back, and drove her down into the earth before it. For three days her shrieks were heard before the spectre would put an end to her wretched life.

The moon's phases, also, are said to have an influence on birth. In Cornwall, for example, when a child is born in the interval between an old moon and the first appearance of a new one, it is said that it will never live to reach the age of puberty; hence the saying, "No moon, no man." In the same county, when a boy is born in the wane of the moon, it is believed that the next child will be a girl, and *vice versâ;* and according to another popular notion, when a birth takes place on the "growing of the moon," the next child will be of the same sex. Again, certain seasons are thought to be more propitious for births than others. In Cornwall, children born in May are called "May chets," and an old proverb declares that—

"May chets
Bad luck begets:"

a superstition which the life of our good Queen Victoria contradicts.

There is an idea prevalent, too, on the Continent, that when a child is born in Leap Year† either it or its mother will die within the course of the year—a superstition not unknown in our own country.

Many dangers are supposed to hover around the newborn infant, and during the time previous to its baptism, one of the foremost among them being the propensity of witches or fairies to secretly exchange their own ill-favoured imps for some well-favoured child—a superstition to which Shakespeare makes King Henry IV allude, who, when speaking of Hotspur compared with his own profligate son, says—

* Henderson's "Folk-lore of Northern Counties," 1879—10.
† See "Leisure Hour," February, 1880:—Article, "Leap Year."

"O, that it could be proved,
That some night-tripping fairy had exchanged,
In cradle clothes, our children where they lay,
And called mine Percy, his Plantagenet!
Then would I have his Harry, and he mine."

With a view of inducing the fairies to restore the stolen child, it was customary in Ireland either to put the one supposed of being a changeling on a hot shovel, or to torment it in some other way. It seems that, in Denmark, the mother heats the oven, and places the changeling on the peel, pretending to put it in, or whips it severely with a rod, or throws it into the water. In the Western Isles of Scotland idiots are believed to be the fairies' changelings, and, in order to regain the lost child, parents have recourse to the following device. They place the changeling on the beach, below high-water mark, when the tide is out, and pay no heed to its scream, believing that the fairies, rather than suffer their offspring to be drowned by the rising waters, will convey it away and restore the child they had stolen. The sign that this has been done is the cessation of the child's crying. In the West Riding of Yorkshire the safety of the infant was considered secure by hanging a carving-knife from the head of the cradle, with the point suspended near its face. The most effectual preservative, however, against fairy influence is supposed to be baptism, and hence among the superstitious this rite is performed as soon as possible. Curiously enough, Martin Luther believed in this species of superstition, if we are to accept the following extracts from his "Table Book":* "Changelings Satan lays in the place of the genuine children, that people may be tormented with them. He often carries off young maidens into the water." Again, "Eight years ago there was a changeling in Dessau, which I, Dr. Martin Luther, have both seen and touched; it was twelve years old, and had all its senses, so that people thought it was a proper child; but that mattered little, for it only ate, and that as much as four ploughmen or thrashers, and when any one touched it, it screamed; when things in the house went wrong, so that any damage took place, it laughed and was merry; but if things went well, it cried. Thereupon I said to the Prince of Anhalt, 'If I were prince or ruler here, I would have this child thrown into the water, into the Moldau, that flows by Dessau, and would run the risk of being a homicide.' But the Elector of Saxony and the Prince of Anhalt would not follow my advice. I then said they ought to cause a paternoster to be said in the church, that God would take the devil away from them. This was done daily at Dessau, and the said changeling died two years after."

Spenser mentions this notion:—

"From thence a fairy thee unweeting reft,
There as thou slep'st in tender swaddling band,
And her base elfin brood there for thee left;
Such men do changelings call, so changed by fairy theft."

Infants are also said to be subject to the influence of the Evil Eye, and in order to counteract the ill effects, various specifics have been used. Thus, in some parts of Scotland the newly-born child was bathed in salt water, and made to taste it three times. Baptism, too, has been supposed to be a good remedy; and Mr. Napier, in his "Folk-lore of West of Scotland" (31), quotes an instance in which the baby was born on a Saturday and carried two miles to church next day rather than a week's delay be risked. In the north of England, when a child pines or wastes away, the cause assigned is the "Evil Eye." In days gone coral beads were hung round the necks of babies from an ancient superstitious notion that these would protect them from evil influences of every description. Herrick, too, has given us the following charm:—

"Bring the holy crust of bread,
Lay it underneath the head;
'Tis a certain charm to keep
Hags away while children sleep.
Let the superstitious wife
Near the child's heart lay a knife,
Point be up and haft be down;
This, 'mongst other mystick charms,
Keeps the sleeping child from harmes."

In the north of England, women still wear round their necks blue woollen threads, or small cords, till they wean their children, for the purpose of warding off fevers, or, as they are nicknamed, "weeds and onfas." These threads are handed down from mother to child, and esteemed in proportion to their antiquity. According to a Yorkshire notion,* a newborn infant should be laid first in the arms of a maiden before any one touches it; and in some places the infant's right hand is left unwashed in order that he may gather riches. It is, too, considered very important by many that an infant should go up in the world before it goes down. Thus, in Cleveland, says Mr. Henderson, "if a child should be born in the top storey of a house, for want of a flight of stairs, one of the gossips will take it in her arms and mount a table, chair, or chest of drawers, before she carries it downstairs." In the north of England, when an infant for the first time goes out of the house, it is presented with an egg, some salt, a little loaf of bread, and occasionally with a small piece of money —these gifts being supposed to ensure that the child shall never stand in need of the common necessaries of life. In the East Riding of Yorkshire a few matches are added, to light the child to heaven.

It was, too, in former times customary, and the practice is not yet obsolete, of providing a large cheese and cake, and cutting them at the birth of a child. These were called the "Groaning Cake and Cheese," and were distributed among all the neighbours. In Yorkshire this cake is termed the "Pepper Cake," and in some localities the "Sickening Cake." It is the source of a species of divination, for, being cut into small pieces by the medical man, it is divided among the unmarried of the female sex, under the name of "Dreaming Bread." Each one takes a piece, places it on the foot of the left stocking, and throws it over the right shoulder. This being done, they must retire to bed backwards, without uttering a word, and those who are lucky enough to fall asleep before midnight are favoured with a sight of their future husbands in their dreams.

Children born with a caul—a thin membrane covering the head of some infants at birth—are supposed to be lucky, and great care was always taken that the caul should not be lost or thrown away, lest

* Quoted by Thorpe, "Northern Mythology," ii.

* Henderson's "Folk-lore of Northern Counties," 1879—18.

the child should die or pine away. The carrying of a caul on board ship was believed to prevent shipwreck, and owners of vessels paid a large price for them. Advocates, also, purchased them that they might be endued with eloquence. This superstition was very prevalent in the primitive ages of the Church; and St. Chrysostom inveighs against it in several of his homilies. In France it is proverbial, and "Être né coiffée" is an expression signifying that a person is extremely fortunate. Grose tells us that any one possessed of a caul may know the state of health of the party who was born with it: if alive and well, it is firm and crisp; if dead or sick, relaxed and flaccid. Mr. Henderson, in his "Folk-lore of Northern Counties" (1879-23), relates an anecdote of a servant who was found by her mistress in a state of dejection, for which at first there seemed no assignable cause. After much questioning the lady ascertained that the servant had been born with a veil over her head, which was now presaging evil to her. The veil, she said, had been carefully preserved by her mother, who had entrusted it to her on coming to woman's estate. It had been stretched and dried, and so had remained for many years. The girl kept it locked in her chest of drawers, and regularly consulted it as her oracle and adviser. If danger was at hand, the veil shrivelled up; if sickness, the veil became damp; when good fortune was near, the veil laid itself smoothly out; and if people at a distance were telling lies about her, the veil nestled in its paper. Again, the veil did not like her to cut her hair, for when she did so, it changed colour and became uneasy. The owner firmly believed that when she died the veil would disappear altogether. She regarded it with mysterious awe, and only her most intimate friends were allowed to know of its existence.

Among the many other items of folk-lore associated with infancy may be mentioned, in the next place, those relating to the teeth and nails. Thus, if a child's tooth is first in the upper jaw, it is considered ominous of its dying in infancy; and when the teeth come early it is regarded as an indication that there will soon be another baby. In Sussex there is a dislike to throwing away the cast teeth of children, from a notion that should they be found and gnawed by any animal, the child's new tooth would be exactly like the animal's that had bitten the old one. In Durham, when the first teeth come out, the cavity must be filled with salt, and the tooth burned while the following words are repeated:—

> "Fire, fire, burn bone,
> God send me my tooth again."

In Sussex* children often wear a necklace of beads, made from the root of the peony, to prevent convulsions and to assist the cutting of their teeth. Referring to the ceremonies connected with the cutting of the baby's nails, these are equally important. Thus, in many places, it is said, they should not be cut till he is a year old, and then they must be bitten off by the mother, lest the child should grow up to be dishonest. Mr. Henderson mentions a notion current in Northumberland that if the first parings are buried under an ash-tree, the child will turn out a "top-singer." Anyhow, when the time arrives for baby's nails to be cut, this event must not take place either on a Sunday or Friday:—

> "Better a child had ne'er been born
> Than cut his nails on a Sunday morn!"

Equally, too, unlucky is it to cut the hair on a Friday:—

> "Friday hair, Sunday horn,
> Better that child had ne'er been born!"

In the Midland counties, hair or down upon the arms is said to prognosticate that the child will one day enjoy great wealth; or, to use the common expression, "is born to be rich."

How much potency is supposed to reside in baptism may be seen from the very many superstitious notions connected with it. The omission of this rite is supposed to be attended with fatal results; and hence it is often performed as soon as possible after the birth of the child. As we have already stated, one reason is that unbaptized children are thought to be at the mercy of fairies, and subject to the influence of the Evil Eye. Another fancy is that, should a child die unchristened, it is destined either to flit restlessly around its parents' abode, or to wander in woods and lonely places, daily lamenting its hard fate. In Germany, unbaptized infants are said to be turned into that delusive meteor known as the will-o'-the-wisp, and ceaselessly to hover between heaven and earth. In Scotland it is said to be unlucky to give the child any name until after baptism; and even nowadays in many country places a child is invariably called by the name of the saint on whose festival it may happen to have been born; any omission of this practice being supposed to bring ill consequences. Hence not unfrequently children are found with very strange names.

It is a very common notion that a child does not thrive until baptized, and in cases of illness the clergyman is, perhaps, more frequently sent for by the poor from a belief in the physical virtue of the rite itself, rather than from any actual conviction of its religious importance. It is considered a good omen for a child to cry at its baptism, as otherwise it shows that the baby is too good to live. Martin, in his "History of St. Kilda," tells us that it was customary for the inhabitants always to baptize their children on a Saturday, from a superstitious notion that if this ceremony were observed on another day they would die. An odd idea prevails in Norfolk, that when there are girls and boys to be baptized, the boy must come first, or else the girl will have a beard. In Scotland, when a baby was carried to church to be baptized, it was considered important that the nurse appointed for this purpose should be known to be lucky. She generally took with her a piece of bread and cheese, which she presented to the first person she met—this representing a gift from the baby. If the party readily accepted and ate the proffered present, it was a good omen; but if refused, it was considered tantamount to wishing evil to the child; and in after life if any misfortune befel the child it was invariably associated with this circumstance. Brand tells us it was formerly the custom at Christening entertainments "for the guests not only to eat as much as they pleased, but also for the ladies to carry away as much as they liked in their pockets." Stow, in his "Survey of London," gives an account of the great christenings in 1561 and 1562. After the first was "a splendid banquet at home," and the other, he said, "was concluded with a great banquet consisting of wafers and hypocras,

* "Folk-lore Record," i., 44.

French, Gascoign, and Rhenish wines, with great plenty, and all their servants had a banquet in the hall with divers dishes." At the christening entertainments of the poorer classes in the Northern and Midland counties it was customary for the guests to make a collection among themselves to defray the expenses, which oftentimes amounted to a good sum. It was anciently the custom for the sponsors at baptism to present the children with spoons, commonly called Apostle Spoons, because the figures of the twelve apostles were carved on the tops of the handles. Rich sponsors gave twelve, and those in poorer circumstances gave as many as they could afford. It is in allusion to this custom that when Cranmer professes to be unworthy of being sponsor to the young princess, Shakespeare makes the king reply:—

"Come, come, my lord, you'd spare your spoons."

Many of these spoons are still preserved in various museums, and are curious as relics of the past.

There are countless other items of folk-lore associated with this subject, which space, however, will not permit us to speak of—not to mention those found in foreign countries. Indeed, to enter fully into the customs and superstitions relating to birth and childhood would require a large volume instead of a few columns of a magazine. At the same time, those already briefly enumerated are good specimens of the extensive folk-lore that has clustered round the infancy of human life; and if oftentimes apparently meaningless to us, yet embody, it must be remembered, the beliefs and superstitions of our ancestors, who, if they were in our midst now, would, no doubt, be able to explain and account for what is often looked upon as childish fancy and so much nursery rubbish.

T. F. THISELTON DYER.

THE DARWINS:

GRANDFATHER, FATHER, AND SON; ERASMUS, ROBERT, AND CHARLES.

THE name Darwinism has become familiar to us in the present day as denoting a theory very popular among free-thinkers, and zealously espoused by some scientific men, expounded mainly by Mr. Charles Darwin, now himself a veteran of threescore years and ten, to explain afresh the origin of species. The name is not new, for Coleridge employed it to designate the similar theories of the grandfather, Dr. Erasmus Darwin, many years ago. "This," he wrote, in his notes upon Stillingfleet, "is *Darwinizing* with a vengeance."* Confronting the majestic statements of Genesis, "God created every living creature *after his kind*," "God created man in His own image," Darwin the grandfather and Darwin the grandson espouse the ancient doctrine, traceable in Anaximander and Lucretius, of natural evolution. Both appeal to the fact of the survival of the fittest, Erasmus assigning as its cause "directly the actions and requirements of the forms themselves, and indirectly changed outward conditions," and Charles attributing it to what he calls "natural selection." Younger men of science are now appealing from Darwin the grandson to Darwin the grandfather, as propounding a theory nearer the truth; and thus the names of both are prominently before us. Upon the question in dispute we do not enter; as believers in Revelation we rest assured that science will itself confirm the truth of Divine creation of species, Divine providence and design. Our purpose here simply is to acquaint our readers with the interesting history of the remarkable family, father, son, and grandson, whose names are thus before the public, and to discover the social and religious soil out of which these theories have afresh sprung up. In doing so we are much indebted to the writings of three ladies, Miss Seward, Mrs. Schimmelpenninck, and Miss Meteyard, together with a brief life of Erasmus Darwin compiled by Mr. Charles Darwin himself.

ERASMUS DARWIN, the grandfather, was born at Elston, near Newark, Nottinghamshire, on December 12th, 1731. He was sprung, we are told, of "a gouty family," members of which fought for Charles I, and were patronised by Charles II. His father adopted a metrical litany, one triplet of which, in seeking deliverance from sundry evils, ran thus:—

"From a morning that doth shine,
From a boy that drinketh wine,
From a wife that talketh Latine!"

Hence it is surmised that he was an advocate of temperance, and that his wife, the mother of Erasmus, was not a blue stocking. Erasmus in his boyhood was very fond of poetry, and very fond also of mechanics, and both tastes prevailed in him, and showed themselves to the end of his life. At ten years old he was sent to the Grammar School at Chesterfield, under the Rev. Mr. Burrows, and there he remained nine years, a long term of schooling, during which he had plenty of Latin and Greek drilled into him; for he speaks feelingly in after years against "those classical schools which not only overcome the struggling efforts of genius and bind his proteus forms till he speak the language they require, but divert his attention from the nice comparison of things with each other, and from associating the ideas of causes with their effects, and amuse him with the looser analogies, the vain verbal allusions which constitute the ornaments of poetry and of oratory."

He obtained a scholarship of £16 a year at St. John's, Cambridge, and afterwards studied medicine at Edinburgh. He attempted to begin practice as a physician at Nottingham, but in three months removed (November, 1756) to Lichfield, where, by successfully treating some important cases, he soon won an extensive practice, and married Mary Howard, aged 17, daughter of a respectable inhabitant of Lichfield, a superior and charming girl. By her he had three sons: Charles, a youth of high promise, who died in his twentieth year; Erasmus, a man of retiring disposition, a solicitor, who, in a fit of temporary insanity, committed suicide in his fortieth year; and Robert Waring, the father of the

* Coleridge's notes upon Stillingfleet were discovered by Mr. Richard Garnett, of the British Museum, and published by him in the "Athenæum" a few years ago.

present Mr. Charles Darwin. Their mother died, after a long and suffering illness, in 1770. In 1781 Dr. Erasmus Darwin married the widow of Colonel Pole, a brilliant accomplished lady with a jointure of £600 a year, and thereupon he removed to Derby, where, after many years' practice in his profession, and much literary labour, he died very suddenly in the year 1802, aged seventy-one years.

In person Dr. Erasmus Darwin was above the middle height; his form ponderous and inclined to corpulence; his features deeply pitted with the small-pox; his head half-buried in his shoulders, and covered with "a scratch wig and bobtail;" his eye sagacious, keen, and benevolent. From the loss of his teeth he looked much older than he was. He limped, owing to an injury of the knee when thrown from his carriage. He stammered extremely when he spoke, but what he said was well worth waiting for, for that uncouth exterior was the tabernacle of a powerful mind. A young man once asked him offensively whether he did not find stammering very inconvenient. He answered, "No, sir; it gives me time for reflection, and saves me from asking impertinent questions." He possessed great facility in explaining a difficult subject, and great felicity of expression with the pen.

Dr. Erasmus Darwin was usually in practice what is now called a teetotaler, and always expressed the strongest aversion to "vinous potations." During his life he almost banished wine from the tables of the rich of his acquaintance, and his influence and example sobered the town of Derby. This was forty years before total abstinence societies were heard of. He recommended "a total prohibition of the destructive manufacture of grain into spirits or strong ale, and thus converting the natural nutriment of mankind into a chemical poison, and thinning the ranks of society both by lessening the quantity of food and shortening their lives by disease." "Prometheus and the vulture gnawing his liver affords," he said, "an apt allegory for the effects of drinking spirituous liquors." He enjoyed uninterrupted health, which he attributed to his temperate mode of living.

ERASMUS DARWIN.

[*After a Portrait by J. Rawlinson, 1804.*

C. Darwin

[*From Photograph by Elliott & Fry.*

But he had withal a strong belief in hearty eating "Eat or be eaten" was his motto. "Eat, eat, eat as much as you can," was the frequent advice he gave. His horror of fermented liquors, and his belief in the advantages both of eating largely and eating abundance of sweet things, was known to all his friends. On one occasion, having sat at a table spread with fruits and creams for three hours, entertaining the company with his wit and his anecdotes, he expressed joy at hearing the dressing-bell, and hoped that dinner would soon be announced. In his carriage, called a sulky, because it carried only one—a curious machine of his own planning, with a skylight in the top, and a box before the occupant, containing knife, fork, and spoon, as well as writing materials—he carried on one side a pile of books, on the other a hamper of food, cream, and fruit, and behind a pail with hay and oats for the horse. Thus he was provisioned for the distant visits he had repeatedly to make, providing for man and beast with a bountiful hand. He had an extensive practice, and his carriage was so constantly going that a gentleman humorously directed a letter, "Dr. Darwin, Upon the road."

Dr. Erasmus Darwin was an early riser, a hard worker, and owed as much to industry as to genius. In the earlier days of his professional life he gave lectures upon anatomy, as appears from the following singular advertisement: "Oct. 23, 1762. The body of the malefactor, who is ordered to be executed in Lichfield on Monday, the 25th inst., will afterwards be conveyed to the house of Dr. Darwin, who will begin a course of anatomical lectures at four o'clock on Tuesday evening, and continue them every day as long as the body can be preserved; and shall be glad to be favoured with the company of any who profess medicine or surgery, or whom the love of science may induce." Even in 1793, when his son urged him to leave off professional work, he replied, "It is a dangerous experiment, and generally ends in drunkenness or hypochondriacism. One must do something; and one may as well do something advantageous to oneself and friends or to mankind as employ oneself in cards or other things equally insignificant."

He had a large correspondence with distinguished men, and his house in Lichfield was the intellectual centre of the Midland counties. Mr. Edgeworth, father of Maria Edgeworth; Josiah Wedgwood, the potter of Etruria; Day, the author of "Sandford and Merton;" James Watt, Bolton, Kerr, Small, and other notable men of those times, were among his steadfast friends through life. But he could never get on with the celebrated Dr. Johnson, who often visited Lichfield. Perhaps the two men were too like each other in self-assertion to get on well together, even if Johnson could have tolerated Darwin's principles and character.

In religion he appears to have been what is called a Theist, and he did not believe in Divine revelation. On the death of his father, when still young, he wrote "that there exists an *Ens entium* (a Being of beings) which formed these wonderful creatures is a mathematical demonstration. That He influences things by a particular providence is not so evident." He used often to say, "Man is an eating animal, a drinking animal, and a sleeping animal, and one placed in a material world which alone furnishes all the human animal can desire. He is gifted, besides, with knowing faculties, practically to explore and to apply the resources of this world to his use. These are realities. All else is nothing; conscience and sentiment are mere figments of the imagination."

This is Mrs. Schimmelpenninck's record, but she qualifies it with the remark that "many allow themselves to say colloquially what they would not fully sanction when in earnest." She says that Dr. Darwin's conversation was characterised by the merriment and so-called wit which aimed its perpetual shafts against those holy truths which afforded her the only comfort. To her cousin, his patient, Dr. Darwin said, "My dear madam, you have but one complaint; it is one ladies are very subject to, and it is the worst of all complaints, and that is having a conscience. Do get rid of it with all speed; few people have health or strength enough to keep such a luxury, for utility I cannot call it." "But, doctor, you will surely allow dear Priscilla to read religious books." To which the doctor replied, "My dear madam, toss them every one into the fire. I cannot permit one of them, excepting 'Quarles's Emblems,' which may make her laugh." One of the party expressing the hope that one day he would receive Christianity, he replied, "Before I do that you Christians must all be agreed. The other morning I received two parcels, one containing a work by Dr. Priestley, proving there is no spirit; the other, a work by Berkeley, proving there is no matter. What am I to believe amongst you all?" Coleridge styled Erasmus Darwin "Everything but Christian." That he believed in conscience, however, we infer from his noble lines on Slavery:—

"Throned in the vaulted heart, his dread resort,
Inexorable *conscience* holds his court,
With still small voice the plots of guilt alarms,
Bares his masked brow, his lifted hand disarms.
But wrapped in might, his terrors all his own,
He speaks in thunder when the deed is done.
Hear him, ye senates! hear the truth sublime,
He who allows oppression shares the crime."

He published an ode beginning thus:—

"Dull Atheist, could a giddy dance
Of atoms, lawless hurled,
Construct so wonderful, so wise,
So harmonised a world?"

And with reference to morality, he says, "The sacred maxims of the author of Christianity, 'Do as you would be done by,' and 'Love your neighbour as yourself,' include all our duties of benevolence and morality." Still, as his grandson, who naturally gives the most favourable account, himself allows, Dr. Erasmus Darwin did not believe in Revelation; nor did he feel much respect for Unitarianism, for he used to say that "Unitarianism was a feather-bed to catch a falling Christian."

Shrewdness, sympathy, and benevolence were striking features in Dr. Erasmus Darwin's character. He thought that almost all virtue consisted in benevolence. He once wrote thus wisely to his son: "The best way when any slander is told me, is never to make any piquant or angry answer, as the person who tells you what another says against you always tells them in return what you say of them. . . . Dr. Small always went and drank tea with those who he heard had spoken against him; and it is best to show a little attention at public assemblies to those who dislike one, and it generally conciliates them." While resident at Lichfield he never took fees of clergymen, and he diligently attended to the health of the poor. Having to see a patient at Newcastle during the races, he slept at an hotel, and in the night the door opened and a man came to his bedside and said, "I heard that you were here, but durst not come to speak to you during the day. I have never forgotten your kindness to my mother in her bad illness, but have not been able to show you my gratitude before. I now tell you to bet largely on a certain horse (naming one), and not on the favourite whom I am to ride, and *who we have settled is not to win.*" He afterwards saw in the newspaper that, to the astonishment of every one, the favourite had not won the race.

As Lord Chesterfield undertook to train his "son," Dr. Darwin guided the career of two "daughters," the Miss Parkers. He gave them a good education, established them in a school at Ashbourne, and wrote and published for their guidance a work entitled "A Plan for the Conduct of Female Education in Boarding Schools." He describes female education as consisting "in uniting health and agility of body with cheerfulness and activity of mind; in superadding graceful movements to the former, and agreeable tastes to the latter; in the acquirement of the rudiments of such arts and sciences as may amuse ourselves or gain us the esteem of others; with a strict attention to the culture of morality and religion." "The art of pleasing in conversation," he remarks, "consists in two things, one of them to hear well and the other to speak well."

In 1778 he purchased about eight acres of land near Lichfield, which he made into a botanic garden. Miss Seward, his biographer, wrote some lines upon the spot, which he liked so much that he said, "I shall send them to the periodical publications, but they ought to form the exordium of a great work. I will write the notes, you shall write the verse." This was the beginning of the "Botanic Garden," a poem in two books, published in 1781, which immediately became popular and famous. He sent Miss

Seward's verses to the "Gentleman's Magazine," and in her name, and afterwards incorporating them into the beginning of his poem "in compliment to the lady," he wrote both the poetry and the notes himself. The work was very popular for a time, and paid him well, but the famous parody by Canning, entitled "The Loves of the Triangles," suddenly caused its fame to collapse.

His next work was the strange medley of valuable facts and wild speculations, entitled "Zoonomia," published in 1794, which anticipates much in the writings of the French naturalist Lamarck. This is the work which contains an exposition of his views upon evolution and the origin of species. "Give me a fibre," he said, "susceptible of irritation, and I will make a tree, a dog, a horse, a man."

Robert Waring Darwin, third son of Dr. Erasmus Darwin by his first wife, was born at Lichfield on May 30th, 1766. He lost his mother when he was four years old, and his father acted towards him in his youth rather harshly and imperiously, and not always justly, the remembrance of which was never quite obliterated. We first hear of him in one of Josiah Wedgwood's letters, January, 1775: "I have two of Dr. Darwin's sons come to stay some days with me." And again, after his brother Charles's death, we find Robert styled "the young doctor," and as such invited over to Etruria to share with young John Wedgwood Waltire's private lessons in chemistry. "The boys," writes Wedgwood the potter, "drink in knowledge like water, with great avidity and quite to my satisfaction." Next we hear of him as a student at Edinburgh, where he took with honours his several degrees, and wrote with marked ability the necessary Latin thesis. Here he spent much of his time with the celebrated Dr. Black, of whose extreme simplicity of character and kindness of heart he often related anecdotes. He subsequently visited Paris, where he had familiar intercourse with the celebrated Benjamin Franklin, then in the height of his fame, and afterwards he travelled in Germany, and spent some time at the University of Leyden, where that polished scholar and eminent physician, Dr. Fryer, formed a close intimacy with him, and a lasting friendship subsisted between them.

In the year 1786 Robert settled down to a life-long practice as a physician in the ancient and picturesque town of Shrewsbury. Erasmus brought him to Shrewsbury before he was twenty-one years old, and left him £20, saying, "Let me know when you want more, and I will send it to you." His uncle also sent him £20, and this was the sole pecuniary aid he ever received. To a large portion (says Miss Seward) of his father's science and skill he joined all the ingenuous kindness of his mother's heart. His early abilities and their early *eclât* recompensed to his father a severe deprivation in the death of his son Charles. His practice during the first year allowed him to keep two horses and a man-servant. After he had been settled for only six months he had already between forty and fifty patients, and this was the more surprising because his professional rivals in the town were numerous, three physicians, six surgeons, and divers apothecaries. His father wishing his son to be an F.R.S., applied for aid to the elder Josiah Wedgwood, "It would be a feather in his cap, and might encourage him in philosophical pursuits." Robert wrote a paper upon "Ocular Spectra," in relation to some disorder which had attacked the elder Wedgwood's eyes, and this was said to be a clever production for the period. It was printed in the Royal Society's proceedings, and he was elected Fellow, chiefly through the influence of friends, in 1788.

In 1789 he wrote and published "An Appeal to the Faculty concerning the case of Mrs. Houlston," with reference to Dr. Withering, of Birmingham, who had been called in and supplanted him. The young Doctor Darwin's treatment, which his senior reversed, was considered by the profession to be right, and though the controversy was sharp, and his opponent a man of wide reputation, he seems to have had the best of it, and concludes his pamphlet by laughing at his opponent's pomposity and boasting.

His success was the more remarkable because for some time he detested the profession, and said that if he had been sure of gaining a hundred pounds a year in any other way he would never have practised as a doctor. Now, however, he was fairly and successfully at work; and he bought some fields on the Welsh side of the town, and built a plain and substantial family house, which, from its elevation, about a hundred feet above the River Severn, he named The Mount. It was close to Frankwell, one of the poorest parts of Shrewsbury, but the situation was exquisite in the extreme, and the view lovely. Here he spent the rest of his life.

In April, 1796, he married Susan, eldest daughter of the great English potter, Josiah Wedgwood, of Etruria. They had known each other from childhood, and their fathers had been as brothers. She brought him as fortune £25,000, but her higher fortune was a gentle sympathising nature. She entered zealously into all her husband's pursuits, and as he took almost as much interest as his father in botany and geology, their gardens and grounds became noted for the choicest shrubs and flowers. They petted and reared birds and animals; and the beauty, variety, and tameness of "The Mount pigeons," were well known in the town and beyond. When at home, his garden, greenhouse, and books afforded him never-failing pleasure and occupation, and all that was new and aggressive in literary thought found its way to The Mount.

Dr. Robert Darwin had an extraordinary memory for dates, and could tell the day of the birth, marriage, and death of most of the gentlemen of Shropshire. His spirits were generally high, and he was a good talker. One of his golden rules was never to become the friend of any one whom you could not thoroughly respect. Of all his qualities his sympathy was pre-eminent. He was quick to read character and to look a man through and through. He visited the poor without reward, and assisted them in other ways, sending fruit and vegetables, and in cases of sickness wine, to their homes. He occasionally made small loans to struggling tradesmen, and assisted them by giving work, and by recommending them to others.

After a long decline, his partner in life, Mrs. Darwin, died at The Mount, July 17, 1817, aged fifty-two years. Her remains lie in the chancel of the beautiful little church of Montford, four miles from Shrewsbury. After her death her daughters became their father's ministers, and aided him in all his labours. In the year 1823 he and they established the first infant-school in Shrewsbury, at the cost of about £300. It included a specially-erected school-house in a squalid district by the Welsh Bridge, which was furnished with the best apparatus for educational purposes.

For full fifty years his practice was wonderful. Like his father, he was always on the road. His small yellow carriage, within which, so exactly did it fit him, there was not an inch to spare, his two sleek horses, and his steady coachman, were to be seen everywhere. This, and his burly form and countenance, were known to every man, woman, and child over a wide extent of country. He was as much a feature of the town as the river, the abbey, and the schools. He always sat in his carriage as if carved in stone; unlike his father in this, that he was never reading, but with the same unimpassioned, mild, and thoughtful face inspiring confidence and respect. Dr. Erasmus Darwin was cast in a gigantic mould, but his son in a still greater. He stood more than six feet in height, his bulk was proportionate, and he became enormous as age increased. Like his father, he was a great feeder, eating a goose for his dinner as easily as other men do a partridge. In his latter days it was impossible for him to ascend or risk narrow staircases and rotten floors, and as both were common in the more ancient parts of Shrewsbury, a confidential servant was sent to make a survey beforehand.

In Dr. Robert Darwin the love of children was a striking feature. He would address them in his small, high-pitched voice, and occasionally lifting them on to a chair or table, he would measure their heads with his broad hand, as though reading character and mentally prognosticating their future fate. The writer of this sketch remembers well being taken by his father when a delicate child to Dr. Darwin's house to ask his advice. The kind doctor's prescription was, "You may have as many pies and puddings, apples and pears, as you can eat, and an egg every morning to your breakfast, but," he added, "you must eat the shell of it." This last proviso was not so palatable, still the prescription was for a long time obeyed to the letter, and the shell of every egg eaten up when the contents were finished. It was a quaint way of giving lime to make bone, and in keeping with the doctor's family motto, *E conchis omnia*. After this advice, when the child's father handed the usual guinea fee, Dr. Robert received it out of his right hand and put it back into his left with a pleasant laugh, saying, "Thank you, my friend."

He was often purchasing beautiful ware for his table from the works of his father-in-law Wedgwood; and so greatly did he feel the importance of making the mouth do its work before sending the food to the stomach, that he had a dinner-service made with the words printed round the border of each plate, "Masticate, denticate, chump, chew, and swallow." He also made a design for a nursery lamp for use in feeding children, which was manufactured in Etruria and had a large sale.

As to religion, he was, it would appear, like his father, a Theist. There was unhappily at that period little of true Christian life in the circles in which he moved. Still his religious opinions did not interfere with his practice, for his professional skill was universally felt and acknowledged, and in his private character, along with sagacity, he always evinced a winning benevolence and strong feelings of sympathy which made him widely beloved by poor and rich. Each day brought abundant work, and when it was got through and evening came, fatigue and drowsiness overpowered him. "Once on my remarking," says his son, "how greatly fatigued he seemed to be after his day's work, he answered, 'I inherit it from my father.'" At length when that long life's work was done—and it was a very long and hard one—his portly form vanished from the streets of Shrewsbury, and his remains were conveyed to the quiet resting-place at Montford, beside his favourite Severn. He died November 15th, 1848, aged eighty-two years. On the morning of his death, in the streets leading to his house, the lowest cottager had darkened his windows, and the children who morning after morning had left his house never empty-handed stood at their own doors weeping.

Charles Darwin, grandson of Erasmus, and son of Dr. Robert Waring Darwin, was born at Shrewsbury on February 12th, 1809. He attended the public grammar school at Shrewsbury for several years, under Dr. Butler, afterwards Bishop of Lichfield, and when sixteen years old he was sent to Edinburgh, where for two years he studied at the University, giving special attention to marine zoology. In 1828 he went to Christ College, Cambridge, and graduated B.A. in 1831, and M.A. in 1837. His hereditary aptitude for the study of natural science was early perceived by his instructors. The Rev. Mr. Henslow, Professor of Botany at Cambridge, recommended him to Captain Fitzroy and the Lords of the Admiralty, and in 1831, when a naturalist was wanted to accompany the second surveying expedition of H.M.S. Beagle in the Southern Seas, Mr. Darwin, having volunteered, was given the appointment. He served without salary, and partly paid his own expenses, on condition that he should have the entire disposal of his zoological and geological collections. On this long voyage, we are told, he was never able to overcome a tendency to sea-sickness, from which he suffered at times severely; but in spite of this drawback he persevered in his investigations. During the voyage, the greater part of the South American coast, the Pacific Islands, Australia, New Zealand, and the Mauritius were visited and examined. Before his return he was elected F.R.S. in 1834. He arrived in England October 2, 1836, and since then his entire life, so far as health has permitted, has been devoted to scientific researches. In 1839 a "Narrative of the Voyage of the Beagle" was published in three volumes, of which volume III, containing an account of the discoveries in natural history and geology, was contributed by Mr. Darwin. A second edition of this volume was published separately in 1845, entitled "The Voyage of a Naturalist." It is a most interesting and beautifully-written work. In 1839 Mr. Charles Darwin married Miss Emma Wedgwood, his cousin, the granddaughter of Josiah Wedgwood the potter, by whom he has a large family. He resided in London down to 1842, when he removed to his country house at Down, near Beckenham, Kent. Here he has led a quiet, retired, and uneventful life, pursuing his investigations with patient, persevering zeal, and under constant infirm health. Yet no scientific man has been so widely spoken of, owing to the important works which from time to time have issued from his pen. He is tall, bald-headed, with a fine beard and benevolent eye, but he is not corpulent like his father. In the year 1842 he published a work upon "The Structure and Distribution of Coral Reefs." In 1844 appeared from his pen, "Geological Observations on Volcanic Islands;" and in 1846 "Geological Observations on

South America." After numerous papers on scientific subjects, there appeared, in 1851 and 1853, his two volumes upon "The Family Cirripedia;" and soon after two other volumes on the Fossil Species of the same class. In 1853 the Royal Society awarded to him the Royal medal, and in 1859 he received the Wollaston medal from the Geological Society.

Mr. Charles Darwin is best known by his work, published by Mr. Murray, entitled "The Origin of Species by means of Natural Selection; or, the Preservation of Favoured Races in the Struggle for Life." In the introduction he tells us, "After five years' work I allowed myself to speculate upon the subject (that mystery of mysteries, the Origin of Species), and drew up some short notes. These I enlarged in 1844 into a sketch of the conclusions which then seemed to me probable. From that period to the present day I have steadily pursued the same object. My work is now nearly finished; but as it will take me two or three more years to complete it, and as my health is far from strong, I have been urged to publish this abstract."

This work created considerable stir, not only in the scientific but in the religious world. It speedily passed through several editions, and was translated into most European languages. "Natural Selection" became either a watchword or a byword. Caricatures of monkeys and gorillas developing into men filled the comic prints, and magazines and reviews, quarterly and monthly, abounded in articles *pro* or *con* upon the work. By its champions the rejection of the fashionable theory was regarded with scorn as the mark of ignorance and bigotry; by some who rejected it on religious grounds its espousal was branded as Atheism. The investigations of some eminent men of science led them to reject the hypothesis of Mr. Darwin as unsupported by facts. In particular Mr. W. Carruthers, F.R.S., Keeper of the Botanic Collection in the British Museum, and President of the Geologists' Association, has published the results of many years' inquiry, and affirms that the whole evidence supplied by fossil plants is opposed to Mr. Darwin's hypothesis of genetic evolution. Mr. Darwin's popular work upon the "Origin of Species" was followed by a succession of works in its support—the "Fertilisation of Orchids" in 1862, "Variation of Plants and Animals under Domestication" in 1867, the "Descent of Man, and Selections in relation to Race" in 1871. This last-named book reveals fully the bearing of the theory upon morals and religion, man's moral nature as well as his intellect and physical form being explained as a natural outgrowth from his ape-like progenitors. Here Mr. Darwin's avowed purpose is to show that man is certainly descended from some ape-like creature, and this not only as to his body, but as to his mind, conscience, and emotion. "In a series of forms graduating insensibly from some ape-like creature to man as he now exists, it would be impossible to fix on any definite point when the term 'man' ought to be used. But this is a matter of very little importance." "The so-called moral sense is aboriginally derived from the social instincts," which must have been acquired even by his early ape-like progenitors. To turn from this book of Mr. Darwin's to the Bible declarations concerning man in Genesis, Job, or the Psalms, is like passing out from the sickening air of a menagerie to a clear mountain top with its bracing breezes.

The large and varied crop of publications which Mr. Charles Darwin's theory has evoked is surprising, and in some respects amusing. The mere list of these books in the British Museum catalogue occupies forty folio pages, and includes a hundred and fifty different works. The titles of some of these may suffice to indicate their tone and tenour. "What is Darwinism?" by Dr. Hodge; "Moses, not Darwin," by B. G. Johns; "Darwinism refuted," by Laing; "Homo *versus* Darwin," by W. P. Lyon; MacCann's "Anti-Darwinism;" "Darwinism brought to Book;" "Difficulties of Darwinism," by the Rev. F. O. Morris; and many others.

Thus made notorious in the publications of the day, Mr. Charles Darwin has also been loaded with badges of honour by various scientific societies. He has been created a knight of the order *Pour le Mérite* by the Prussian Government, and in January, 1874, a Corresponding Member of the Academy of Vienna. The University of Leyden conferred upon him the honorary degree of M.D. in February, 1875, and the University of Cambridge gave him the honorary degree of LL.D. on November 17th, 1877. He was elected a Corresponding Member of the French Academy of Sciences in August, 1878.

As to religion, it must be noted that Mr. Charles Darwin speaks of the "ennobling belief in the existence of an Omnipotent God," but affirms that "the idea of a universal and beneficent Creator does not seem to arise in the mind of man until he has been elevated by long-continued culture." The question, however, whether it does or not, he reminds us is "wholly distinct from that higher one, whether there exists a Creator and Ruler of the universe; this," he continues, "has been answered in the affirmative by some of the highest intellects that have ever existed." The work upon the Origin of Species itself concludes with the observation, "There is a grandeur in this view of life, with its several powers, having been originally breathed by the Creator into a few forms or into one."

In his brief memoir of his grandfather, moreover, Mr. Charles Darwin indignantly repels the surmise that Dr. Erasmus was an Atheist; and this, together with other observations scattered through his works, fairly shows that he moves in religious belief upon much the same lines as his father and grandfather. The expression "Natural Selection," which he has introduced in preference to "Survival of the Fittest," does not exclude belief in a Divine Creator, Designer, and Sustainer of all.* It may be employed to denote, not a *cause*, but a *law* according to which He works. For instance, the astronomer who understands the law of attraction regulating the movements of the heavenly bodies, need not reject, he may adopt, and may feel more fully and deeply than the devout but unlettered shepherd could, the truth and beauty of the psalmist's words, "The heavens declare the glory of God, and the firmament sheweth His handiwork." And in like manner the naturalist, who believes that he can trace the working of a simple and general law of selection in the vegetable and animal kingdom, need not of necessity reject, but may, with intelligence and reverence deeper far, take up the same inspired psalmist's words, "Let every thing that hath breath praise the Lord. I will praise Thee, for I am fearfully and wonderfully made: marvellous are Thy works, and that my soul knoweth right well."

* This does not, however, go beyond a mere natural religion. Hugh Miller, in reviewing the kindred views of Lamarck, has shown them to be incompatible with revealed religion.—ED. L. H.

THE "Fifteen Puzzle" has again directed attention to the so-called "Arithmetical Squares." The subject is a very old one. A learned volume, "Die Propaedeutik der Araber," by Dr. Friedrich Dieterici, of the University of Berlin, which informs us of the arithmetic, geometry, astronomy, geography, and music of the Arabs in the tenth century, gives the magic squares of 3^2, 4^2, 5^2, and 6^2, as known to them, and states that 7^2, 8^2, and 9^2, were treated in the like manner. These four squares (combining arithmetic and geometry) are:—

2	7	6
9	5	1
4	3	8

4	14	15	1
9	7	6	12
5	11	10	8
16	2	3	13

21	3	4	12	25
15	17	6	19	8
10	24	13	2	16
18	7	20	9	11
1	14	22	23	5

11	22	32	5	23	18
25	16	7	30	13	20
27	6	35	36	4	3
10	21	1	2	33	34
14	19	8	29	26	15
4	17	28	9	12	21

In the Arabic manuscript is also a reference to the usefulness of the square of 1 to 81, and then there follows a description of the movements of the pieces in the game of Chess.

The papers which we published last year ("Leisure Hour," pp. 255 and 414), have brought us many letters, with suggestions and additional specimens, but we can give now only the following supplementary notes, and must not again return to the subject.

D. P., of Brechin, says:

I forward a plan whereby the 64 numbers can be so arranged that the sums of each row, horizontal, perpendicular, and diagonal, shall amount to 260.

First, having made three squares of 64 compartments, place the first 8 units in the first row, in any order, providing only that each pair of squares, equidistant from the middle, shall amount to 9; in the second row reverse the order; in the third repeat the first; in the fourth repeat the second; in the fifth repeat the fourth; and then continue the alternation to the close (see first square). Secondly, take the multiples of 8, beginning with 0; as 0, 8, 16, 24, 32, 40, 48, 56. Arrange these in the first perpendicular row of the second square, so that each pair equidistant from the middle shall amount to 56. Then follow the same order of alternating and repeating towards the right as was followed downward in the first (see second square). Lastly, add together the numbers in the corresponding compartments of the two former squares, and the problem is solved (see third square).

1st.

2	4	3	1	8	6	5	7
7	5	6	8	1	3	4	2
2	4	3	1	8	6	5	7
7	5	6	8	1	3	4	2
7	5	6	8	1	3	4	2
2	4	3	1	8	6	5	7
7	5	6	8	1	3	4	2
2	4	3	1	8	6	5	7

2nd.

8	48	8	48	48	8	48	8
24	32	24	32	32	24	32	24
16	40	16	40	40	16	40	16
0	56	0	56	56	0	56	0
56	0	56	0	0	56	0	56
40	16	40	16	16	40	16	40
32	24	32	24	24	32	24	32
48	8	48	8	8	48	8	48

3rd, completed square.

10	52	11	49	56	14	53	15
31	37	30	40	33	27	36	26
18	44	19	41	48	22	45	23
7	61	6	64	57	3	60	2
63	5	62	8	1	59	4	58
42	20	43	17	24	46	21	47
39	29	38	32	25	35	28	34
50	12	51	9	16	54	13	55

The old method for *uneven* numbers shall be shown here for $7^2=49$; it holds good for all others: $3^2=9$, $5^2=25$, $9^2=81$, $11^2=121$, $13^2=169$, $15^2=225$, etc.

22	47	16	41	10	35	4	
5	23	48	17	42	11	29	5
30	6	24	49	18	36	12	
13	31	7	25	43	19	37	13
38	14	32	1	26	44	20	
21	39	8	33	2	27	45	
46	15	40	9	34	3	28	
22		16		10		4	

Write the middle number, $\frac{1+49}{2}=25$ in the centre; the smallest, which is 1, under it; fill up the diagonal down to the right; carry 4 to the top; continue in the diagonal as before; carry 5 to the left; fill up the diagonal; after 7 go two squares down; from 8 to 10 again the diagonal; carry 10 again to the top, and so on; 22 is carried to the top; after 28 go two steps down, which is the square under the right top corner, under 4.

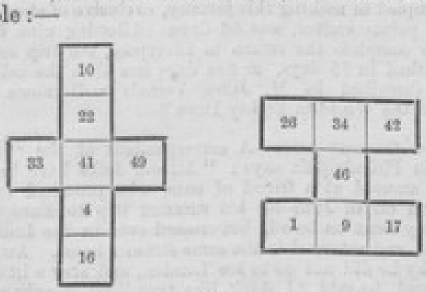
The following are from Wm. Jeffrey, of Belfast:

Square 1 to 49—to add to 175.

14	15	23	31	39	47	6
26	34	42	43	2	10	18
38	46	5	13	21	22	30
1	9	17	25	33	41	49
20	28	29	37	45	4	12
32	40	48	7	8	16	24
44	3	11	19	27	35	36

Any seven numbers in a straight row add to 175.
Any diagonal line containing less than seven numbers, will, if added to the seventh parallel line, amount to 175.

Any of the fifteen standing crosses of seven numbers each, and any of the fifteen groups resembling a letter H, thrown on one side, will add 175; for example:—



The table is radiant; any three pairs of opposite numbers added to the centre number amount to 175.

Among the nine circles around the centre there are six of four numbers which add 100, and three of eight numbers which add 200 each.

Notice that the numbers 1, 9, 17, 25, 33, 41, 49 in the central horizontal line are progressive by 8; and so they are in the following diagram progressive by 10 from 1 to 81.

Square 1 to 81—to add to 369. Table No. 4.

77	60	67	26	9	16	47	30	37
20	3	10	50	33	40	80	63	70
53	36	43	74	57	64	23	6	13
58	68	78	7	17	27	28	38	48
1	11	21	31	41	51	61	71	81
34	44	54	55	65	75	4	14	24
69	76	59	18	25	8	39	46	29
12	19	2	42	49	32	72	79	62
45	52	35	66	73	56	15	22	5

Any nine numbers in a straight row will add 369.

Any diagonal line containing less than nine numbers will, if added to the ninth parallel line, amount to 369.

Any square group of nine numbers add 369.

The table is radiant; any four pairs of opposite numbers added to the centre number amount to 369.

Sequence 1 to 144—to add 870.

2	144	45	99	6	140	41	103	10	136	37	107
71	73	28	118	67	77	32	114	63	81	36	110
100	46	143	1	104	42	139	5	108	38	135	9
117	27	74	72	113	31	78	68	109	35	82	64
14	132	57	87	18	128	53	91	22	124	49	95
50	85	16	130	55	89	20	126	51	93	24	122
88	58	131	13	92	54	127	17	96	59	123	21
129	15	86	60	125	19	90	56	121	23	94	52
26	120	69	75	30	116	65	79	34	112	61	83
47	97	4	142	43	101	8	138	39	105	12	134
76	70	119	25	80	66	115	29	84	62	111	33
141	3	98	48	137	7	102	44	133	11	106	40

Each of the twenty-six straight lines which contain twelve numbers will add 870.

Any diagonal line added to its twelfth parallel line will amount to 870. Twenty-two such combinations can be formed.

Forty-nine diagonal crosses containing twelve numbers can be formed, and each add 870.

Eighty-one groups which will add 870 can be arranged thus: 144, 45, 71, 73, 28, 118, 100, 46, 143, 1, 27, 74.

Eighty-one square circular lines of twelve numbers can be formed, each of which will add 870, one of the lines being 2, 144, 45, 99, 118, 1, 72, 74, 27, 117, 100, 71.

There are one hundred and twenty-one groups of four numbers standing together, and any three of such groups will add 870.

A simple method for the construction of a square of eights is suggested by H. A., and also by R. S., of London. The transposition by which they complete their square will be best seen by a comparison of the two below. First write the numbers 1 to 64 in their natural order, distinguishing the alternate figures in the several quarters, as marked.

1	2	**3**	4	5	**6**	7	**8**
9	**10**	11	**12**	**13**	14	**15**	16
17	18	**19**	20	21	**22**	23	**24**
25	**26**	27	**28**	**29**	30	**31**	32
33	**34**	35	**36**	**37**	38	**39**	40
41	42	**43**	44	45	**46**	47	**48**
49	**50**	51	**52**	**53**	54	**55**	56
57	58	**59**	60	61	**62**	63	**64**

Now compare the square as transposed:—

1	63	**3**	61	60	**6**	58	**8**
56	**10**	54	**12**	**13**	51	**15**	49
17	47	**19**	45	44	**22**	42	**24**
40	**26**	38	**28**	**29**	35	**31**	33
32	**34**	30	**36**	**37**	27	**39**	25
41	23	**43**	21	20	**46**	18	**48**
16	**50**	14	**52**	**53**	11	**55**	9
57	7	**59**	5	4	**62**	2	**64**

A. T. S. sends this simple arrangement:—

1	2	3	4	61	62	63	64
60	59	58	57	8	7	6	5
56	55	54	53	12	11	10	9
13	14	15	16	49	50	51	52
17	18	19	20	45	46	47	48
44	43	42	41	24	23	22	21
40	39	38	37	28	27	26	25
29	30	31	32	33	34	35	36

A correspondent in the "English Mechanic" of September 8, 1876 (vol. xxiii. p. 669), gave this:

"Write the numbers in a natural square—that is, in their arithmetical order. In the middle of this square rule out a square of four numbers in a side, and produce the lines to cut off the corners of the square. The numbers thus cut off in the middle and at the corners of the natural squares remain the same in the magic squares. Each of the other numbers change places with what may be called its complement—that is, the number exactly opposite to it, and which, together with it, makes up $65 = n^2 + 1$. Thus:—

1	2	62	61	60	59	7	8
9	10	54	53	52	51	15	16
48	47	19	20	21	22	42	41
40	39	27	28	29	30	34	33
32	31	35	36	37	38	26	25
24	23	43	44	45	46	18	17
49	50	14	13	12	11	55	56
57	58	6	5	4	3	63	64

Varieties.

Fresh Air.—Dr. Robert Darwin, son of the celebrated Erasmus Darwin, and father of the equally celebrated Charles Darwin, was a strong advocate for plenty of fresh air. To a young man who consulted him before emigrating to America, the doctor said, "When in Paris many years ago, I one day met in the street the celebrated Benjamin Franklin, and he said to me, 'People have been a thousand years finding out that fresh air is good for the sick. They will be another thousand finding out that it is good for those in health.' Now," said Dr. R. Darwin to the young man, "my advice is, when you go to America, *sleep with your window open.*" The advice may be excellent in some circumstances, but might be disastrous in others.

Value of Land in London.—At a recent sale by direction of the First Commissioner of her Majesty's Works, premises in Seething Lane, Tower Street, were sold by auction at the Mart at £4 17s. 4d. per square foot, or at the rate of £211,992 per acre. There were also sold, by direction of the Court of Chancery, ten freehold houses in Ely Place, Holborn, occupying together about 13,412 feet, all with vacant possession, the leases granted ninety-nine years ago having expired. The total amount of sale was £34,570, being at the rate of £2 11s. 6d. per square foot, equal to £112,167 per acre.

Round the World in Seventy-five Days.—Mr. Ismay, senior partner in the firm of Ismay, Imrie, and Co., proprietors of the White Star Line of European steamships, recently arrived in New York, with his wife and family, after an extraordinary voyage. Leaving Liverpool on the 13th of March last in the steamship Oceanic, they successively visited Suez, Point de Galle, Singapore, Hongkong, Canton, Shanghai, and Yokohama. The last-named port they left on June 6 for San Francisco. When they arrived at New York they had travelled 22,320 miles. The time occupied in making this journey, exclusive of stoppages at different points visited, was 66 days. Allowing nine days in which to complete the return to Liverpool, the trip could be accomplished in 75 days, or five days less than the celebrated journey described in M. Jules Verne's well-known story, "Around the World in Eighty Days."

Seeing George off.—A correspondent of the "Leisure Hour" in Philadelphia says: "All our folks have been immensely amused at a friend of ours, who promised to see a companion off in June for his summer trip to Europe. He not merely went on board, but crossed over in the Indiana to Liverpool, and returned in the same steamer home. And when asked why he did not go to see London, and stay a little time in England, he said, 'I don't like travelling, I only went to see George off.' He is a man of leisure and of large means, but something like myself, too lazy to travel."

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PRESS NOTICES.

THE REALIZATION OF AN ANCIENT DREAM.

"Oh wad the power some giftie gie' us
To see oursels as ithers see us."— ROBERT BURNS.

SCIENCE is a much-needed periodical, admirably edited and managed, and steadily growing in interest and usefulness. It deserves a large constituency, and we have no doubt that it is gaining one. — *Christian Union.*

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People who like to read of scientific progress, whether as professionals or lawyers, would do well to acquaint themselves with the merits of the weekly publication known as SCIENCE. This magazine or review contains the freshest scientific information of the day. Its comment and criticism is both full and brief, and its articles are always seasonable. Its Paris letter reviews the condition of scientific thought abroad, and its notes and letters to the editor, together with the so-called "supplement," go to make up an excellent weekly scientific budget. — *Bucks Co.* (Penn.) *Intelligencer*, June 19, 1886.

In a brief notice of SCIENCE last week, that excellent publication is mentioned as being adapted to the wants of both "professionals and lawyers." Of course, it should have been printed "professionals and laymen." Those chronic little sinners, the types, played the trick. This week's copy of SCIENCE, now before us, discusses some of the questions relating to butterine, or artificial butter. The Imperial Health Office at Berlin has recently made a report on the subject. The whole matter has been pretty fully reviewed in recent issues of SCIENCE. We mention this merely to show the practical kind of information that fills the pages of this publication. It is a magazine that might well find a place upon the desks of our most progressive and wide-awake school-teachers, for it is brimful of information and suggestion. — *Bucks Co.* (Penn.) *Intelligencer*, June 26, 1886.

The value of this comprehensive scientific weekly to the student, the scientific worker, the manufacturer, and to the whole of that large and daily-growing class to which scientific knowledge is a necessity, can hardly be over-estimated. With this month (June) closes the seventh volume, and the public will be glad to learn that the publishers intend to so enlarge the scope of the journal as to keep its readers *au courant* with the progress of scientific investigation in all its fields. The article on artificial butter, of which we gave a summary; the map of the oil and gas wells of Ohio in the last number; the letters from correspondents at London, Paris, Vienna, St. Petersburg, Tokio, and elsewhere; the important papers on economics from such men as Sumner, Newcomb, Ely, and Seligman; and the excellent reviews and comments, — give evidence of the wide range of investigation and discussion dealt with in SCIENCE. No student, business or professional man should be without it. — *Montreal Gazette*, July 6, 1886.

Julian Hawthorne, son of America's greatest novelist, and himself an author and critic of whom his country is by no means ashamed, gives the following extended abstract of one number of SCIENCE in his column of "Literary Notes" in the *New York World* of June 18, 1886: "SCIENCE publishes a good number this week. We learn from it that the brain of the unfortunate King of Bavaria has been examined by six German physicians, who found signs of degeneration, some of old standing, others recent. This confirms the fact of his insanity, and in so far discredits the sensational rumor that he was murdered.— Dr. Dowdeswell claims to have found the germ of hydrophobia in the central canal of the spinal cord and in the medulla oblongata. — O. T. Mason of the United States National Museum, gives an account of 'The planting and exhuming of a prayer,' by Wa-Wah, the Zuñi priestess, in Washington. It is a curious affair, and is illustrated by a double-page wood-engraving. — Dr. McKee, at a recent meeting of the Ohio State Medical Society, maintained the opinion that consanguineous marriages are not followed by evil effects upon the offspring. — There are some forty cases on record of men who were ruminating animals (physically, not mentally). The process is in all its steps essentially the same as in other ruminating animals, and generally occurs in those who are large eaters, — a provision of nature, apparently, to secure more thorough mastication in those who eat to excess, or do not take the trouble to chew their food properly in the first instance.— Evidence is accumulating that ether is a safer anaesthetic than chloroform, but as a local anaesthetic aniline-oil is being used with excellent results. — Experiments by MM. Regnard and Loye of Paris tend to show that conscious life ceases immediately upon decapitation of the human subject. — The passage of the Suez Canal is now made in sixteen hours, instead of forty-eight, as formerly. Vessels are fitted with an electric-light apparatus, and are therefore able to travel by night as well as by day. — It is calculated that it would take from fifty to one hundred years, under favorable conditions, to flood the Sahara desert; but it is highly probable that the water would evaporate as fast as it was admitted."

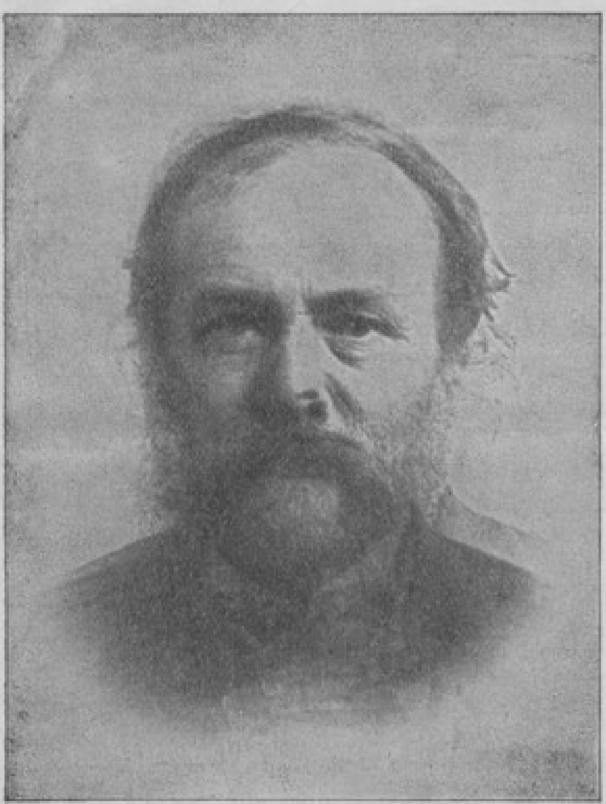


Fig. 1.—Twelve mathematicians.

Fig. 2.—Sixteen naturalists.

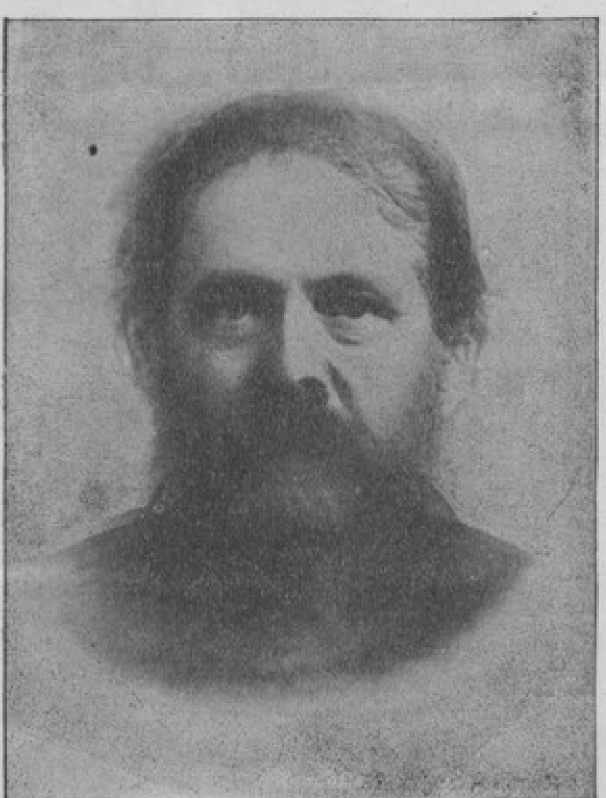


Fig. 3.—Thirty-one academicians.

Fig. 4.—Twenty-six field-geologists, topographers, etc.

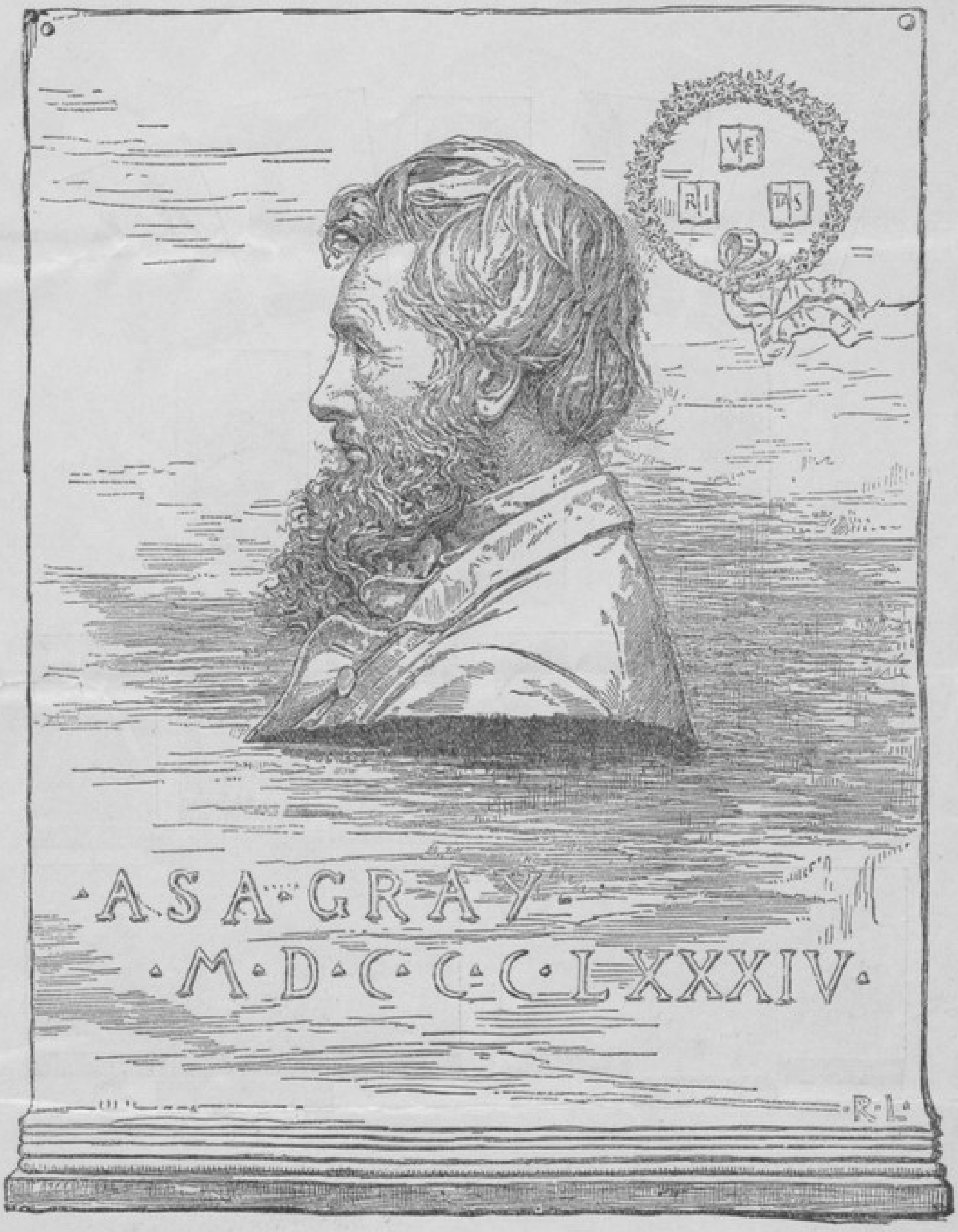
COMPOSITE PORTRAITS OF AMERICAN SCIENTIFIC MEN.

SCIENCE, May 8, 1885.

SCIENCE, July 9, 1886.

BURYING A PRAYER IN WASHINGTON: A REMNANT OF AN EXPIRING WORSHIP.

SCIENCE, October 16, 1885.



SCIENCE, *May* 29, 1885.

THREE NEW PORTRAITS OF WASHINGTON.

SCIENCE, December 11, 1885.

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Volume VII. No. 170 May 7, 1886

Composites of Amer: Indians

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SCIENCE.

FRIDAY, MAY 7, 1886.

COMMENT AND CRITICISM.

THE STATEMENTS of the report and conclusions of Mr. Allison's commission, which have appeared in the public prints, and were partially reproduced in our last number, we learn, on good authority, to be premature in several respects. The fact is, that the commission has not finally formulated either a bill or a report, and may not do so for a week or more. What it has done is to vote on certain general conclusions; to direct its members to draw up reports expressing the views of the commission, or those of the individual members, on points in which they were a minority; to authorize the members to introduce bills expressing their individual views; and to remove the seal of secrecy from the proceedings. In reaching general conclusions, the commission, by a vote of four to two, decided to make no change in the coast survey, and it is not even believed that any legislation defining its work will be formally recommended. The members are unanimously of opinion that the policy of the signal office should be moulded with a view of erecting it, at no distant day, into a civil bureau, but on the question of making the change immediately they are equally divided. They are opposed to the school of instruction at Fort Myer, as now conducted, and, it is said, to what is known as the study-room in Washington. In the matter of the geological survey, they are of opinion that its operations should be restricted by law in the direction indicated by Mr. Herbert's bill, mentioned in our last number, but are not yet agreed upon all details.

All parties will agree that this is a very lame conclusion of two years of such careful investigation as has been bestowed upon this subject by the commission. The only parties that can be pleased are those who, knowing how broad and easy is the road to bad legislation, and how narrow the path to that which is good, will be grateful that more harm has not been done. The most curious feature of the conclusion is, that the complaints which gave rise to the investigation appear to have been only lost sight of; and the only organization which comes in for serious condemnation is one against the integrity of which no charge has ever been made, except to be refuted. It is now conceded by all disinterested parties, including the members of the commission, that the geological survey has been conducted with the highest ability and integrity, and in accordance with the laws making the appropriations for its support. The ground of complaint is, that it has undertaken too wide a range of geological and allied investigation, not pertaining to its proper functions; that it has secured political support by employing a large body of scientific men scattered over the country in these investigations, and has put the government to great expense in printing the results of such work. Paleontological research seems to have come in for the largest share of condemnation; mainly, we suppose, on the authority of Professor Agassiz, who claims that such research is not a proper function of public geological survey.

On the merits of so broad a question as this, including innumerable details within its scope, it would be unwise to pass a summary judgment. The views expressed in Mr. Herbert's report form, however, a legitimate subject of examination. If correctly reported in the public prints, they are not characterized by judicial impartiality and fairness of statement. For example: he gives what professes to be an exhibit of the cost of the geological surveys in nearly a dozen different countries, so widely separated as Canada, Japan, and Victoria, without any statement of the considerations which determine their selection, and finds that the aggregated cost does not exceed that of our own geological survey. But he gives no definition of the objects and limitations of these various surveys with a view of determining to what extent they are identical with our own. We believe, that, as a matter of fact, the geological survey of England has been completed for some time, and that the work now done, on the small cost of which Mr. Herbert lays stress, is not properly a survey at all. An advocate of the other side might with equal fairness have taken the cost of all the surveys now in progress in

England, and shown that that country alone appropriates twice as much for its surveys as we do. Again, a list is given of some seventy persons having other employments; most of them being college professors, who have been employed by the geological survey. The report fails to state that this list is in no way a list of employees, but a complete list of persons who at some past time have received one or more payments from the survey, for some special service rendered, without being in any way permanently connected with it or salaried by it. It is clear that a final conclusion cannot be drawn from statements like this until the other side is heard.

IN THE JANUARY NUMBER of the *Nineteenth century*, Mr. Frederic Harrison published an article on the practice, now so common, of spelling foreign and ancient names as they are spelled in the original tongues, even in cases where an anglicized form of the name has been long in use. He spoke particularly of the re-writing of familiar Greek names in conformity with the original spelling, and also of the names of persons and places in the earliest history of England. This practice he characterizes as 'a pedantic nuisance,' and makes some very good points against it. He remarks that "'Alfred,' 'Edward,' and 'Edgar' are names which for a thousand years have filled English homes and English poetry and prose. To re-write these names is to break the tradition of history and literature at once;" and he speaks in the same way of the re-writing of familiar Greek names. He also asks where the practice is going to stop, and thinks "we shall soon be invited to call 'Moses,' 'Môsheh,' as his contemporaries did; 'Judah' should be written Yehûda;' 'Jacob' will be 'Ya'aqób;' and 'Jesus' will be 'Jehoshua.' In short, Mr. Harrison condemns the practice in unqualified terms, on the ground that it violates the established usage of English literature without conferring any compensatory benefits.

To this article of Mr. Harrison's, Mr. E. A. Freeman has replied in the April number of the *Contemporary review*. Mr. Harrison had spoken of Mr. Freeman as one of the worst offenders in the matter in question, and the historian's reply is little else than a personal vindication of himself. Viewed in this light, his article is more or less successful, and he convicts his opponent of some mistakes and inaccuracies. But, as a defence of the practice that Mr. Harrison condemns, we are obliged to say that Mr. Freeman's reply is unsatisfactory. Indeed, he doesn't argue the main question at all, but treats the matter as little more than a personal affair between himself and Mr. Harrison. This is disappointing; for the question involved is one that greatly needs a final settlement, and such a settlement can only be reached on some ground of principle. The question is, whether we are to write all foreign names as they are written in the original languages; and, if not, then what ones we are to write in that way, and what ones are to be anglicized. Mr. Harrison shows that the writers he criticises are not at all consistent with themselves; and Mr. Freeman virtually admits that his own practice is not consistent, and that he doesn't follow any general rule. He says that he writes 'Aelfred' and 'Eadward' because he finds these names so written in the ancient authorities; but, nevertheless, he writes 'Rochester' and 'Canterbury,' although the old forms of these names are 'Hrofesceaster' and 'Cantwarabyrig.' He says, too, that he writes 'Buonaparte,' pronouncing the word in four syllables, for the reason that he learned to do so in his childhood, which strikes us as no reason at all. We hoped, when we took up Mr. Freeman's article, to find him laying down some definite rule or principle which might serve as a guide to all writers in this perplexing matter; and we are disappointed at finding that he does not even attempt to do so.

STORIES OF THE OCCURRENCE OF PETRIFIED FLESH, or of frogs and toads enclosed in solid rock, and other fables of the same nature, frequently appear in the daily and weekly papers. One not dissimilar, though vastly more absurd, of the finding of two living bats embedded in a solid lump of bituminous coal, from a coal-mine in Maryland, is now going the rounds, and will probably not rest till the press from Maine to California has given publication to it. There was said to have been no crevice admitting the entrance of these wonderful bats, and that there was a clearly formed impression left by them. The inference, no, the only 'conclusion,' is, that these hoary chiropterans are living remnants of the coal-forming age. It was not long ago that just such a story was told of an ancient toad in another coal-mine, only this time the carboniferous batrachian had become, as was naturally expected, very much desiccated. It is very strange with what persistence such myths and fables retain their hold on popular credence. Men of high intelligence will aver their belief in petrified human bodies, and we have known a shrewd business-man to exhibit what he firmly believed was a large mass of fossil buffalo flesh, sinews, muscles, blood and all. What more natural thing could there be than the finding of a toad or bat, dead, hibernating or active, in the crevices of a coal-mine? and yet, doubtless, to one wholly unacquainted with geological and zoölogical principles, a carboniferous fossil fish or living bat seems equally inexplicable and wonderful. Such fanciful flights of imagination might pass unnoticed, were they not so industriously circulated in the columns of even the highest class of metropolitan newspapers.

THE COAST SURVEY AND THE NAVY.

The latest argument for the transfer of the coast survey to the navy department is embodied in a paper by Lieutenant Dyer, U. S. N., recently published in the Proceedings of the U. S. naval institute. A very slight examination of this production shows that the author travels over an easy and well-trodden path instead of grappling with the real difficulties of the question. Nothing is easier than to demonstrate to the satisfaction of any writer who chooses to espouse the cause, that the coast survey ought to be turned over to the navy department. If nothing more were necessary than a "Be it enacted, etc., that the hydrographic work of the coast survey shall be transferred to the navy department," the problem would be a very simple one. It is to this simple form of it that all the arguments heretofore brought forward by the navy department have been directed.

Fault can be found with every system of public administration; and the thought, "How much better we could manage things if congress would put us in charge of them!" will be prevalent so long as human nature remains as it is. The real difficulties of the question begin when we attempt to decide just what work, what records, and what appliances shall be transferred to the navy department, and how the navy department shall utilize the appliances and carry on the work. One difficulty met with at the very start is found in that custom of the naval service which requires that almost every officer, certainly every young and energetic officer, shall change his duty at the end of every three years. Howsoever well a cadet at Annapolis may be trained in the theory of marine surveying, he cannot possibly acquire at the academy that experience in practical work of any kind which is necessary to its effective prosecution. His first year, perhaps his first two years, in the work of the survey, would be very largely taken up in learning how to do it, so that he would hardly have become an expert before he must leave to keep watch on board a ship of war. Of course, we refer here to the more difficult and technical work of chart-construction, and not to such matters as running a line of soundings. It would therefore be a necessity of the service that a permanent corps of skilled map-makers should be organized, or that a part of the existing corps should be transferred. Even then it would be contrary to naval custom to allow these civilian assistants to hold any other than subordinate positions; and all branches of the direction, from the head of the office down, would be intrusted to men who were continually changing.

This is a consideration which would have to be kept in view in deciding what work should be transferred. One important function of the survey is the study of the effect of tidal and other action upon harbors. We all know that most of our harbors are in a continual state of change; and the study of the causes of such changes can be effectively prosecuted only by experts who make it a considerable part of the business of their lives. Can the navy be relied upon to furnish such experts? Tidal observations at numerous points along the coast form an essential part of the work. Will they be effectively kept up under the continual changes of naval administration? Can the records of the coast survey which pertain to hydrography be separated from the others and transferred to another department without any inconvenience? If not, can the navy department get along without them, and not waste labor in repeating work already done? Can a portion of the draughtsmen and engravers be transferred, or must new men be employed in their places?

We suggest these questions, not claiming that their solution presents insurmountable difficulties, but only as showing where discussions should be directed in order to be effective. Such general considerations as Secretary Chandler and the naval officers have presented on the subject may be very effective in starting people to think about it, but can never suffice to show what policy should be adopted. To demonstrate what ought to be done is one thing; but to show how to do it is, as all practical men know, a very different and generally a much more difficult thing. We hope, therefore, that if our naval friends, for whose professional ability *Science* entertains the highest respect, really desire the transfer, they will present such a detailed plan of proceeding from beginning to end, that every one shall be able to understand and criticise it. Until they do this, they must not expect to excite congress to action.

We may add one general consideration. A considerable number of naval officers are actually engaged in coast-survey work. Is not their work as effectively performed under the present system as it would be if the navy department had charge of it? What would the officers themselves, or the navy at large, gain by the transfer? We are aware that Secretary Chandler considered it a very great hardship that officers should be removed from the immediate control of the department to which they belong. But where does the real evil come in? These questions must be answered, and the public benefit to be gained by the change must be made clear, before the project can receive the really effective support of scientific men. The latter are not disposed to prejudge the question, but before supporting the measure they want to be satisfied of its practical advisability; and this can be done only by the advocates of the change fully considering such questions as those above suggested.

COMPOSITE PORTRAITS OF AMERICAN INDIANS.

ON the plate accompanying this number is given, so far as known, the first presentation of composite portraits taken of North American Indians.

No. 1 is of three full-blood Dakota or Sioux young women belonging to the band commonly known as the Brulé, and living at the Crow Creek agency, Dakota territory. Their ages range from nineteen to twenty-three years. Their average height is five feet six inches and a half; their average weight, a hundred and forty-one pounds. This composite is made from photographs taken on the same day and in rapid succession. On the same afternoon, composite No. 2 was taken from the same persons, each one sitting her allotted seconds before the camera. In No. 1 and No. 2 the order of the faces is identical, and care was exercised to try and procure similar results in the portrait; but, as will be observed, the composites are different. The controlling face in No. 1 is given in picture No. 3, which was the first photograph to be exposed in making up composite No. 1. The dominant face in No. 2 is given in picture No. 4. It belonged to the last sitter, and her photograph was the last one exposed in making composite No. 1. In two composites similarly made, of Omaha women, the one from sitters varies in a like manner from the one made up from photographs, only in a different order. In the one from life the broad face of the last sitter controls the composite, and in the other the long face of the first photograph influences the picture. This variation of composites made from the same faces — one taken from life, the other from photographs — is mentioned for what it may be worth.

A composite of Omaha men, a cognate tribe, differs but little from a Dakota composite, except in the eyes. In the Omaha composite the eyes are larger and fuller. The height and breadth of head, the strong but not unduly heavy lower face, are noticeable in both Omahas and Dakotas. A composite of Omaha women does not differ in any marked manner from the Dakota portrait. In both the pictures of the women, there is to be observed a similar variation between the female and the male of the same tribe, notably in the shape of the head, and the greater prominence, proportionally, of the cheek-bones in the women's faces.

It is premature to judge of the value of composite portraits. They are certainly curious and interesting, and many points will occur to the observer of these Indian faces. In a general way, they seem to confirm the results of a close study of the home-life and the various customs, including the most savage rites of war and religion, made by the writer among this family of Indian tribes, by showing them to be a people, intellectual rather than brutal, unawakened rather than degraded. The portraits indicate the stamp of tribal fixity, and reveal the unconsciousness within the individual of the analytical powers of mind by which man masters nature, — a peculiarity which is the key to much in Indian sociology and religion.

The writer is indebted to Mr. Jenness Richardson of Washington, D.C., for the making of the composites. ALICE C. FLETCHER.

GEOGRAPHICAL NOTES.

Siberian trade-routes. — The practical failure of the route by sea has stimulated the search for routes of inland communication between Russia and Siberia. The latest investigations are those be-

FIG. 1.—COMPOSITE FROM PHOTOGRAPHS.

FIG. 2—COMPOSITE FROM DIRECT SITTINGS.

FIG. 3.—RULING FACE IN FIG. 1.

FIG. 4.—RULING FACE IN FIG. 2.

COMPOSITE PORTRAITS OF THREE DAKOTA WOMEN, SHOWING THE EFFECT OF THE METHOD OF PRODUCTION.

SCIENCE, May 7, 1886.

SCIENCE.

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