PROCEEDINGS

OF THE

ROYAL IRISH ACADEMY

VOLUME XXVIII

DUBLIN: HODGES, FIGGIS, & CO., LTD.
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SECTION A.—MATHEMATICAL, ASTRONOMICAL, AND
PHYSICAL SCIENCE.

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CONTENTS

SECTION A.—MATHEMATICAL, ASTRONOMICAL, AND PHYSICAL SCIENCE.

ERRATA.

SECTION A.

Page 16, line 14, *for* $\frac{\partial}{\partial p_1} + \frac{\partial}{\partial p_2} + \ldots + \frac{\partial}{p_n}$ *read* $\frac{\partial}{\partial p_1} + \frac{\partial}{\partial p_2} + \ldots + \frac{\partial}{\partial p_n}$

Page 19, line 4 from bottom, *for* movement *read* moment

Page 20, line 15, *for* $\left(\dot{a}^2 p_a^2\right)$ *read* $\left(\dot{a}^2 p_a^2\right)^{\frac{1}{2}}$

PROCEEDINGS

OF

THE ROYAL IRISH ACADEMY

PAPERS READ BEFORE THE ACADEMY

I.

ON THE MOTION OF AN ELECTRIFIED SPHERE.

By ARTHUR W. CONWAY, M.A. (Oxon. and R.U.I.), D.Sc.,

Professor of Mathematical Physics, University College, Dublin.

Read December 13, 1909. Ordered for Publication January 12. Published February 24, 1910.

CONTENTS.

I.—Introduction and Summary.

In this Paper the following problem is dealt with:—A sphere perfectly conducting and supposed not to be subject to a Lorentz-Fitzgerald shrinkage is charged and moved in any field: required the distribution of electricity on its surface. It was shown long ago by Searle that, if its velocity was uniform, the surface-density remained uniform; and an important paper by Walker,* dealing with several cases of initial motions, was sufficient to show the complexity of the problem. In any field of force, and for any state of motion, there is an infinite number of solutions, namely, the simplest solution and the solution due to the free oscillations of the sphere. In all cases the current on the sphere can be divided (in a hydrodynamical sense) into an irrotational and a rotational current. These give rise to two classes of functions which we term *harmonicoid* functions of the first and second type respectively. These functions are generalized forms of similar functions employed by Lamb, Love, and others in the problem of the fixed sphere.

* G. W. Walker, Proceedings of the Royal Society, vol. lxxvii, p. 260.

They consist of infinite series the first term of which is in each case the corresponding term for the fixed sphere. The solution obtained here consists of a method of approximating to as many terms as we please to the surface-density arranged in descending powers of c, the velocity of radiation. Quaternion notation and electromagnetic or electrostatic units are employed. The latter units are much more convenient for this problem and generally in electronic investigations than the "rational" units employed by Lorentz and Heaviside. The most remarkable results obtained are as follows:—If a sphere be placed in a uniform field of force, and if it possesses no Newtonian mass, it will move so as to have a uniform surface-density. If, however, it possesses this mass, an excess of negative electricity is formed on the side opposite to the acceleration, and excess of positive on the opposite side, following the simple cosine law in addition to the uniform layer. As the mass increases, the cosine layers approach the electrostatic value for a fixed sphere, but *in all cases the total masses longitudinal and transverse have the same values as for a sphere having a uniform fixed surface-density.* It is also true that the radiation is the same in both cases. Now the rigid electron of Abraham* is the conception which agrees most closely with the now classic experiments of Kaufmann, so that we see now that we may, if we please, consider the electron to have the properties of a perfect conductor, or, if the sphere has no mass, the interior might be an insulator. Phenomena such as Röntgen rays might then be due to the oscillations on the electron itself. The mechanism might be such that the oscillations would not be so highly damped as for those of a spherical conductor. Electrons of equal charge might then differ from one another on account of being in different modes of vibration. Certain phenomena such as the number of molecules ionized by Röntgen rays and the differences in secondary β-particles observed by McClelland and others might be thus explained. The result obtained in 5—that a slow velocity diminishes the damping factor and lengthens the period—would perhaps strengthen this supposition.

II.—The Electromagnetic Equations and the Boundary Conditions.

In free aether the electric force ε and the magnetic force η are derived [illegible] P and a vector potential ϖ by means of the equations

$$c^{-2}\varepsilon = -\nabla P - \dot{\varpi}, \qquad (1)$$

$$c^{-2}\eta = V\nabla\varpi, \qquad (2)$$

where c is the speed [illegible] radiation and the units are electromagnetic. P and ϖ

* [illegible] electron of Bucherer gives a better agreement with recent experimental results.

are connected by the relation $c^{-2}\dot{P} = S\nabla\varpi$, and are solutions of the equation

$$\nabla^2 + c^{-2}\partial^2/\partial t^2 = 0.$$

The vectors ϵ and η satisfy

$$c^{-2}\dot{\epsilon} = \nabla\eta, \qquad (3)$$

$$-\dot{\eta} = \nabla\epsilon. \qquad (4)$$

If, however, there exists a current ι, these latter equations become

$$c^{-2}\dot{\epsilon} + 4\pi\iota = \nabla\eta, \qquad (5)$$

$$-\dot{\eta} = \nabla\epsilon. \qquad (6)$$

If the origin is moving with velocity $\dot{\sigma}$, we may write them

$$c^{-2}\dot{\epsilon} + c^{-2}S\dot{\sigma}\nabla.\epsilon + 4\pi\iota = V\nabla\eta$$

$$-\dot{\eta} - S\dot{\sigma}\nabla.\eta = V\nabla\epsilon.$$

Suppose that the current becomes confined to an infinitely thin sheet, the unit normal to which is $U\nu$, and that the sheet moves with velocity $\dot{\sigma}$ as if rigidly attached to the origin, and let ϵ, η be the values of the vectors on the positive side of the surface (i.e. containing ν) and infinitely close to it, and let ϵ', η' be the corresponding values on the negative side; then by integration we obtain the following boundary conditions* :—

$$c^{-2}(\epsilon - \epsilon')S\sigma U\nu + 4\pi\iota = V.U\nu(\eta - \eta'), \qquad (7)$$

$$-(\eta - \eta')S\sigma U\nu = V.U\nu(\epsilon - \epsilon'), \qquad (8)$$

where ι is now the *surface* current density. In fact, since it is only the normal component of ∇ which causes the discontinuity, we can replace ∇ by $-U\nu SU\nu\nabla$ and integrate. The above then represent the boundary conditions at any moving current sheet where

$$-S\dot{\sigma}U\nu$$

is the velocity at the point of the sheet normal to itself. If ι_0 denote the relative current density, and e the electrical surface-density, we have

$$\iota = \iota_0 + e\dot{\sigma} \quad \text{where} \quad S\iota_0\nu = 0.$$

* Royal Dublin Society Transactions, vol. viii, ser. II, 7. Macdonald, "Electric Waves," pp. 14, 15.

From equation (8) we get $SU\nu(\eta - \eta') = 0$, so that

$$\eta - \eta' = -\, VU\nu VU\nu(\eta - \eta'),$$

and

$$VU\nu VU\nu(\eta - \eta')S\dot{\sigma}U\nu = -\, V.U\nu V\sigma(\eta - \eta').$$

Hence

$$V.U\nu[\epsilon - \epsilon' + V\sigma(\eta - \eta')] = 0.$$

If the negative side of the surface is a perfect conductor,

$$\epsilon' + V\sigma\eta' = 0;$$

and we thus get the surface condition to be, that the vector

$$\epsilon + V\dot{\sigma}\eta$$

must be normal.

Operating on (7) with $SU\nu$, we find $4\pi e = -\, c^{-2}SU\nu(\epsilon - \epsilon')$, which gives us the surface-density e in terms of ϵ and ϵ', whilst the relative current ι_0 is given by $\iota - e\dot{\sigma}$.

In the case of a conductor moving in a general manner as a rigid body the electromotive intensity at each point inside is zero, so that

$$\epsilon' + V(\sigma + V\omega\rho)\eta' = 0,$$

where $\dot{\sigma}$ is the velocity of the origin, and ω is the angular rotation, ρ being the distance of the point from the origin. Operating on this with $V\nabla(\quad)$, we find, by the aid of (3) and (4),

$$\frac{d\eta'}{dt} - S(\sigma + V\omega\rho)\nabla.\eta = 0,$$

which shows that each part of the conductor preserves in *magnitude* and carries with it the magnetic force which was there originally. The problem thus loses nothing in generality if we suppose that the initial magnetic field is initially and always afterwards null. The internal electric force will then also be zero, so that the boundary condition is that *the vector* $\epsilon + V\dot{\sigma}\eta$ *is normal to the surface*. The general problem consists of calculating vectors ϵ and η which satisfy this condition, and then the equations

$$c^{-2}\epsilon S\dot{\sigma}U\nu + 4\pi\iota = VU\nu\eta, \qquad (9)$$

$$4\pi e = -\, c^{-2}S\epsilon U\nu, \qquad (10)$$

$$\iota = \iota_0 + e\dot{\sigma} \qquad (11)$$

give us the electrical condition of the surface.

III.—THE HARMONICOID FUNCTIONS OF THE FIRST AND SECOND KINDS.

If the position of a moving point be denoted by σ, it is necessary to assume that the function σ has a differential coefficient $\dot{\sigma}$. Let us denote the values of σ at the times t' and t_1 respectively by σ' and σ_1; then the function

$$c^2(t-t')^2 + (\rho - \sigma')^2$$

has a real positive zero t_1 between O and t if $c^2t^2 + \rho^2 > 0$ and $T\dot{\sigma} < c$.* These conditions express the facts that ρ is to be taken inside the sphere of radius ct, and having the centre as origin, and that the speed $T\dot{\sigma}$ of the point is less than c. If t' is complex, and if we take a contour integral enclosing only the zero t, the function

$$\frac{ci}{\pi}\int \frac{f(t')\,dt'}{c^2(t-t')^2 + (\rho-\sigma')^2}$$

possesses a pole in real space at the point $\rho = \sigma_1$, and satisfies

$$\nabla^2 + c^2\frac{\partial^2}{\partial t^2} = 0.$$

The integral may be written

$$\frac{ci}{2\pi}\int \frac{f(t')\,dt'}{T(\rho-\sigma')\,[c(t-t') - T(\rho-\sigma')]}.$$

If now it is possible to draw a contour enclosing t_1 and no other zero and the point t, and such that on the boundary $c|t-t'| > |T(\rho-\sigma')|$, then it is possible to expand the integral in inverse powers of c, and we obtain

$$\frac{ci}{2\pi}\sum_0^\infty \int \frac{(t')\,\tau(\rho-\sigma')^{n-1}\,dt'}{c^{n+1}(t-t')^{n+1}} = \sum_0^\infty \frac{(-)\,c^{-n}}{n\,!}\left(\frac{\partial}{\partial t}\right)^n [(f)\,t\,T(\rho-\sigma)^{n-1}].\dagger$$

If we change the notation so that ρ is now the distance of any point from σ, and put $T\rho = r$, we have for the scalar potential P_0 of a point-charge E the series‡

$$P_0 = E\sum_0^\infty \frac{(-)^n c^{-n}}{n\,!}\left(\frac{\partial}{\partial t}\right)^n r^{n-1},$$

* Proceedings of the London Mathematical Society, series 2, vol. i.

† Proceedings of the Royal Irish Academy, vol. xxvii, Section A, No. viii, G. A. Schott, Annalen der Physik, 25, p. 79.

‡ Mr. W. R. W. Roberts, F.T.C.D., suggests a compact form for P_0 and similar series: thus

$$P_0 = E\,\mathrm{Exp}\,(\partial/\partial t\,.\,r),$$

where after expansion the operator is placed at the beginning of each term.

and for the vector potential

$$\varpi_0 = c^{-2}E \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^n \dot{\sigma} r^{n-1},$$

more generally if $f_m(\nabla)$ in any scalar harmonic function of ∇ homogeneous and of m dimensions, and if $\nabla f_m(\rho) = f'_m(\rho)$, so that $S\rho f'_m(\rho) = -mf_m(\rho)$, then scalar and vector potentials are given by the equations (u being any arbitrary function of t):

$$P_m = \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^n (f_m(\nabla) r^{n-1} u), \qquad \text{(A)}$$

$$\Pi_m = -\frac{c^{-2}}{m} \sum_0^\infty \frac{(-)c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^{n+1} (f'_m(\nabla)\, r^{n-1} u). \qquad \text{(B)}$$

The corresponding electrical force

$$\epsilon_m = -\frac{c^2}{m} \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^n (V\nabla V\nabla f'_m \nabla r^{n-1} u), \qquad \text{(C)}$$

and the magnetic force

$$\eta_m = -\frac{1}{m} \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^{n+1} (V\nabla f'_n \nabla r^{n-1} u). \qquad \text{(D)}$$

In these expressions the coefficients of the operational function $f_m(\nabla)$ may be functions of the time. If these coefficients, or u, are such that the differentiations with respect to t bring in powers of C, we can arrange the series differently; for example, if $u = e^{kct}$, we find, on collecting,

$$P_m = e^{kct} \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^n (f_m(\nabla)\, r^{n-1} e^{-kr}), \qquad \text{(E)}$$

$$\Pi_m = -\frac{\partial}{\partial t}\left\{\frac{c^{-1} e^{kct}}{m} \sum_0^\infty \frac{(-)^n c^{-n}}{n!}\left(\frac{\partial}{\partial t}\right)^n (f'_m(\nabla)\, r^{n-1} e^{-kr})\right\}. \qquad \text{(F)}$$

We shall call the solutions (A), (B), (C), (D), (E), and (F), *harmonicoid solutions of the first kind.*

We have also a second class of solutions of a conjugate type, in which the electric and magnetic forces ϵ'_m and η'_m are connected by the equations

$$\epsilon'_m = -\eta_m; \quad \eta'_m = c^{-2}\epsilon_m.$$

We shall call these *harmonicoid solutions of the second kind.*

If the centre of the sphere is at rest, these solutions assume well-known forms. We may first notice that if $F(r)$ is any function of r

$$f_m(\nabla)F(r) = f_m(\rho)\left(\frac{\partial}{r\partial r}\right)^m F(r).*$$

* Hobson: Proceedings of London Mathematical Society, vol. xxiv.

If, for instance, $u = 1$, in (A),

$$P_m = f_m(\nabla)\frac{1}{r} = f_m(\rho)\left(\frac{\partial}{r\partial r}\right)^m \frac{1}{r},$$

whilst (E) gives

$$P_m = e^{kct} f_m(\nabla)\frac{e^{-kr}}{r} = e^{kct} f_m(\rho)\left(\frac{\partial}{r\partial r}\right)^m \frac{e^{-kr}}{r}.$$

Hence we see that if the centre of the sphere is at rest, the harmonicoid solutions degenerate into the known solutions of harmonic or Bessel-harmonic type which are employed in fixed sphere problem. We shall speak of a harmonicoid solution as a *continuation* of the corresponding solution for the fixed sphere.

IV.—Method of General Solution and Examples.

The sphere being placed in any field of force, solve the problem as if the centre of the sphere were at rest. We thus get an electric force α_0 and a magnetic force $c^{-2}\beta_0$ expressed as sums of functions of harmonic type. *Continue* this function, and we get an electric force

$$\varepsilon = \alpha_0 + c^{-1}\alpha_1 + c^{-2}\alpha_2 + c^{-3}\alpha_3 + \ldots$$

and a magnetic force

$$\eta = c^{-2}\beta_0 + c^{-3}\beta_1 + c^{-4}\beta_2 + \ldots$$

The electromotive intensity

$$\alpha_0 + c^{-1}\alpha_1 + c^{-2}(\alpha_2 + V\sigma\beta_1) \ldots$$

(where $\dot{\sigma}$ is the velocity of a point on the boundary) is, however, not normal to the sphere, with the exception of the first term α_0. Suppose again that the centre of the sphere is at rest, and find an electric force $c^{-1}\gamma_0$, such that

$$c^{-1}(\alpha_1 + \gamma_0)$$

is normal, and let $c^{-3}\delta_0$ be the magnetic force. On forming the continuation and adding, we have

$$\varepsilon' = \alpha_0 + c^{-1}(\alpha_1 + \gamma_0) + c^{-2}(\alpha_2 + \gamma_1) + \ldots$$
$$\eta' = c^{-2}\beta_0 + c^{-3}(\beta_1 + \delta_0) + \ldots$$

The electromotive intensity is now normal for the first two terms, but the third term $c^{-2}(\alpha_2 + \gamma_1 + V\dot{\sigma}\beta_0)$ is not normal; we can, however, determine an electric force $c^{-2}\lambda_0$ and magnetic force $c^{-4}\mu_0$, such that

$$c^{-2}(a_2 + \gamma_1 + V\dot{\sigma}\beta_0 + \lambda_0)$$

is normal; and we thus get

$$\epsilon'' = a_0 + c^{-1}(a_1 + \gamma_0) + c^{-2}(a_2 + \gamma_1 + \lambda_0) + c^{-3}(a_3 + \gamma_2 + \lambda_1)$$
$$\eta'' = \quad c^{-2}\beta_0 + c^{-3}(\beta_1 + \delta_0) + c^{-4}(\beta_2 + \delta_1 + \delta_0).$$

The electromotive intensity is normal as for the first, second, and third terms; and we can thus carry the solution to any degree of approximation. The case in which the external field can be expanded in powers of c can be solved by treating separately each term.

As a first example consider the case of a sphere moving without rotation under the action of no external electromagnetic field, the charge on the sphere being E in electrostatic units. The equilibrium state comes from a potential Er^{-1}; and its continuation gives

$$P_0 = \frac{E}{r} + \frac{Ec^{-2}}{2\,!}\frac{\partial^2}{\partial t^2}r - \frac{Ec^{-3}}{3\,!}\frac{\partial^3}{\partial t^3}r^2 + \ldots$$
$$= Er^{-1} + \tfrac{1}{2}Ec^{-2}\{r^{-1}(-\dot{\sigma}^2 + S\rho\ddot{\sigma}) - r^{-3}(S\rho\sigma)^2\}$$
$$- \tfrac{1}{6}Ec^{-3}\{2S\rho\dddot{\sigma} - 2S\dot{\sigma}\ddot{\sigma}\},$$

and the vector potential

$$\varpi_0 = Ec^{-2}\dot{\sigma}r^{-1} - Ec^{-3}\sigma + \ldots$$

To the first approximation the electric force ϵ which is $-\nabla P_0 - \varpi_0$

$$= Er^{-3}\rho + Ec^{-2}\{\rho[\tfrac{1}{2}r^{-3}(-\dot{\sigma}^2 + S\rho\ddot{\sigma}) - \tfrac{3}{2}r^{-5}(S\rho\dot{\sigma})^2] - \tfrac{1}{2}\sigma r^{-1}\}.$$

To get electromotive intensity we add

$$V\sigma V\nabla\varpi_0 \quad \text{or} \quad Ec^{-2}r^{-3}(\rho\dot{\sigma}^2 - \dot{\sigma}S\rho\dot{\sigma}).$$

We have now the following term:—

$$Ec^{-2}[-\tfrac{1}{2}\ddot{\sigma}r^{-1} + r^{-3}\dot{\sigma}S\rho\dot{\sigma}],$$

which is not normal to the sphere.

Terms must be added such that to the first approximation the non-normal terms are annulled. Assume a scalar potential

$$P_1 = AS\ddot{\sigma}\nabla.\frac{1}{r} + B\left(S\dot{\sigma}\nabla\right)^2\frac{1}{r},$$

and we find by taking

$$A = -\frac{a^2}{2}Ec^{-2} \quad \text{and} \quad B = \frac{a^2Ec^{-2}}{6}$$

that the conditions are satisfied. We thus get for the complete scalar potential as far as c^{-2}

$$\frac{E}{r} + Ec^{-2}\left\{\frac{1}{2}\left(\frac{\partial}{\partial t}\right)^2 r - \frac{a^2}{2}S\ddot{\sigma}\nabla.\frac{1}{r} + \frac{a^2}{6}\left(S\dot{\sigma}\nabla\right)^2\frac{1}{r}\right\}.$$

In the same manner we proceed to terms involving c^{-4}; and we determine an additional term

$$Ec^{-3}\left\{-\frac{1}{3!}\left(\frac{\partial}{\partial t}\right)^3 r^2 + \frac{2}{3}\,S\ddot{\sigma}\nabla.\frac{1}{r}\right\};$$

and we find for the vector potential

$$Ec^{-2}\dot{\sigma}r^{-1} - Ec^{-3}\ddot{\sigma} + Ec^{-4}\left(\frac{1}{6}\frac{\partial^2}{\partial t^2}(r\dot{\sigma}) - \frac{a^2}{2}\frac{\partial}{\partial t}\frac{\ddot{\sigma}}{r} + \frac{a^2}{6}\frac{\partial}{\partial t}\,\sigma S\dot{\sigma}\nabla\frac{1}{r}\right) + \ldots$$

The electrical force ε at the surface of the sphere is

$$\frac{E}{a^3}\left\{\rho + c^{-2}(2\rho S\rho\ddot{\sigma} - a^{-2}\rho V\rho\sigma S\rho\dot{\sigma}) + c^{-3}(-2\rho a S\rho\dddot{\sigma}) + \ldots\right\}$$

and the magnetic force at the surface is

$$Ec^{-2}a^{-3}V\dot{\sigma}\rho.$$

If the internal magnetic force is initially and afterwards zero, the surface-density is simply obtained from the normal component of the electric force, and this forms at each step a check on our calculations; for the total charge on the sphere must be constant. In this case we find for the surface-density

$$\frac{E}{4\pi a^2}\{1 + 2ac^{-2}SU\rho\ddot{\sigma} - 2a^2c^{-3}SU\rho\dddot{\sigma} + \ldots\}.$$

We find from the boundary conditions the current i_0 to be

$$\frac{E}{4\pi a^2}\{c^{-2}V\rho V\rho\ddot{\sigma} - ac^{-3}V\rho V\rho\dddot{\sigma} + \ldots\}.$$

Other examples easily solved by this method would be the case of constant electric and magnetic force, plane waves, etc.

V.—On Oscillatory Distributions.

For a sphere at rest there is not only the simple distribution, but also an infinite number of possible oscillatory distributions, and these can be continued in the usual manner. The method can best be explained by an example. For the fundamental mode take

$$P_1 = e^{kct}Sa\nabla\left(\frac{e^{-kr}}{r} - c^{-1}\frac{\partial}{\partial t}(e^{-kr}) + \frac{c^{-2}}{2!}\frac{\partial^2}{\partial t^2}(re^{-kr}) + \ldots\right),$$

$$\Pi_1 = \frac{\partial}{\partial t}e^{kct}c^{-2}a\left(\frac{e^{-kr}}{r} - c^{-1}\frac{\partial}{\partial t}e^{-kr} + \ldots\right),$$

where a is a fixed direction in space, and we shall suppose that the sphere moves without rotation. We find, on the surface $r = a$,

$$- \epsilon = ae^{-ka}\left(\frac{1}{a^3} + \frac{k}{a^2} + \frac{k^2}{a}\right) + \rho Sa\rho e^{-ka}\left(\frac{3}{a^5} + \frac{3k}{a^4} + \frac{k^2}{a^3}\right)$$

$$+ kc^{-1}\left\{- aS\rho\dot{\sigma}\left(\frac{1}{a^3} + \frac{k}{a^2} - \frac{k^2}{a}\right) + \dot{\sigma}Sa\rho\left(\frac{1}{a^3} + \frac{k}{a^2}\right)\right.$$

$$\left. + \rho Sa\rho S\dot{\sigma}\rho\left(\frac{3}{a^5} + \frac{3k}{a^4} + \frac{k^2}{a^3}\right) + \rho Sa\dot{\sigma}\left(\frac{1}{a^3} + \frac{k}{a^2}\right)\right\} e^{-}$$

$$+ \frac{c^{-2}}{2!}\frac{\partial^2}{\partial t^2}(\nabla Sa\nabla - a\nabla^2)\, re^{-kr} + \ldots;$$

and for the magnetic force we find

$$- V\sigma\eta = kc^{-1}\left[V\dot{\sigma}V\rho a\left(\frac{1}{a^3} + \frac{k}{a^2}\right)e^{-ka}\right] + c^{-2}\frac{\partial}{\partial t}\left(\frac{1}{a^3} + \frac{k}{a^2} - \frac{k}{a}\right)e^{-ka} + \ldots$$

To a first approximation we find that the non-normal terms vanish if $k^2a^2 + ka + 1 = 0$. If k_0 denote this value of k, we may assume that the complete value is of the form $k_0 + c^{-1}k_1 + c^{-2}k_2 + \ldots$ There is, however, no term containing a multiplied by a constant coefficient in the term multiplying c^{-1} in $\epsilon - V\sigma\eta$, and no term will arise, as shall be seen, in compensating there the non-normal force, so that $k_1 = 0$. The non-normal term will be found to be

$$kc^{-1}V\rho V\dot{\sigma}a\frac{k^2_0}{a},$$

which can be annulled by a "harmonicoid" of second kind

$$- \epsilon' = kc^{-1}V\rho V\sigma a\left(\frac{1}{r^3} + \frac{k}{r^2}\right)e^{-kr} - c^{-2}V\dot{\sigma}V\dot{\sigma}a\left(\frac{1}{r^3} + \frac{k}{r^2} - \frac{k^2}{r}\right)e^{-kr} + \ldots$$

It will be found on inspection that the only term containing a in the coefficient of c^{-2} arises from

$$\frac{c^{-2}}{2!}\frac{\partial^2}{\partial t^2}\left(\nabla Sa\nabla - a\nabla^2\right) re^{-kr}.$$

On arrangement of terms we find

$$ka = -\frac{1 + \sqrt{3}i}{2} + \frac{v^2}{c^2}\left(\frac{5}{4} - \frac{7\sqrt{3}i}{12}\right) + \ldots$$

where v is the velocity, and $i = \sqrt{-1}$.

The general tendency is thus to diminish the damping factor and to lengthen the period from which we may infer that the charge is less stable than before.

From a knowledge of the normal component of the electric force we find that the surface-density is proportional to

$$Sa\rho + \frac{k}{c}\left(\tfrac{3}{2}Sa\rho S\dot{\sigma}\rho + \tfrac{1}{2}a^2 Sa\dot{\sigma}\right) + \ldots$$

Thus the harmonic distribution of first order involves also one of the second, so that the principal modes of oscillation are different from those of a fixed sphere.

We can now deal with the case of discontinuous motions, i.e. when any differential coefficient becomes discontinuous. For example, suppose that the sphere is moving with an acceleration $\ddot{\sigma}'$, and that when $t = t_0$ the acceleration is $\ddot{\sigma}$. Before the time t_0 the surface-density is

$$\frac{E}{4\pi a^2}\left\{1 + 2c^{-2}S\rho\ddot{\sigma}' + \ldots\right\},$$

then after $t = t_0$ the surface-density is

$$\frac{E}{4\pi a^2}\left\{1 + 2c^{-2}S\rho\ddot{\sigma} + \ldots\right\} + Sa\rho + \ldots$$

where a is a solution of

$$\ddot{a}a^2 + \dot{a}ac + ac^2 = 0$$

such that when $t = t_0$ the densities and the currents (which depend on the differential coefficients of the density) are equal. In this case we find

$$a = \frac{Ec^{-2}}{2\pi a^2}(\ddot{\sigma}_0' - \ddot{\sigma}_0)\,e^{-\frac{kc}{2a}(t-t_0)} \sin\left[\frac{\sqrt{3}}{2a}(t-t_0) + \frac{\pi}{3}\right]\Big/\sin\frac{\pi}{3}$$

$$- \frac{Ec^{-3}}{2\pi a}(\dddot{\sigma}_0' - \dddot{\sigma}_0)\,e^{-\frac{kc}{2a}(t-t_0)} \sin\frac{\sqrt{3}}{2a}(t-t_0)\Big/\sin\frac{2\pi}{3}.$$

VI.—QUASI-STATIONARY MOTION.

A particular class of motion called quasi-stationary motion has received much attention in modern dynamics of an electron. In this motion the acceleration is supposed to be so small that its differential coefficients and its square and higher power can be neglected. Our formulæ become in this case somewhat simpler; but another method (which can be applied to any other case of motion) seems more direct in this case.

The harmonicoid functions used above have no simple physical meaning, but, by the aid of a theorem which can be easily verified, we can construct harmonicoid functions which represent potential of spherical shells having a given assigned surface charge represented in spherical harmonics. This theorem is as follows:—If dP be the potential due to an element of unit density according to any law of force which depends only on the time and the relative position of element and attracted point, and if $f_n(\rho)$ be a solid spherical scalar harmonic in which, for simplicity, we may regard the coefficients as constants in time, then

$$\frac{(-)^n}{a^{n-1}} f_n(\nabla) \int_0^a a_{n-1} da_{n-1} \int_0^{a_{n-1}} a_{n-2} da_{n-2} \ldots \int_0^{a_1} dP$$

(where $\int_0^{a_1} dP$ means the potential of a sphere of radius a_1) is the potential of a surface-distribution of amount $f_n(U\rho)$ over a sphere of radius a, and this holds both for external and internal points.

We have also the fact that the potentials P and Π, and a uniform spherical shell of charge E, are given by

$$P' = \frac{cE}{2a} \sum_1^\infty \frac{(-)^n c^{-n}}{n!} \left(\frac{\partial}{\partial t}\right)^{n-1} \frac{(r-a)^n - (r+a)^n}{r}, \quad \text{externally,}$$

$$P = \frac{cE}{2a} \sum_1^\infty \frac{(-)^n c^{-n}}{n!} \left(\frac{\partial}{\partial t}\right)^{n-1} \frac{(a-r)^n - (a+r)^n}{r}, \quad \text{internally,}$$

$$\Pi' = \frac{E}{2a} \sum_1^\infty \frac{(-)^n c^{-n}}{n!} \left(\frac{\partial}{\partial t}\right)^{n-1} \dot{\sigma} \frac{(r-a)^n - (r+a)^n}{r}, \quad \text{externally,}$$

$$\Pi = \frac{E}{2ac} \sum_1^\infty \frac{(-)^n c^{-n}}{n!} \left(\frac{\partial}{\partial t}\right)^{n-1} \dot{\sigma} \frac{(a-r)^n - (a+r)^n}{r}, \quad \text{internally.}$$

From these formulae we find for the electric force t inside such a shell

$$\frac{2E}{3ac^2} \sigma S\sigma^{-1}\ddot{\sigma} \left(1 - \frac{6}{5}\frac{a^2}{c^2} + \frac{9}{7}\frac{a^4}{c^4} + \ldots\right)$$

$$- \frac{2E}{3ac^2} \sigma V\sigma^{-1}\ddot{\sigma} \left(1 + \frac{3}{2}\cdot\frac{3}{5}\frac{a^2}{c^2} + \frac{3}{2}\cdot\frac{4}{7}\frac{a^4}{c^4} + \ldots\right),$$

and we find for the magnetic force η the equation

$$V\sigma\eta = \frac{2E}{3ac^2} \sigma V\sigma^{-1}\ddot{\sigma} \left(\frac{3}{2}\cdot\frac{1}{3}\frac{a^2}{c^2} + \frac{3}{2}\cdot\frac{2}{5}\frac{a^4}{c^4} \ldots\right).$$

We thus find for the electromotive intensity inside the expression

$$-\frac{M}{E}\dot{\sigma}S\dot{\sigma}^{-1}\ddot{\sigma} - \frac{M'}{E}\dot{\sigma}V\dot{\sigma}^{-1}\ddot{\sigma},$$

where

$$M = \frac{2E^2}{3ac^2}\left(1 + \frac{5}{6}\frac{u^2}{c^2} + \frac{9}{7}\frac{u^4}{c^4}\cdots\right) = \frac{E^2}{2ac^2}\frac{1}{k^2}\left\{-\frac{1}{k}\log\frac{1+k}{1-k} + \frac{2}{1-k^2}\right\},$$

and

$$M' = \frac{2E^2}{3ac^2}\left(1 + \frac{6}{3.5}\frac{u^2}{c^2} + \frac{9}{5.7}\frac{u^4}{c^4}\cdots\right) = \frac{E^2}{2ac^2}\frac{1}{k^2}\left\{\left(\frac{1+k^2}{2k}\right)\log\frac{1+k}{1-k} - 1\right\},$$

where $u = T\sigma$ and $k = u/c$.

It will be noticed that M and M' are Abraham's expressions for longitudinal and transverse mass.*

If we suppose now a surface-density of amount

$$pS\rho\dot{\sigma}S\dot{\sigma}^{-1}\ddot{\sigma} + qS\rho\dot{\sigma}V\dot{\sigma}^{-1}\ddot{\sigma},$$

we find an internal electromotive force of amount

$$ap_1p\dot{\sigma}S\dot{\sigma}^{-1}\ddot{\sigma} + aq_1q\dot{\sigma}V\dot{\sigma}^{-1}\ddot{\sigma},$$

where

$$p_1 = \frac{2\pi(1-k^2)}{k^2}\left\{\frac{1}{k}\log\frac{1+k}{1-k} - 2\right\},$$

$$q_1 = \frac{\pi(1-k^2)^2}{k^2}\left\{-\frac{1}{k}\log\frac{1+k}{1-k} + \frac{2}{1-k^2}\right\}.$$

For example, if we require the distribution of electricity due to a field ϵ_0, η_0, we find the linear equation:

$$\left(ap_1p - \frac{M}{E}\right)\dot{\sigma}S\dot{\sigma}^{-1}\ddot{\sigma} + \left(aq_1q - \frac{M'}{E}\right)\dot{\sigma}V\dot{\sigma}^{-1}\ddot{\sigma} + \epsilon_0 + V\dot{\sigma}\eta_0 = 0.$$

This contains two scalar unknowns p and q, and a vector unknown σ, so that another equation is necessary. In the next section this will be found.

VII.—DYNAMICAL RESULTS.

As a basis for our results we can assume with Lorentz† that the total force on the conductor is that due to the aethereal forces on each element of electricity. If in addition we have Newtonian forces, including reversed effective forces, then the whole system of forces, electrical and non-electrical, must be in equilibrium. The electromotive intensity on the elements gives

* Cf. Abraham, *Theorie der Electricität*, II., p. 191.
†Cf. Lorentz: *Theory of Electrons*, p. 19.

rise to a force $\epsilon e + V\iota\eta$, where e is the surface-density. By the aid of the boundary conditions one form of this is

$$4\pi\nu \frac{e^2(1 - c^{-2}(V\dot{\sigma}\nu)^2) + c^{-2}\iota^2}{1 - (S\dot{\sigma}\nu)^2 c^{-2}},$$

where $\nu\ (T\nu = 1)$ is the normal to the boundary; and as we are dealing with surface-distributions, we must take one-half of this in computing the total force. It may be noticed that this force is entirely normal, so that for a sphere such forces have no tendency to cause rotation. The current $\iota = \iota_0 + e\sigma$ can be obtained from the boundary-conditions. However, if harmonicoids of the first type only are present, ι_0 is "irrotational," and can be calculated from e by the differential equations

$$S\rho^{-1}V\rho\nabla\iota_0 = \dot{e},$$
$$V(\rho^{-1}V\rho\nabla\iota_0) = 0.$$

For example: if $\epsilon = f_n(\rho)$, a solid harmonic of degree n, then

$$\nabla^2 f_n(\rho) = 0$$

may be written

$$\left\{(\rho^{-1}V\rho\nabla)^2 + \frac{n(n+1)}{\rho^2}\right\} f_n(\rho) = 0,$$

so that the current is

$$\frac{-\rho V\rho\nabla}{n(n+1)} \frac{\partial}{\partial t} f_n(\rho).$$

Consider the case of the isolated sphere. We have

$$e = e_0(1 + 2c^{-2}S\rho\ddot{\sigma} - 2ac^{-3}S\rho\dddot{\sigma}\ \ldots)$$

where $E = 4\pi a^2 e_0$, and the current

$$\iota_0 = e_0(c^{-2}V\rho V\rho\ddot{\sigma}\ \ldots).$$

Hence

$$\frac{e^2(1 - c^{-2}(V\dot{\sigma}\nu)^2) + c^{-2}\iota^2}{1 - (S\dot{\sigma}\nu)^2 c^{-2}}$$

$$= e_0^2[(1 + 2c^{-2}S\rho\ddot{\sigma} - 2ac^{-3}S\rho\dddot{\sigma})^2 + c^{-2}(\sigma + 2c^{-2}\sigma S\rho\sigma + c^{-2}V\rho V\rho\ddot{\sigma})^2]$$
$$[1 + (S\dot{\sigma}\nu)^2 c^{-2} + (S\dot{\sigma}\nu)^4 c^{-4} + \ldots]$$

$$= e_0^2[1 + 2c^{-2}(2S\rho\sigma + \dot{\sigma}^2 + (S\sigma\nu)^2) - 4ac^{-3}S\rho\dddot{\sigma} + \ldots].$$

It is clear that only terms of odd degree will contribute to the final result, so that on multiplying by $2\pi\nu$, and integrating, we find

$$\frac{2E^2}{3ac^2}\left(-\ddot{\sigma} + ac^{-1}\dddot{\sigma} + \ldots\right).$$

It will be noticed that this is the same as if the charge on the sphere was uniform and fixed. The energy wasted and conserved is the same (to this degree of approximation) in both cases, but if the sphere is suddenly brought to rest, the mode of attaining the final state is different in both cases. In the one case the total kinetic energy is radiated in the form of a thin shell; in the other case the charge assumes the equilibrium position after a number of oscillations.

If the isolated sphere had in addition an oscillatory distribution of surface-density $c^{-2}S\alpha\rho + c^{-3}S\beta\rho$, we find for the opposing force

$$\frac{2}{3}\frac{E^2}{ac^2}\left[-\sigma - \frac{1}{2}\frac{\alpha}{e_0} + c^{-1}\left(a\dddot{\sigma} - \frac{1}{2}\frac{\dot{\alpha}\beta}{e_0}\right)\right],$$

where α and β satisfy

$$\ddot{\alpha}a^2 + \dot{\alpha}ac + \alpha c^2 = 0,$$

$$\ddot{\beta}b^2 + \dot{\beta}ac + \beta c^2 = 0.$$

In the case of quasi-stationary motion, employing the notation of the last section, we have, if m denote the Newtonian mass, and ξ the Newtonian force, the equation of motion

$$-Ea\,(pp_1\dot{\sigma}S\dot{\sigma}^{-1}\ddot{\sigma} + qq_1\dot{\sigma}V\dot{\sigma}^{-1}\sigma) - m\sigma + \xi = 0,$$

where

$$pS\rho\sigma S\dot{\sigma}^{-1}\sigma + qS\rho\dot{\sigma}V\sigma^{-1}\ddot{\sigma}$$

is the surface-density. This, taken along with the equation

$$\left(app_1 - \frac{M}{E}\right)\dot{\sigma}S\sigma^{-1}\ddot{\sigma} + \left(aqq_1 - \frac{M'}{E}\right)\dot{\sigma}V\sigma^{-1}\ddot{\sigma} + \varepsilon_0 + V\dot{\sigma}\eta_0 = 0,$$

completes the solution. We deduce at once

$$(M + m)\,\sigma S\dot{\sigma}^{-1}\ddot{\sigma} + (M' + m)\,\dot{\sigma}V\dot{\sigma}^{-1}\sigma = \zeta + (\varepsilon_0 + V\sigma\eta_0)E.$$

This is the equation of motion of a *rigidly* uniformly electrified sphere; and we notice that if

$$m\sigma - \xi = 0, \quad \text{then} \quad p = 0, \quad \text{and} \quad q = 0,$$

and the sphere is uniformly electrified.

II.

CONTRIBUTIONS TO THE THEORY OF SCREWS.

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CONTENTS.

I.—*On the expression for the Virtual Coefficient of two Vector-Screws.*

The properties of the virtual coefficient of two screws are of fundamental importance in that branch of mathematics which is known as the Theory of Screws. The term "virtual coefficient" was first introduced into the Theory of Screws in a memoir by the present writer.* It must, however, be remembered that a certain function of geometrical quantities, which is called the fundamental invariant of two linear complexes, and which is exactly parallel to the virtual coefficient in the Theory of Screws, had been previously employed by Klein† in a series of important investigations.

The evanescence of the virtual coefficient of two screws indicates that the screws stand in that remarkable relation which we have expressed by designating them as reciprocal. In the earlier investigations of the Theory of Screws there had been no occasion for the employment of the virtual coefficient except in connexion with reciprocal screws. But when in a later

* Phil. Trans. Roy. Soc., 1874, p. 16.

† Math. Ann., vol. ii., pp. 198–226 (1869). For further details and references, see the "Treatise on the Theory of Screws" by the present writer. Cambridge, 1900, pp. 17, 517. In future references to this book in the present paper, it will be termed simply "Treatise."

memoir* it became necessary to introduce the Theory of Screw co-ordinates, the virtual coefficient as a function of the two screws, and now no longer zero, assumed a significance which it had not previously appeared to possess.

It may perhaps be thought strange that after the lapse of so many years it should now have been found necessary to re-examine the rigour of the original expression for the virtual coefficient. That expression was given in terms of the pitches p_α, p_β of the two screws α and β, of d the shortest distance between their two axes, and of θ the angle between them, and was stated† to be

$$\tfrac{1}{2}\{(p_\alpha + p_\beta)\cos\theta - d\sin\theta\}.$$

In the course of the Quaternion developments of the Theory of Screws, to which a considerable part of the present paper is devoted, a doubt arose, not indeed as to the formal accuracy of this expression, but as to the rigour of the process by which it was supposed to have been established. It presently appeared that there was a flaw in the proof, owing to the absence of any definite convention as to the way in which the angle between the two screws is to be measured. If the angle $360° - \theta$ had been used instead of θ, then the second term in the virtual coefficient would have a positive sign instead of a negative sign; and so far as the original deduction of the expression was concerned there was nothing to show which of the two angles was to be used in the expression of the virtual coefficient. The ordinary rule for estimating the angle between two vectors does, no doubt, distinguish between θ and $180° - \theta$. It fails, however, to distinguish between θ and $360° - \theta$. Unless, therefore, some further convention be established, the virtual coefficient must have an ambiguous sign for its second term. Our immediate object is to establish the convention necessary so that in all cases the sign of the second term shall be negative. Fortunately it is possible to establish such a convention in the case of two vector-screws which do *not* intersect.

I had already attempted‡ to remove this uncertainty in the mode of specifying the angle between two screws; but as the result was not completely satisfactory, I have returned to the subject. I am glad to say that the difficulty has now been overcome, and a great improvement in the foundations of the Theory of Screws is the result. I here set down the method of obtaining the virtual coefficient in the way I would desire it to be obtained if I were commencing to write the Theory of Screws over again.

To the apparatus of the Theory of Screws as it has hitherto existed the important addition of the geometrical conception known as the *vector-screw*

* Trans. Roy. Ir. Acad., vol. xxv., pp. 259–327 (1874).

† "Treatise," p. 17.

‡ Trans. Roy. Ir. Acad., vol. xxxii., pp. 109–115 (1902).

has now to be made. By a vector-screw, which is here defined for the first time, I mean a screw in the original sense of the word,* on the axis of which a unit vector is laid. Thus a vector-screw differs from a screw in that the former possesses an indication as to which of the two directions along the axis is to be regarded as positive, while there is no such indication of the positive direction in the latter. It must not be supposed that the vector by which a particular direction is indicated as positive on a vector-screw stands in any relation to the pitch of the screw. The sign of the pitch may be positive or negative, but is quite irrespective of the sense of direction imparted to the vector-screw when it carries a unit vector. Of course the pitch of a vector-screw may be zero, and two quite distinct vector-screws of zero or any other pitch may lie on the same axis with their unit vectors in opposite directions.

Five data are in general sufficient to determine a screw; but it would not be quite correct to say that five data suffice to determine a *vector-screw*. We have just seen that every screw will be the seat of two distinct vector-screws according to the direction of the vector. Thus five data, though insufficient to specify a vector-screw complete, will yet show that the vector-screw must be one of a definite pair of vector-screws of the same pitch and on the same axis.†

The distinction between a right-handed rotation‡ about a vector and a left-handed rotation about a vector is perhaps most becomingly based on the relations of the diurnal rotation of the Earth to the North and South Poles of the Earth. We accordingly distinguish the right-handed rotation from the left-handed rotation as follows:—

The Diurnal rotation of the Earth is said to be *right-handed* about a vector from its centre to the North Pole, and *left-handed* about a vector from its centre to the South Pole.

It is to be understood that when a body is said to have had a right-handed rotation about a vector it is implied not only—

(1) That the body has received a rotation about that vector as an axis; but also

* "Treatise," p. 7.

† It will be seen a little later that when a screw is represented by the vector coordinates μ, λ the geometrical form indicated is really a vector-screw and not merely a screw. Thus the quaternion method of representing Dynames is free from the present ambiguity.

‡ See Hamilton, "Lectures on Quaternions," art. 68; also Hamilton, "Elements of Quaternions," 2nd ed., edited by Charles Jasper Joly (1899), vol. i., p. 245, foot-note. It is this edition of the great work which will be referred to throughout this paper whenever Hamilton's "Elements of Quaternions" is quoted. On the subject of the convention respecting the direction of a right-handed rotation about a vector, reference may be made to "A Manual of Quaternions" by Charles Jasper Joly, 1905, p. 7. This work will be quoted briefly as Joly's "Manual" in the frequent references made to it in the present paper.

(2) That if we conceived the vector to be lying upon the Earth's axis, and pointing in the same direction as the vector from the Earth's centre to the North Pole, then a right-handed rotation of the body will turn it in the same direction as that in which the Earth is rotating.

As a convenient method of remembering the relation of a right-handed rotation to the vector about which the rotation has been performed, we may note that the direction in which the numbers increase on the face of a watch is *right-handed* with regard to a vector *from the dial to the back.*

The conception due to Chasles, that any movement of a rigid body is a twist about a screw, is, of course, a fundamental principle in the Theory of Screws. The word "twist" was defined with regard to a screw at the beginning of the original memoir* with which the present series commenced. At present we are concerned with vector-screws rather than screws; and it has become necessary to explain how the vector-screw introduced in the present paper for the first time enables an absolutely precise specification of a twist to be made, and thus attention is called to the fact that any specification of a twist with regard to a screw (*i.e.*, not a vector-screw) must be necessarily defective in one detail.

A twist may be completely represented by a vector-screw α (of pitch p_α) and a scalar α' which is termed the amplitude of the twist. The twist is produced by compounding—(1) a rotation, and (2) a translation.

1. The rotation is right-handed or left-handed about the vector, according as the given scalar α' is positive or negative.

The angular magnitude of the rotation is α' radians.

2. The translation is to be in the same direction as the vector, or in the opposite direction according as $\alpha' p_\alpha$ is positive or negative.

The linear magnitude of the translation is

$$(\alpha'^2 p_\alpha^2)^{\frac{1}{2}}.$$

If $p_\alpha = 0$, the twist is simply a rotation. If $p_\alpha = \infty$ and the twist is to be finite, then $\alpha' = 0$, and the twist is a translation.

In the Theory of Screws, α' is always regarded as a small quantity. When this is the case, the result of the composition of any number of twists is independent of the order of their application.

If a rigid body is not at rest, its movement must be at every movement a twisting motion about some instantaneous vector-screw.

An instantaneous twisting motion may be completely represented by a vector-screw α of pitch p_α, which may be either positive or negative, and a

* Trans. Roy. Ir. Acad., vol. xxv., p. 159 (1871). See also "Treatise," p. 7.

scalar α' which may be either positive or negative, and which is termed the twist velocity of the motion.

The instantaneous twisting motion is formed by compounding (1) a motion of rotation, and (2) a motion of translation.

(1) The motion of rotation is right-handed or left-handed about the vector on the vector-screw, according as α' is positive or negative. In this we see the advantage of the vector-screw over the screw. Had it not been for the vector, we should have had no means of indicating the *direction* of the rotation in the specification of the twist.

The angular velocity of this rotation is α' radians per unit of time.

(2) The motion of translation is in the same direction as the vector, or in the opposite direction according as $\alpha' p_\alpha$ is positive or negative.

If α be the angular velocity with which α changes, then the numerical value of the velocity of translation is

$$(\dot{\alpha}^2 p_\alpha^2) .$$

To show how the employment of the vector-screw enables all possible conditions of the twisting motion to be specified, we observe that

If $p_\alpha > 0$ and $\alpha' > 0$, the rotation is right-handed, and the translation is with the vector.

If $p_\alpha < 0$ and $\alpha' > 0$, the rotation is right-handed, and the translation is against the vector.

If $p_\alpha > 0$ and $\alpha' < 0$, the rotation is left-handed, and the translation is against the vector.

If $p_\alpha < 0$ and $\alpha' < 0$, the rotation is left-handed, and the translation is with the vector.

The statement that a couple is right-handed about a vector implies not only

(1) That the vector is normal to the plane of the couple,

but also

(2) That the couple tends to give a body a right-handed rotation about that vector.

A wrench may be completely specified by a vector-screw α (of pitch p_α), and a scalar α'', which is termed the Intensity of the Wrench. The wrench is produced by the combination of (1) a force, and (2) a couple.

(1) The intensity of the force is α'' units of force, and its tendency is with the vector or against the vector, according as α'' is positive or negative.

(2) The couple is to be right-handed or left-handed about the vector, according as $\alpha'' p_\alpha$ is positive or negative.

The numerical value of the moment of the couple is

$$(\alpha''^2 p_\alpha^2) .$$

If p_α is zero, the wrench is merely the force α''. If p_α is infinite, then a finite wrench is possible only when α'' is zero. In this case the wrench reduces to a couple.

We have now to lay down the rule for discriminating as to which of the two angles θ or $360° - \theta$, between a pair of non-intersecting vector-screws shall be designated as the right-handed angle between those vector-screws.

Let P be a point on one vector-screw α, and Q be a point on the other vector-screw β, such that PQ is the common perpendicular to α and β. Imagine α to receive such a right-handed rotation through an angle θ with respect to the vector from P to Q, as shall bring the unit-vector on α to point in the same direction as the unit-vector on β, then θ is said to be the right-handed angle between β and the original position of α.

If the two vector-screws were in the same plane, the vector PQ is evanescent, the construction would break down, and consequently our means of discriminating between the right-handed angle and the left-handed angle have vanished.

A convenient practical rule for finding the right-handed angle between a pair of vector-screws may be obtained by the hands and the dial of a watch, it being observed of course that the hands are not coplanar.

The hands are taken to be the axes of two non-intersecting vector-screws, the vectors of which point outwards from the centre along the hands. The hour indicated by the minute-hand (i.e., the uppermost hand) is subtracted from that indicated by the hour-hand. The difference turned into angle at the rate of 30° per hour is the right-handed angle between the two screws. For example, if the minute-hand was at III, and the hour-hand at V, the difference is two hours, and the right-handed angle is 60°. If the minute hand is at I and the hour hand at X, the difference is 9 hours, and the right-handed angle is 270°. If the minute-hand is at XI and the hour-hand is at II, the difference is XII + II − XI = 3^h, and the right-handed angle of the two screws is 90°. Finally, if the minute-hand be at XII, the hour-hand itself shows the right-handed angle.

In a figure representing a pair of vector-screws parallel to the plane of the paper, the analogy of the hands of a watch suggests as a useful convention that the longer line OA shall be *above* OB. Of course in this case OA and OB cannot represent the lengths of the vectors on the two vector-screws, for these by hypothesis are both unit-vectors.

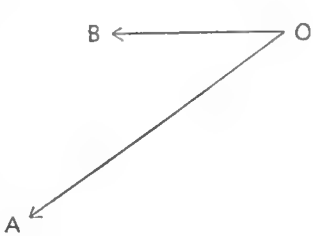

FIG. 1

The necessity for a clear understanding as to the distinction between the right-handed angle and the left-handed angle between two vector-screws will be obvious from the following considerations:—

The angle between two screws (i.e., not vector-screws) is an ambiguous expression; the angle may mean θ, or $180° - \theta$, or $180° + \theta$, or $360° - \theta$, just as in the case of the angle between two lines.

The angle between two vectors is not ambiguous to the same extent; it can only be θ or $360° - \theta$, if we agree that we are to measure the angle between vectors diverging from their point of intersection.

But it is worthy of special note that when the two vectors are not in the same plane, as, for example, when they are the vectors on two non-intersecting vector-screws, we can distinguish geometrically one of the two angles whose sum is 360° as the right-handed angle, and the other as the left-handed angle. Thus the right-handed angle between two vector-screws which do not intersect is free from all ambiguity; and it may be any angle between 0° and 360°.

We are now to reconsider the fundamental problem which introduces the virtual coefficient. This lies, indeed, at the commencement of our subject; but the expression of the virtual coefficient as it has been used hitherto has, unfortunately, been sometimes haunted by ambiguity as to which of the two angles between the two screws was to be understood. This ambiguity is henceforth removed. The two screws involved each receives the addition of the unit-vector, by which they are transformed into vector-screws; and then the convention is established that the right-handed angle between the two vector-screws is the angle to be employed in the expression of the virtual coefficient. No doubt this had been to some extent implied in the paper* already referred to; but it is now for the first time explicitly stated. The deduction of the expression for the virtual coefficient will here be set forth not as it was originally given,† nor as it was given many years later in a general treatise‡ on the Theory of Screws, but as it should have been given.

The subject had been always troublesome; and when I saw at last what I ought to have seen at first, it was plain that a difficulty had been removed from the foundation of the Theory of Screws. I therefore desire that this emendation shall have a place in the series of memoirs which the Academy have so kindly received from me for so many years.

The problem is as follows:—It is required to find an expression for the work done when a body makes a small twist of amplitude α' about one

* Trans. Roy. Ir. Acad., vol. xxxii., pp. 109–115 (1902).

† Trans. Roy. Ir. Acad., vol. xxv., p. 167 (1871).

‡ "Treatise," p. 17 (1900).

vector-screw α, while at the same time the body is acted upon by a wrench of intensity β'' on another vector-screw β.

We denote by θ the right-handed angle between α and β. We take P a point on α, and Q a point on β, such that PQ is at right angles both to α and β, and of course $PQ = d$ is the shortest distance between α and β.

The wrench on β is composed

(1) of a force of β'' units acting on Q, and in the direction of the vector on β; and

(2) of a couple of moment $\beta'' p_\beta$ right-handed or left-handed about the vector on β, according as $\beta'' p_\beta$ is positive or negative.

The couple may be represented by the two forces $\beta'' p_\beta d^{-1}$ separated by the distance d. One of these forces acts at P and the other at Q; and they are normal both to β and PQ. We sacrifice no generality by making both β'' and p_β positive, so that the couple shall tend to a right-handed rotation about β.

The original wrench on β is thus replaced by three equivalent forces, viz. :—

β''	acting on	Q,
$\beta'' p_\beta d^{-1}$	acting on	Q,
$\beta'' p_\beta d^{-1}$	acting on	P.

As all the forces forming the wrench are thus brought to bear either at P or at Q, it follows that in the determination of the virtual moment we are only concerned with the displacements of the two points P and Q.

The twist about the vector-screw α gives to P a displacement $\alpha' p_\alpha$ in the direction of the vector on α. The same twist produces two displacements in Q, to wit, $\alpha' p_\alpha$, in the direction of the vector on α, and $\alpha' d$, which lies in the normal to α and PQ, and tends in the direction of a right-handed rotation about α.

There is thus one virtual moment at P, but there are four at Q; for each of the two displacements of Q will have a virtual moment with each of the two forces at Q. The algebraic sum of these five quantities expresses the virtual moment of the original twist and the original wrench.

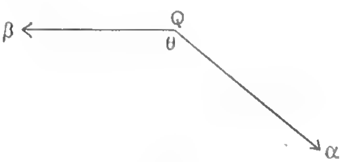

FIG. 2.

Fig. 2 shows the vector-screw α projected down on the plane of the paper, which is supposed to contain β, and to which QP is normal. The actual situation of α is above the plane of the paper; and this is suggested in fig. 2 by making α longer than β. With this agreement it is obvious from the definition that θ and not $360^\circ - \theta$ is the *right-handed angle* between the two screws α and β.

Fig. 3 is in the plane drawn through P and normal to PQ. Thus fig. 3 represents a plane above the plane of fig. 2.

Fig. 4 is in the plane of fig. 2; i.e., it is the plane drawn through Q and normal to QP.

In figs. 3 and 4 we represent the three forces into which the wrench has been analyzed, and also the one displacement of P and the two displacements of Q. The displacements are shown by the dotted lines and the forces by continuous lines.

As the body is translated through the distance $\alpha' p_\alpha$; in the direction of α this displacement must be assigned both to P in fig. 3, and to Q in fig. 4.

The rotation α' about α is without effect on P, and therefore does not appear in fig. 3. But this rotation displaces Q, as shown in fig. 4, through the distance $\alpha' d$. The direction of this displacement in fig. 4 is determined by remembering that the rotation is right-handed about α, and that α is above the plane of the paper in fig. 4.

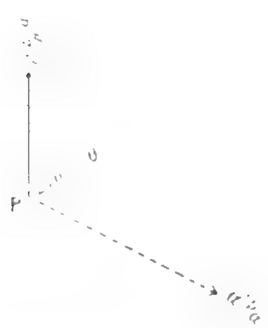

Fig. 3.

Fig. 4.

The directions given to the forces $\beta'' p_\beta d^{-1}$ in figs. 3 and 4 are such as to make the couple which they form right-handed with regard to β.

The virtual moment at P is accordingly expressed by the single term

$$-\alpha' \beta'' p_\alpha p_\beta d^{-1} \sin\theta.$$

The virtual moment at Q, fig. 4, is the sum of 4 terms.

The virtual moment of	β''	and	$\alpha' p_\alpha$	is	$+\alpha' \beta'' p_\alpha \cos\theta$,
,, ,, ,,	β''	,,	$\alpha' d$	,,	$-\alpha' \beta'' d \sin\theta$,
,, ,, ,,	$\beta'' p_\beta d^{-1}$	,,	$\alpha' p_\alpha$	,,	$+\alpha' \beta'' p_\alpha p_\beta d^{-1} \sin\theta$,
,, ,, ,,	$\beta'' p_\beta d^{-1}$	,,	$\alpha' d_\alpha$	,,	$+\alpha' \beta'' p_\beta \cos\theta$.

Assembling the five terms, which collectively form the virtual moment of the wrench on β and the twist about α, it is seen that the virtual moment at P is cancelled by the third term in the virtual moment at Q, and that the final result is

$$\alpha'\beta''\{(p_\alpha + p_\beta)\cos\theta - d\sin\theta\}. \tag{1}$$

We have next to consider the effect of an interchange which, instead of assigning the wrench to β and the twist to α, makes the twist belong to β and the wrench to α. The problem may be enunciated as follows:—

It is required to find the virtual moment when a body receives a twist of small amplitude β' about the vector-screw β; while at the same time it is acted upon by a wrench of intensity α'' about the vector screw α.

The answer is obtained by the interchange of α and β in the expression just proved for the virtual moment. It is first of all to be noticed that this interchange does not alter the expression

$$(p_\alpha + p_\beta)\cos\theta - d\sin\theta$$

in any way whatever, for $(p_\alpha \times p_\beta)$ is of course unchanged, and remembering the definition of the right-handed angle between two screws, it is easily seen that the right-handed angle between α and β is also the right-handed angle between β and α. Thus the interchange of α and β is devoid of effect on θ, nor is d altered, for this is a signless quantity. As the quantity

$$(p_\alpha + p_\beta)\cos\theta - d\sin\theta$$

is unaltered by the interchange of α and β, the only alteration in the virtual moment caused by the interchange of α and β lies in the factor outside the bracket, which becomes $\alpha''\beta'$ instead of $\alpha'\beta''$. Thus the required result is

$$\alpha''\beta'\{(p_\alpha + p_\beta)\cos\theta - d\sin\theta\}.$$

The *virtual coefficient* is the name given to that symmetrical function of two vector-screws which is expressed by

$$\varpi_{\alpha\beta} \equiv + \tfrac{1}{2}\{(p_\alpha + p_\beta)\cos\theta - d\sin\theta\}, \tag{2}$$

where θ is the right-handed angle between the two screws.

This has of course been the expression so long used in the Theory of Screws. The particular point now brought out is that to make the virtual coefficient so written universally valid exactly as it stands, it is necessary that the two screws shall be vector-screws, and that θ shall be the right-handed angle between them.

If the vector-screw β coincides with the vector-screw α, then $p_\beta = p_\alpha$, $\theta = 0$, $d = 0$; and, consequently, the virtual coefficient reduces simply to p_α. That this reduction shall take place is the principal reason why the factor $\frac{1}{2}$ has been introduced into the function which defines the virtual coefficient.

The convenience arising from our adoption of the *right-handed angle* between two vector-screws, as one of the elements indicating their relative position, may be illustrated by showing the inconvenience that would arise if we adopted another angle which may or may not be the right-handed angle, namely, the acute angle between the two screws.

In fig. 5 the acute angle between α and β is θ, whether α be above β or β above α. But, in the former case, the virtual coefficient would be

FIG. 5.

$$\tfrac{1}{2}\{(p_\alpha + p_\beta)\cos\theta - d\sin\theta\},$$

and, in the latter, it can easily be proved that the virtual coefficient would be

$$\tfrac{1}{2}\{(p_\alpha + p_\beta)\cos\theta + d\sin\theta\}.$$

We avoid this change of sign in the second term by agreeing that the angle to be employed in the expression of the virtual coefficient shall be the right-handed angle. When α is above β, this angle is θ; but when α is below β, the angle is $360° - \theta$. Thus the sign of the second term in the virtual coefficient is always to be negative, and ambiguity is escaped when the angle θ is understood to be the right-handed angle between the two vector-screws. Of course ambiguity would have been equally escaped by consistently taking the left-handed angle for θ. We have preferred to take the right-handed angle, because the form that it gives to the virtual coefficient is that with which we had already been familiar.

Owing to the symmetry of the virtual coefficient as respects the two screws to which it relates, we are enabled to make the following statement:—

If a wrench on a screw β does not disturb the equilibrium of a body only free to twist about a screw α, then, conversely, a wrench on a screw α will not disturb the equilibrium of a body only free to twist about β.

In both cases $\varpi_{\alpha\beta} = 0$, and the screws α and β are said to be reciprocal.* It is abundantly shown in the preceding memoirs that the doctrine of reciprocal screws is fundamental in the present theory.

We have hitherto been discussing the right-handed angle between two *vector*-screws; but we may sometimes find it convenient to introduce the notion of the right-handed angle between two screws (i.e. not necessarily vector-screws), presuming only that in this more general case the right-handed angle may be ambiguous to the extent of any integral number of multiples of 180°; whereas the right-handed angle between two *vector*-screws never becomes ambiguous so long as they do not intersect. (Of course we do not now count integral multiples of 360°.)

* "Treatise," p. 26.

Let P, Q be the two points in which any two screws α and β are respectively intersected by their common perpendicular. If we imagine α to be rotated in a right-handed direction about the vector PQ until it becomes parallel to β, the angle θ through which α has been turned is the right-handed angle between β and the original position of α. But if we then continue the rotation of α for another 180° in the same direction, it will, in the absence of the indicating vectors, resume precisely the same position with regard to β, so that $180° + \theta$ has just as much claim as θ to be regarded as the right-handed angle between the screws α and β. If in the expression already found for the virtual coefficient (2) we increase θ by 180°, the magnitude is unaltered though the sign is changed.

Thus the virtual coefficient of two screws is definite in magnitude but indefinite in sign. In this respect the virtual coefficient of two screws offers a parallel to the cosine of the angle between two *lines.*

The virtual coefficient of two vector-screws is definite in magnitude and not indefinite in sign. This is, of course, parallel to the case of the cosine of the angle between two *vectors.*

The only indefiniteness in the right-handed angle between two screws which do not intersect is an integral multiple of 180°.

If two vector-screws are reciprocal, they will remain reciprocal if the directions of either or both of the vectors are reversed. In speaking of reciprocal vector-screws we may therefore omit the word 'vector'; for the relation indicated is irrespective of the sense of direction on either screw.

II.—*On the Composition of Twists or Wrenches on Vector-Screws.*

Let α', β', γ' be the amplitudes of the twists on three vector-screws α, β, γ; the relations between the three amplitudes and the three screws being such that the body after the last twist is restored to the same place which it occupied before the first.

Let η'' be the intensity of a wrench on any fourth vector-screw η. Then the virtual moment of this wrench while the body receives the twist α' is $2\eta''\alpha'\varpi_{\alpha\eta}$. Hence the total work done in the course of the three twists is

$$2\eta''\alpha'\varpi_{\alpha\eta} + 2\eta''\beta'\varpi_{\beta\eta} + 2\eta''\gamma'\varpi_{\gamma\eta}. \qquad (3)$$

As the body is restored to its original position after the completion of the three twists, the expression just written must be zero, whatever be the screw η or whatever be the magnitude η'': we therefore have*

$$\alpha'\varpi_{\alpha\eta} + \beta'\varpi_{\beta\eta} + \gamma'\varpi_{\gamma\eta} = 0 \ . \ . \ . \qquad (4)$$

* "Treatise," p. 18.

From this we can prove the following fundamental theorem:—

If twists of amplitudes α', β', γ' about three vector-screws α, β, γ neutralize each other when applied to the same rigid body, then wrenches of intensities $\alpha'', \beta'', \gamma''$ on the same vector-screws α, β, γ will be in equilibrium when applied to a rigid body of

$$\alpha'' : \beta'' : \gamma'' :: \alpha' : \beta' : \gamma'. \tag{5}$$

This is a consequence of the symmetry of the virtual coefficient of two vector-screws with regard to these vector-screws;* for, from the condition stated (5), the equation (4) may be written

$$\alpha''\varpi_{\alpha\eta} + \beta''\varpi_{\beta\eta} + \gamma''\varpi_{\gamma\eta} = 0. \tag{6}$$

If η' be the amplitude of a small twist about η, then (6) may be expressed thus

$$2\eta'\alpha''\varpi_{\alpha\eta} + 2\eta'\beta''\varpi_{\beta\eta} + 2\eta'\gamma''\varpi_{\gamma\eta} = 0. \tag{7}$$

This shows that three wrenches of intensities $\alpha'', \beta'', \gamma''$ on the vector-screws α, β, γ do collectively no work when the body receives a twist about any screw whatever. It follows that three wrenches must equilibrate, and the desired theorem has been proved.

It thus appears that twists and wrenches are compounded by laws which can be derived from (4) and (6) by merely attributing to η various positions and pitches.† We may commence by showing that when wrenches of intensities $\alpha'', \beta'', \gamma''$ respectively on three vector-screws α, β, γ equilibrate, then the line intersecting two of those screws perpendicularly must also intersect the third perpendicularly.

We observe that the virtual coefficient of two screws which intersect at right angles is zero; for then both $d = 0$ and $\cos\theta = 0$. If therefore we take for η any screw on the common perpendicular intersecting α and β, we have

$$\varpi_{\alpha\eta} = 0 \quad \text{and} \quad \varpi_{\beta\eta} = 0,$$

and therefore from (6)

$$\gamma''\varpi_{\gamma\eta} = 0.$$

We cannot satisfy this by making $\gamma'' = 0$; for then the two wrenches on α and β would have to equilibrate, which is not possible unless α and β are identical screws: rejecting this case, we have

$$\varpi_{\gamma\eta} = 0.$$

If as usual d is the shortest distance between γ and η, and θ the right-handed angle between them, we infer that

$$(p_\gamma + p_\eta)\cos\theta - d\sin\theta = 0.$$

* Klein, Math. Ann., vol. iv., p. 413 (1871).

† Of course these laws are already well known ("Treatise," p. 18), but their derivation from formulæ (4) and (6) will be useful in what follows.

But this must be true for all values of p_η whence

$$\cos\theta = 0 \quad \text{and} \quad d = 0,$$

and accordingly η must also intersect γ at right angles.

We shall now investigate generally the conditions which must be satisfied if a body having received three twists of amplitudes α', β', γ' about three vector-screws α, β, γ respectively is to be restored by the third twist to the position it occupied before the first.

It has just been shown that the conditions require α, β, γ to be intersected at right angles by a common axis which we shall suppose to be normal to the plane of the paper at O, fig. 6.

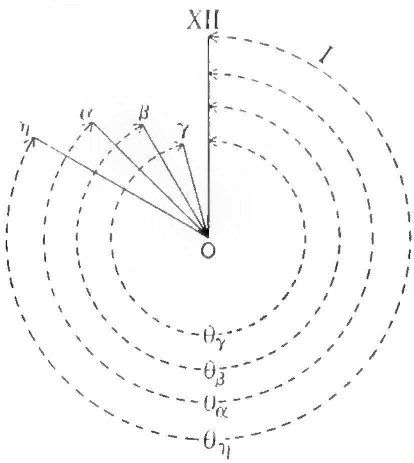

FIG. 6.

We now take a screw η which is subject to no other limitation than that it shall also intersect the same axis at right angles.

In drawing the figure I have made

$$O\eta > O\alpha > O\beta > O\gamma,$$

as has been already indicated. This is the conventional device for indicating that $O\eta$ is higher above the plane of the paper than $O\alpha$, that $O\alpha$ is higher than $O\beta$, and that $O\beta$ is higher than $O\gamma$.

By θ_η we may understand the angle measured from XII on a watch-dial in the direction of increasing figures to $O\eta$ which is the projection of η on the dial. Similar meanings attach to θ_α, θ_β, θ_γ.

As η is above α, the right-handed angle between η and α is

$$\eta O\alpha = \theta_\alpha - \theta_\gamma.$$

The respective distances of η and α above the plane of the paper are z_η and z_α, and as the former of these is the greater, the shortest distance between η and α is $z_\eta - z_\alpha$.

We thus obtain the virtual coefficient of η and α by the following equation, which is succeeded by the two similar equations for η and β, and η and γ:—

$$\left.\begin{aligned} 2\varpi_{\eta\alpha} &= (p_\alpha + p_\eta)\cos(\theta_\alpha - \theta_\eta) - (z_\eta - z_\alpha)\sin(\theta_\alpha - \theta_\eta \\ 2\varpi_{\eta\beta} &= (p_\beta + p_\eta)\cos(\theta_\beta - \theta_\eta) - (z_\eta - z_\beta)\sin(\theta_\beta - \theta_\eta) \\ 2\varpi_{\eta\gamma} &= (p_\gamma + p_\eta)\cos(\theta_\gamma - \theta_\eta) - (z_\eta - z_\gamma)\sin(\theta_\gamma - \theta_\eta) \end{aligned}\right\} \quad (8)$$

As the three twists are to neutralize, we must have from (4)

$$\alpha'\varpi_{\eta\alpha} + \beta'\varpi_{\eta\beta} + \gamma'\varpi_{\eta\gamma} = 0,$$

and by substituting in this the values just found for

$$\varpi_{\eta\alpha}, \quad \varpi_{\eta\beta}, \quad \varpi_{\eta\gamma},$$

we see that

$$\begin{aligned} 0 = &+ \alpha'(p_\alpha\cos\theta_\alpha + z_\alpha\sin\theta_\alpha)\cos\theta_\eta, \\ &+ \beta'(p_\beta\cos\theta_\beta + z_\beta\sin\theta_\beta)\cos\theta_\eta, \\ &+ \gamma'(p_\gamma\cos\theta_\gamma + z_\gamma\sin\theta_\gamma)\cos\theta_\eta, \\ &+ \alpha'(p_\alpha\sin\theta_\alpha - z_\alpha\cos\theta_\alpha)\sin\theta_\eta, \\ &+ \beta'(p_\beta\sin\theta_\beta - z_\beta\cos\theta_\beta)\sin\theta_\eta, \\ &+ \gamma'(p_\gamma\sin\theta_\gamma - z_\gamma\cos\theta_\gamma)\sin\theta_\eta, \\ &+ (\alpha'\cos\theta_\alpha + \beta'\cos\theta_\beta + \gamma'\cos\theta_\gamma)(p_\eta\cos\theta_\eta + z_\eta\sin\theta_\eta), \\ &+ (\alpha'\sin\theta_\alpha + \beta'\sin\theta_\beta + \gamma'\sin\theta_\gamma)(p_\eta\sin\theta_\eta - z_\eta\cos\theta_\eta). \end{aligned} \quad (9)$$

This equation must be satisfied for all values of p_η, for all values of θ_η, and for all values of z_η. These conditions will be fulfilled if, but only if, the following four equations are true:—

$$\begin{aligned} &+ \alpha'(p_\alpha\cos\theta_\alpha + z_\alpha\sin\theta_\alpha), \\ &+ \beta'(p_\beta\cos\theta_\beta + z_\beta\sin\theta_\beta), \\ &+ \gamma'(p_\gamma\cos\theta_\gamma + z_\gamma\sin\theta_\gamma) = 0. \end{aligned} \quad (10)$$

$$\begin{aligned} &+ \alpha'(p_\alpha\sin\theta_\alpha - z_\alpha\cos\theta_\alpha), \\ &+ \beta'(p_\beta\sin\theta_\beta - z_\beta\cos\theta_\beta), \\ &+ \gamma'(p_\gamma\sin\gamma_\gamma - z_\gamma\cos\theta_\gamma) = 0. \end{aligned} \quad (11)$$

$$\alpha'\cos\theta_\alpha + \beta'\cos\theta_\beta + \gamma'\cos\theta_\gamma = 0. \quad (12)$$

$$\alpha'\sin\theta_\alpha + \beta'\sin\theta_\beta + \gamma'\sin\theta_\gamma = 0. \quad (13)$$

The formulæ (10), (11), (12), (13) express the necessary relations of the positions and pitches of the three vector-screws, and provide a determination of the amplitude-ratios of the neutralizing twists.

From (12) and (13) we obtain

$$\alpha' : \beta' : \gamma' :: \sin(\theta_\beta - \theta_\gamma) : \sin(\theta_\gamma - \theta_\alpha) : \sin(\theta_\alpha - \theta_\beta). \quad (14)$$

Thus we learn that when three twists on three vector-screws neutralize, the amplitude of each twist is proportional to the sine of the angle between the other two.* When the signs of the amplitudes are also required, the formula (14), taken in conjunction with fig. 6, must also be attended to.

It remains to investigate the way in which the three vector-screws are related. It will be convenient for this purpose to suppose that the two screws α and β are given so that p_α, p_β, θ_α, θ_β, z_α, z_β are all known; and we shall seek the equations connecting these quantities with p_γ, θ_γ, z_γ. As γ is now regarded as a current vector-screw, we shall write p, θ, z for p_γ, θ_γ, z_γ.

We can eliminate z by multiplying (10) by $\cos\theta$ and adding it to (11), after multiplication by $\sin\theta$. If at the same time we substitute for α', β', γ' from (14), we obtain

$$\begin{aligned} p\sin(\theta_\beta - \theta_\alpha) = &+ p_\alpha \cos(\theta_\alpha - \theta)\sin(\theta_\beta - \theta) \\ &+ p_\beta \cos(\theta_\beta - \theta)\sin(\theta - \theta_\alpha) \\ &+ z_\alpha \sin(\theta_\alpha - \theta)\sin(\theta_\beta - \theta) \\ &+ z_\beta \sin(\theta_\beta - \theta)\sin(\theta - \theta_\alpha). \end{aligned} \tag{15}$$

If we introduce three new quantities, A, B, C, which are constant so far as p and θ are concerned, and defined by the formulæ

$$A \equiv -p_\alpha \sin\theta_\alpha \cos\theta_\beta + p_\beta \cos\theta_\alpha \sin\theta_\beta + (z_\alpha - z_\beta)\cos\theta_\alpha \cos\theta_\beta, \tag{16}$$

$$2B \equiv (p_\beta - p_\alpha)\cos(\theta_\alpha + \theta_\beta) + (z_\beta - z_\alpha)\sin(\theta_\alpha + \theta_\beta), \tag{17}$$

$$C \equiv +p_\alpha \cos\theta_\alpha \sin\theta_\beta - p_\beta \cos\theta_\beta \sin\theta_\alpha + (z_\alpha - z_\beta)\sin\theta_\alpha \cos\theta_\beta, \tag{18}$$

with this substitution we may write equation (15) as follows

$$p\sin(\theta_\beta - \theta_\alpha) = A\sin^2\theta + 2B\sin\theta\cos\theta + C\cos^2\theta. \tag{19}$$

If p be a maximum or minimum, then of course

$$(A - C)\sin 2\theta + 2B\cos 2\theta = 0. \tag{20}$$

There are thus two values of θ differing by 90°, of which each gives a stationary value of p. We shall take these screws of stationary pitch for α and β, and we shall so adjust the line from which θ is measured that $\theta_\alpha = 0$ and $\theta_\beta = 90°$. The formula (20) must thus reduce to $\sin 2\theta = 0$, whence $B = 0$. If we substitute in the general expression for $2B$, (17) we obtain

$$z_\beta - z_\alpha = 0, \tag{21}$$

from which we learn that the two screws of stationary pitch in the cylindroid, or in what we may also call a two-system of screws, intersect at right angles.

The general expressions also give in this case $A = p_\beta$ and $C = p_\alpha$,

* "Treatise," p. 21.

and thus we have the following remarkable expression for the pitch of the screw corresponding to θ, viz.

$$p = \cos^2\theta p_\alpha + \sin^2\theta p_\beta. \tag{22}$$

This is of course an elementary result in the Theory of Screws,* but this method of obtaining it from the virtual coefficient has not been given in the previous papers.

We can introduce much simplification into the formulæ (10) and (11) by taking as origin the point which is so obviously suggested by being the intersection of the two screws of stationary pitch. We then have $z_\alpha = z_\beta = 0$, and as $\theta_\alpha = 0$ and $\theta_\beta = 90°$, we find (14)

$$\alpha' : \beta' : \gamma' :: \cos\theta : \sin\theta : -1.$$

Thus formulæ (10) and (11) become respectively

$$p_\alpha \cos\theta - p\cos\theta - z\sin\theta = 0,$$

$$p_\beta \sin\theta - p\sin\theta + z\cos\theta = 0,$$

whence

$$z = (p_\alpha - p_\beta)\sin\theta\cos\theta. \tag{23}$$

If the line which all the screws intersect is the axis of z, the surface on which all the screws lie, so well known as the cylindroid,† has as its equation

$$z(x^2 + y^2) = (p_\alpha - p_\beta)xy. \tag{24}$$

This is perhaps the most satisfactory method of investigating the equation of the cylindroid so far as the Theory of Screws is concerned. In the deduction of the equation of the surface previously given‡ I assumed that the two principal screws of the cylindroid intersected at right angles. No doubt the legality of this assumption was subsequently justified, but the method here followed seems not open to objection.

As a further illustration of the formulæ connected with the virtual coefficients, we may prove the following theorem:—

If in a 2-system p_1, p_2, p_3 are the pitches of three vector-screws 1, 2, 3, which make right-handed angles $\theta_1, \theta_2, \theta_3$ respectively with a standard vector-screw also perpendicular to the axis of the 2-system, show that we have the following three equations:—

$$\left.\begin{aligned} p_1\sin(\theta_3 - \theta_2) + \varpi_{12}\sin(\theta_1 - \theta_3) + \varpi_{13}\sin(\theta_2 - \theta_1) &= 0,\\ \varpi_{12}\sin(\theta_3 - \theta_2) + p_2\sin(\theta_1 - \theta_3) + \varpi_{23}\sin(\theta_2 - \theta_1) &= 0,\\ \varpi_{13}\sin(\theta_3 - \theta_2) + \varpi_{23}\sin(\theta_1 - \theta_3) + p_3\sin(\theta_2 - \theta_1) &= 0, \end{aligned}\right\} \tag{25}$$

* "Treatise," p. 19.

† The relation of this surface to the Theory of Screws was first given in Trans. R.I.A., vol. xxv., p. 161 (1871). The discovery of the surface is, however, due to Hamilton (1830): see "Treatise," pp. 510–11.

‡ "Treatise," p. 19.

in which

$$\left.\begin{aligned} 2\varpi_{23} &= (p_2 + p_3)\cos(\theta_3 - \theta_2) - d_{23}\sin(\theta_3 - \theta_2), \\ 2\varpi_{31} &= (p_3 + p_1)\cos(\theta_3 - \theta_1) - d_{31}\sin(\theta_3 - \theta_1), \\ 2\varpi_{12} &= (p_1 + p_2)\cos(\theta_2 - \theta_1) - d_{12}\sin(\theta_2 - \theta_1). \end{aligned}\right\} \quad (26)$$

The three equations (25) are obtained immediately by expressing that three neutralizing twists on 1, 2, 3 respectively can do no work against a wrench on 1, or on 2, or on 3.

In the first group of equations (25) the quantities

$$\sin(\theta_3 - \theta_2) \quad \sin(\theta_1 - \theta_3), \quad \sin(\theta_2 - \theta_1),$$

being the amplitudes of the three twists which neutralize, are formed by taking the angles cyclically. For this purpose, the planes in which the different vector-screws lie are not material.

It might hastily be assumed that the quantities

$$\sin(\theta_3 - \theta_2), \quad \sin(\theta_3 - \theta_1), \quad \sin(\theta_2 - \theta_1),$$

which occur in the equations (26) as the coefficients of d_{23}, d_{31}, d_{12}, should also be formed by taking the angles θ_1, θ_2, θ_3 cyclically. But to do so would have made the formulæ erroneous. The angles here involved are in each case the right-handed angles between the corresponding pair of vector-screws. The order of superposition of these vectors—that is to say, the relative positions of the planes in which they lie—have to be carefully attended to. It will, of course, be remembered that in obtaining the expression of the virtual coefficient, it was particularly specified that the angle introduced into the expression must invariably be the right-handed angle between the two vector-screws.

Right-handed and left-handed Pairs of Lines.

A pair of lines which do not lie in the same plane and are not at right angles may be distinguished as right-handed or left-handed.

A disc *LM*, being supposed to be inserted between the two lines *AB* and *A′B′* in fig. 7, and between *PQ* and *P′Q′* in fig. 8, enables us to represent that *AB* lies over *A′B′*, and that *PQ* lies over *P′Q′*.

As a convenient mnemonic we may fancy the right arm *AB* crossed over the left *A′B′* to form fig. 7, and the left arm *QP* crossed over the right *Q′P′* to form fig. 8. Thus we may appropriately distinguish the two figures as right-handed and left-handed, so long as the two lines of each pair do not intersect, and so long as the angles *AOA′* or *POP′* are both acute. Suppose ∠ *AOA′* was increased up to 90°, then a critical stage is reached; and the distinction between a right-handed pair and a left-handed pair will at that moment vanish. If AOA' exceeds 90°, then the lines AB and $A'B'$ (fig. 7), having passed the critical point, have become left-handed instead of right-handed. By reflection from a looking-glass, a right-handed pair of lines will appear as a left-handed pair, or *vice versa.*

We have now to prove two general properties of a cylindroid, which may be thus stated.

The generator which contains the screw of greatest pitch on the cylindroid makes a left-handed pair with every other generator on the surface.

The generator which contains the screw of least pitch on the cylindroid makes a right-handed pair with every other generator on the surface.

We have from the formula (23)

$$z = (p_\alpha - p_\beta) \sin\theta \cos\theta. \qquad (27)$$

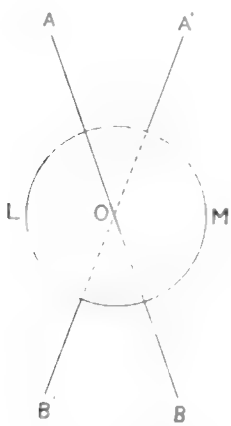

Fig. 7.—Right-handed.

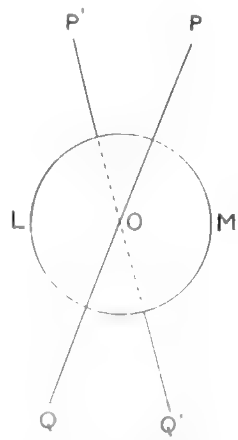

Fig. 8.—Left-handed.

If $p_\alpha > p_\beta$ and $\theta \ngtr 90°$, then z is positive: hence, observing the direction in which θ is measured (fig. 6), and that z is above the plane of the paper, it is obvious that the generator defined by z and θ is above the plane of the paper; and from the position of θ this generator is plainly left-handed with regard to α, for which $\theta = 0$.

If, however, $\theta \nless 90°$, then the corresponding screw is below the plane of the paper; but it is still left-handed with regard to α.

Thus the generator of the cylindroid which contains α is left-handed with regard to every other generator on the surface. Of course, as α and β intersect at right angles, that particular pair are both right-handed and left-handed.

In like manner it can be shown that the generator of the cylindroid which contains β, the screw of least pitch on the surface, is right-handed with regard to every other generator on the surface.

It is instructive to prove the same theorems geometrically as follows:—

Let AA', BB', CC', DD' (fig. 9) be a cube of which O is the centre, and draw LM through O and $\|$ AA', BB', CC', DD'. Draw XY through O and $\|$ CB', $C'B$, AD', $A'D$. Let AB and CD be the bounding screws of the cylindroid, with centre at O and axis LM. We shall suppose that the cylindroid has been made canonical—i.e., that the pitches of the bounding-screws are both zero, and that the pitches of the two principal screws are equal in magnitude and opposite in sign. Any cylindroid can of course be made canonical without any other alteration than the addition of a certain magnitude, positive or negative, to the pitches of all the screws it contains.*

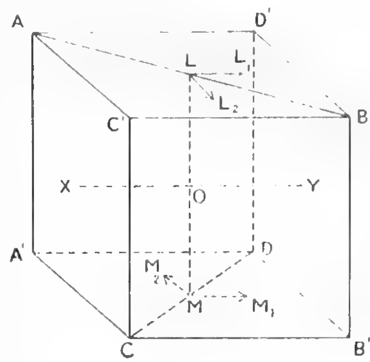

FIG. 9.

From the fundamental property of the cylindroid we see that a twist about any screw on the canonical cylindroid can be resolved into rotations about AB and CD. A rotation about AB does not alter the position of any point on AB, and consequently the effect of any twist on the cylindroid upon the point L will be the same as if the twist were produced merely by a rotation about CD. But remembering that the amplitude of the twist is a small quantity, this is the same so far as L is concerned as a displacement of L along AB. In like manner it is shown that the effect on M produced by a twist about *any* screw on the canonical cylindroid can never be anything but a displacement of M along CD.

Consider now the effect on the point L produced by the combination of a right-handed rotation round the vector XY, with a translation parallel to XY. If α' be the amplitude of the twist, and p_α be the pitch of the screw on XY, and if m be the semiaxis of the cylindroid and equal to OL, then $LL_2 = m\alpha'$ is the distance through which L is moved by the rotation. As, however, the total effect of the twist on L is to move L along AB, we see that the movement LL_2 on one side of AB must be compensated by another displacement to the other side of AB. This is of course $LL_1 = \alpha' p_\alpha$, and consequently for a twist about the vector-screw α, the translation LL_1 must be that of a right-handed screw—i.e., p_α is positive.

But AB and XY form a left-handed pair, as do also XY and CD, and thus the desired theorem has been proved.

* "Treatise," p. 47.

If, however, the two bounding screws of the cylindroid had been $C'D'$ and $A'B'$, it is plain that LL_1 and MM_1 must tend in directions opposite to those given in the figure. In this case the pitch of the screw on XY must be negative. We thus obtain the general result that has been already otherwise proved on p. 34, viz.:—

The screw of smallest pitch on the cylindroid makes a right-handed pair with every other screw on the surface. The screw of largest pitch on the cylindroid makes a left-handed pair with every other screw on the surface.

This theorem may be generalized in the following way, which will show how any one generator on the cylindroid is related as to right-handedness or left-handedness to all the remaining generators.

Let $APP'P''$ (fig. 10) be the circular representation* of the several screws on a cylindroid. ML is the axis of pitch, and A is the point corresponding to the screw of greatest pitch on the surface. Let P be a point on the circle corresponding to any other screw on the cylindroid.

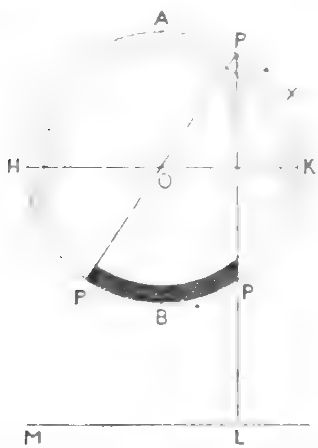

Fig. 10.

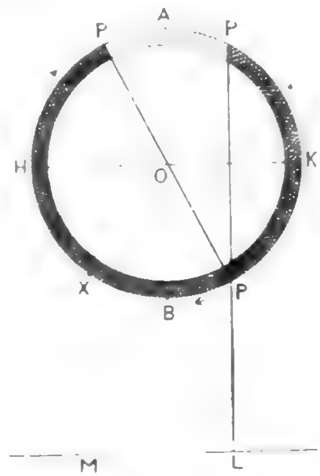

Fig. 11.

Draw PP' (fig. 10), perpendicular to ML, and draw the diameter PP''. It follows from the principles of the circular representation that P' corresponds to that screw on the cylindroid which intersects the screw corresponding to P while P'' corresponds to the screw on the cylindroid which is perpendicular to P. It is plain that P will have a relation as to right-handedness or left-handedness with every other screw on the cylindroid except the two critical screws P' and P'' when the relation vanishes because P and P' intersect, and P and P'' are at right angles.

Let H, K be the bounding screws of the cylindroid. We shall suppose

* "Treatise," p. 45 and p. 120.

at first that P lies on the semicircle HAK; as already shown, each pair of screws are left-handed which lie in that region of the cylindroid defined by HAK.

Let X be a variable screw on the cylindroid which we shall suppose to move in succession over every generator on the surface; and we shall follow the relations as to right-handedness or left-handedness with the other screws. So long as X is in HAK then P and X are a left-handed pair, and there will be no breach of continuity in their condition until X, moving in the direction of the arrow from P towards P', reaches P'. When X has attained this position, the screw corresponding to P and the relation of right-handedness or left-handedness vanish. Thus P' is a critical point, so that when X crosses P' and enters $P'P''$, PX becomes right-handed. This condition remains till X reaches P'', which is another critical point; for there the two screws P and X are at right angles. As X passes to the other side of P'' into the region $P''H$, it again forms a left-handed pair with P; and this condition remains while X moves through the semicircle $P''HAP$ and returns to P.

Thus we see that in fig. 10 the screw corresponding to P makes a right-handed pair with each of the screws on the cylindroid whose representative points lie between P' and P'', while, with every other generator on the surface, P makes a left-handed pair.

If the circumstances had been those represented in fig. 11, then the screws corresponding to P and X would have formed a right-handed pair. This condition would have continued as X advanced in the direction of the arrowhead until the critical point P'' was reached; and PX would be a left-handed pair so long as X was moving from P'' to P'. At P' another critical stage is passed; and P and X would be a right-handed pair as X moved round through $P'KP$.

Thus we see that as fig. 11 is drawn the generator corresponding to P makes a right-handed pair with every generator on the cylindroid except those represented by the points on the arc $P''P'$.

In both figures we see that P and any screw in the hatched portion of the circumference form a left-handed pair, while P and any screw in the cross-hatched portion form a right-handed pair.

As a particular case, we note that, if P coincides with A (fig. 10), then P' coincides with P'', the cross-hatched portion disappears; and consequently every screw on the cylindroid makes a left-handed pair with P.

On the other hand, if P coincides with B (fig. 11), then $P'P''$ vanishes; and the circle is completely cross-hatched: hence we see that the screw of least pitch on the cylindroid forms a right-handed pair with every other screw on the cylindroid.

These theorems ought indeed to have been incorporated with the earliest parts of the Theory of Screws; but I never noticed them until 1909.

We can now see how to construct a system of pitches on the cylindroid when the ruled surface merely has been given.

Let $2m$ be the length of the axis of the cylindroid, and let p_0 be any linear magnitude, positive or negative.

One generator, but only one, can be found on the surface which is right-handed with regard to every other generator on the surface. To this generator we attribute the pitch $p_0 - m$.

One generator, but only one, can also be found on the surface which is left-handed with regard to every other generator on the surface. To this generator we attribute the pitch $p_0 + m$.

The two generators thus indicated form the two principal screws on the cylindroid; and the pitch of any other screw on the surface which makes an angle θ with the screw of maximum pitch will be

$$(p_0 + m)\cos^2\theta + (p_0 - m)\sin^2\theta.$$

We may here notice the following extension of the theorems just given to the case of the 3-system :—

The screw of smallest pitch in a 3-system forms a right-handed pair with respect to every other screw of the 3-system, and the screw of greatest pitch in the 3-system forms a left-handed pair with respect to every other screw of the 3-system.

Let (1), (2), (3) be the three principal screws of the 3-system where $p_1 > p_2 > p_3$.

Let θ be any other screw of the 3-system, and θ_1, θ_2, θ_3 its coordinates with respect to the three principal screws.

The two wrenches θ_1'', θ_2'' compound into a single wrench on a screw ϕ lying on the cylindroid (12), and therefore cutting (3) at right angles.

It is obvious that ϕ and (3) are the principal screws on the cylindroid (ϕ, 3), and that θ must lie on this cylindroid. As p_3 is the smallest pitch on any screw of the system, we must have $p_\phi > p_3$; hence (3) is right-handed with regard to every screw on this cylindroid among which ϕ, and therefore θ, is included.

In like manner, if ψ be any screw on the cylindroid (2), (3), we have θ a screw on the cylindroid (1), ψ; and as p_1 is the greatest pitch of the 3-system, we must have the screws (1) and θ, forming a left-handed pair. Thus the required theorem has been proved.

As an illustration of various principles in this section, we may obtain the locus of the screws of a 2-system, and the law of distribution of the pitch in the following simple manner :—

Let OX, OY be vectors along the two rectangular screws intersecting at O with pitches p_1 and p_2 respectively ($p_1 > p_2$).

Let OA be the projection in the plane of XY of the vector-screw α, which intersects the axis OZ normal to the plane of the paper. As OX has the greatest pitch p_1, it must, as just shown, form a left-handed pair with α; and consequently α is *above* the plane of the paper at the distance z.

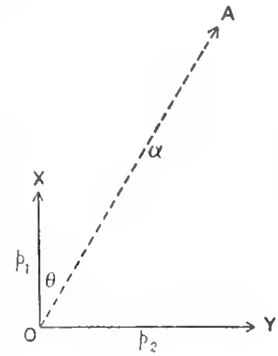

FIG. 12.

Let us imagine another screw on OX to which the pitch $-p_1$ is attributed. Then this is reciprocal to the screw on OX with pitch $+p_1$; and it is also reciprocal to the screw on OY, inasmuch as OX intersects OY at right angles. Thus the screw of pitch $-p_1$ on OX must be reciprocal to α; because, whenever a screw is reciprocal to two screws on a cylindroid, it is reciprocal to every screw.

Observing that α is above the plane of the paper, the right-handed angle between OX and α is $360° - \theta$; and hence we have, from the condition of reciprocity,

$$(p - p_1)\cos(360° - \theta) - z\sin(360° - \theta) = 0.$$

In like manner, observing that α must be reciprocal to a screw of pitch $-p_2$ lying on OY, and that $90° - \theta$ is the right-handed angle between α and OY,

$$(p - p_2)\cos(90° - \theta) - z\sin(90° - \theta) = 0.$$

But if x, y, z be the coordinates of a point on α, we have $\tan\theta = y/x$.

Whence

$$x(p - p_1) + yz = 0, \quad y(p - p_2) - xz = 0;$$

and, eliminating p,

$$z(x^2 + y^2) = (p_1 - p_2)xy$$

is the equation of the cylindroid; and

$$p = p_1\cos^2\theta + p_2\sin^2\theta.$$

The figure is drawn so as to keep in view the suggestive measurement of θ by the watch dial, OX points to XII, and OY to III. As $p_1 > p_2$, we see that when x and y have the same signs z is positive. Thus the surface rises above the paper at OX to meet the paper again in OY.

III.—*On the Pitch Operator* $\frac{\partial}{\partial p_1} + \frac{\partial}{\partial p_2} + \ldots + \frac{\partial}{\partial p_n}$.

Let $\theta_1, \theta_2, \ldots \theta_n$ be n-screws belonging to an $(n-1)$-system. If $\theta_1', \theta_2' \ldots \theta_n'$ be the corresponding amplitudes of n-twists which neutralize, then the work done by a wrench on any screw η in the course of the application of these n-twists must be zero, and consequently

$$\theta_1' \varpi_{\theta_1\eta} + \theta_2' \varpi_{\theta_2\eta} + \ldots \ldots + \theta_n' \varpi_{\theta_n\eta} = 0. \qquad (28)$$

Indeed the necessary and sufficient condition that the n-screws shall belong to an $(n-1)$-system may be expressed by saying that in such a case it must be possible to find a system of quantities, $\theta_1', \theta_2', \ldots \theta_n'$, independent of η, which shall make this equation true for all possible screws η.

If (28) is to be satisfied for all screws η, it must of course be satisfied; if while η remains otherwise unchanged, we change p_η into $p_\eta + h$, where h is any linear quantity.

As p_η only enters into the virtual coefficients $\varpi_{\theta\eta}$ in the several combinations $(p_1 + p_\eta)$, $(p_2 + p_\eta), \ldots (p_n + p_\eta)$, it is plain that the effect of changing p_η into $p_\eta + h$ is just the same as to leave p_η unaltered, but to change $p_1, p_2 \ldots p_n$ into $(p_1 + h)$, $(p_2 + h), \ldots (p_n + h)$ respectively.

Thus we have a result already well known in the theory of screws,* that if $\theta_1 \ldots \theta_n$ be n-screws belonging to an $(n-1)$-system, they will still belong to an $(n-1)$-system if these pitches $p_1, \ldots p_n$ be each increased by the same quantity h, where h may have any value whatever.

As the simplest example we recall that if p be the pitch of a screw on a cylindroid, we know that

$$p = p_1 \cos^2\theta + p_2 \sin^2\theta,$$

which may of course be written thus

$$p + h = (p_1 + h)\cos^2\theta + (p_2 + h)\sin^2\theta.$$

We can now define the pitch-operator

$$\Delta = \frac{\partial}{\partial p_1} + \frac{\partial}{\partial p_2} \ldots + \frac{\partial}{\partial p_n}; \qquad (29)$$

and from what we have just proved, it follows that if $F = 0$ be any general equation connecting n-screws, which belong to an $(n-1)$-system, then

$$\Delta F = 0.$$

If this operation Δ is applied to ϖ_{12}, the virtual coefficient of two screws (1) and (2), it gives

$$\Delta \varpi_{12} = \cos(12),$$

* "Treatise," p. 288.

where (12) is the right-handed angle between the screws 1 and 2. This is obvious from the fact that

$$\varpi_{12} = \tfrac{1}{2}\{(p_1 + p_2)\cos(12) - d_{12}\sin(12)\}. \qquad (30)$$

By the help of the pitch-operator, we are able to obtain many formulæ; and we proceed to give an illustration. We shall first prove the following theorem:—

Let (1), (2), (3) be any three screws of a 2-system—i.e., a system of vector-screws about which three twists can neutralize—it is required to show that

$$p_1p_2p_3 - p_1\varpi^2_{23} - p_2\varpi^2_{31} - p_3\varpi^2_{12} + 2\varpi_{23}\varpi_{31}\varpi_{12} = 0. \qquad (31)$$

If α', β', γ' be the respective amplitudes of the three neutralizing twists, and if η be any other screw whatever, then, as already shown,

$$\alpha'\varpi_{1\eta} + \beta'\varpi_{2\eta} + \gamma'\varpi_{3\eta} = 0.$$

If we allow the screw η to come successively into coincidence with (1), (2), (3), we have the three following equations:—

$$\alpha'p_1 + \beta'\varpi_{12} + \gamma'\varpi_{13} = 0,$$
$$\alpha'\varpi_{21} + \beta'p_2 + \gamma'\varpi_{23} = 0,$$
$$\alpha'\varpi_{31} + \beta'\varpi_{32} + \gamma'p_3 = 0,$$

whence, on elimination of α', β', γ', we obtain the desired result.

The equation (31) must remain true if operated upon by Δ; and we thus obtain

$$\begin{aligned} &p_1p_2 + p_2p_3 + p_3p_1 - \varpi^2_{23} - \varpi^2_{31} - \varpi^2_{12} \\ &\quad - 2p_1\cos(23)\,\varpi_{23} - 2p_2\cos(13)\,\varpi_{31} - 2p_3\cos(12)\,\varpi_{12} \qquad (32) \\ &\quad + 2\cos(23)\,\varpi_{31}\varpi_{12} + 2\cos(31)\,\varpi_{23}\varpi_{12}\ 2\cos(12)\,\varpi_{31}\varpi_{23} = 0. \end{aligned}$$

But this must remain true if again operated upon by Δ, whence we get

$$\begin{aligned} &p_1\sin^2(23) + p_2\sin^2(31) + p_3\sin^2(12) + 2\varpi_{23}(-\cos(23) \\ &\quad + \cos(31)\cos(12)) + 2\varpi_{13}(-\cos(13) + \cos(23)\cos(12)) \\ &\quad + 2\varpi_{12}(-\cos(12) + \cos(31)\cos(23)) = 0. \qquad (33) \end{aligned}$$

Finally the third operation by Δ gives

$$1 - \cos^2(23) - \cos^2(31) - \cos^2(12) + 2\cos(23)\cos(31)\cos(12) = 0. \qquad (34)$$

Of course (34) merely proves the well-known law that the screws (1), (2), (3) must be parallel to the same plane; assuming this to be the case, we may make

$$\angle(12) = \theta_2 - \theta_1;\ \angle(31) = \theta_3 - \theta_1;\ \angle(23) = \theta_3 - \theta_2;$$

and with this substitution (33) becomes after a little reduction

$$\begin{aligned} &p_1\sin^2(\theta_2 - \theta_3) + p_2\sin^2(\theta_3 - \theta_1) + p_3\sin^2(\theta_1 - \theta_2) \\ &\quad + 2\varpi_{23}\sin(\theta_3 - \theta_1)\sin(\theta_1 - \theta_2) + 2\varpi_{13}\sin(\theta_1 - \theta_2)\sin(\theta_2 - \theta_3) \\ &\quad + 2\varpi_{12}\sin(\theta_2 - \theta_3)\sin(\theta_3 - \theta_1) = 0. \qquad (35) \end{aligned}$$

If we now substitute for the virtual coefficients

$$2\varpi_{23} = (p_2 + p_3)\cos(\theta_3 - \theta_2) - d_{23}\sin(\theta_3 - \theta_2),$$
$$2\varpi_{31} = (p_3 + p_1)\cos(\theta_1 - \theta_3) - d_{31}\sin(\theta_3 - \theta_1),$$
$$2\varpi_{12} = (p_1 + p_2)\cos(\theta_2 - \theta_1) - d_{12}\sin(\theta_2 - \theta_1),$$

where attention should be paid to the right measurement of the angles as explained in connexion with fig. 6; it will be seen that the terms involving p_1, p_2, p_3 disappear; and assuming that no two of the screws coincide, the equation reduces to

$$d_{12} + d_{23} = d_{13}. \tag{36}$$

This of course proves no more than the well-known property of the 2-system that the common perpendicular to (1) and (3) also intersects (2).

It is instructive to observe how the original formula (31), taken in conjunction with the pitch-operator, gives at once the fundamental characteristics of the cylindroid.

Let (1) and (2) be the two principal screws of the cylindroid, then $\varpi_{12} = 0$ and also $\Delta\varpi_{12} = \cos(12) = 0$. Thus the formulæ (31) and (32) become

$$p_1p_2p_3 - p_1\varpi^2_{32} - p_2\varpi^2_{31} = 0,$$
$$p_1p_2 + p_3p_1 + p_3p_2 - \varpi^2_{31} - \varpi^2_{32} - 2p_2\varpi_{31}\cos\theta - 2p_1\varpi_{32}\sin\theta = 0, \tag{37}$$

where $360° - \theta$ is the right-handed angle between (1) and (3).

We have

$$2\varpi_{31} = (p_3 + p_1)\cos\theta + d\sin\theta$$
$$2\varpi_{32} = (p_3 + p_2)\sin\theta - d\cos\theta;$$

substituting these values in (37) we obtain

$$(p_3 - p_1\cos^2\theta - p_2\sin^2\theta)^2 + \{d - (p_1 - p_2)\sin\theta\cos\theta\}^2 = 0,$$

whence the well-known fundamental equations

$$\left.\begin{aligned} d &= (p_1 - p_2)\sin\theta\cos\theta, \\ p_3 &= p_1\cos^2\theta + p_2\sin^2\theta. \end{aligned}\right\} \tag{38}$$

In like manner if four screws belong to a 3-system, we must have

$$U = \begin{vmatrix} p_1 & \varpi_{12} & \varpi_{13} & \varpi_{14} \\ \varpi_{21} & p_2 & \varpi_{23} & \varpi_{24} \\ \varpi_{31} & \varpi_{32} & p_3 & \varpi_{34} \\ \varpi_{41} & \varpi_{42} & \varpi_{43} & p_4 \end{vmatrix} = 0 \tag{39}$$

as a general relation to be satisfied by the pitches and the virtual coefficients.

If a screw belongs to a 3-system, it must fulfil three conditions; for example, it must be reciprocal to three screws of the reciprocal system.

Suppose that (1), (2), (3) be three given screws defining the system, then equation (39) is one of the conditions that (4) shall also belong to the system. The conditions will be expressed by

$$U = 0, \quad \Delta U = 0, \quad \Delta^2 U = 0,$$

when Δ is the pitch operator.

If (1), (2), (3) be three coreciprocal screws, then

$$\varpi_{12} = 0, \quad \varpi_{23} = 0, \quad \varpi_{31} = 0\,;$$

and representing (4) by θ, we have the equation $U = 0$ in the form

$$p_\theta = \frac{1}{p_1}\varpi^2_{1\theta} + \frac{1}{p_2}\varpi^2_{2\theta} + \frac{1}{p_3}\varpi^2_{3\theta}. \tag{40}$$

If as usual we denote by θ_1, θ_2, θ_3 the three coordinates of θ with respect to the three coreciprocals, then*

$$p_1\theta_1 = \varpi_{1\theta}, \quad p_2\theta_2 = \varpi_{2\theta}, \quad p_3\theta_3 = \varpi_{3\theta}, \qquad \text{and} \qquad p_\theta = p_1\theta_1^2 + p_2\theta_2^2 + p_3\theta_3^2,$$

which is the well-known expression† for the pitch of a screw of a 3-system expressed in terms of its coordinates. Similar remarks may be made with respect to freedom of the fourth and fifth orders. If six screws belong to a system of the fifth order, there is then only a single condition to be satisfied, which may be written

$$U = \begin{vmatrix} p_1 & \varpi_{12} & \varpi_{13} & \varpi_{14} & \varpi_{15} & \varpi_{16} \\ \varpi_{21} & p_2 & \varpi_{23} & \varpi_{24} & \varpi_{25} & \varpi_{26} \\ \varpi_{31} & \varpi_{32} & p_3 & \varpi_{34} & \varpi_{35} & \varpi_{36} \\ \varpi_{41} & \varpi_{42} & \varpi_{43} & p_4 & \varpi_{45} & \varpi_{46} \\ \varpi_{51} & \varpi_{52} & \varpi_{53} & \varpi_{54} & p_5 & \varpi_{56} \\ \varpi_{61} & \varpi_{62} & \varpi_{63} & \varpi_{64} & \varpi_{65} & p_6 \end{vmatrix} = 0. \tag{41}$$

In this case, as there is only one condition to be satisfied, the formulæ $\Delta U = 0$, $\Delta^2 U = 0$, &c., can be only identities if $U = 0$. The determinant here given is already known in a different form as the sexiant‡ of the six screws, and a quaternion expression of the same function is given further on in the present paper (equation 93).

* "Treatise," p. 34. † *Ibid.*, p. 36. ‡ *Ibid.*, pp. 37, 248.

IV.—*Applications of Quaternions to the Theory of Screws.*

One of the most useful discoveries of Hamilton, at least in so far as our present subject is concerned, is contained in the following proposition* :—

"Any infinitely small change in the position of a rigid body is equivalent to the alteration of each of its vectors α to another of the form

$$\alpha + \delta\alpha = \alpha + \epsilon + V\iota\alpha, \tag{42}$$

ϵ and ι being two *arbitrary* but infinitesimal vectors which do not vary in the passage from one point of the body to another."

This formula is the representation by vector-analysis of the fundamental principles on which the Theory of Screws is based. The vector-conception of a twist which is here indicated shows by its conciseness, elegance, and lucidity that there must be intimate relationship between Quaternions and the Theory of Screws.

The late Professor Charles J. Joly, the editor of "Hamilton's Elements of Quaternions," has contributed an admirable series of original memoirs on Quaternions to the Transactions of the Royal Irish Academy.† These memoirs relate very largely to the Theory of Screws. A concise account of Joly's researches on the application of the Theory of Quaternions to the Theory of Screws has been given by him in the appendix to vol. II. of his edition of Hamilton's "Elements of Quaternions," pp. 390–397 (1901). But the subject has been much more fully dealt with in Joly's "Manual of Quaternions," 1905, a most instructive and useful book, to which, as already indicated, we refer briefly as Joly's "Manual."

The proof by vector-analysis that the most general displacement of a rigid system must be in all cases what we understand as a twist about a

* "Hamilton's Elements," vol. ii., p. 287.

† (1) "The Theory of Linear Vector Functions": Trans. R. I. A., vol. xxx., pp. 597–647 (1894).

(2) "Scalar Invariants of two Linear Vector Functions": Trans. R. I. A., vol. xxx., pp. 709–728 (1895).

(3) "The Interpretation of a Quaternion as a Point-symbol": Trans. R. I. A., vol. xxxii., pp. 1–16 (1901).

(4) "Quaternion Arrays": Trans. R. I. A., vol. xxxii., pp. 17–30 (1901).

(5) "Representation of Screws by Weighted Points": Trans. R. I. A., vol. xxxii., pp. 61–92 (1902).

(6) "The Quadratic Screw System: a Study of a Family of Quadratic Complexes": Trans. R. I. A., vol. xxxii., pp. 155–238 (1903).

(7) "The Geometry of a Three-system of Screws": Trans. R. I. A., vol. xxxii., pp. 239–270 (1903).

(8) "Quaternions and Projective Geometry," communicated by Joly to the Royal Society, and published in the Philosophical Transactions, Series A, vol. 201, pp. 223–327 (1903).

screw, is at once deduced* from Hamilton's fundamental theorem, expressed in (42), which can be written in the form

$$\alpha + \delta\alpha = \alpha + iS\epsilon i^{-1} + Vi\,(\alpha - V\epsilon i^{-1}). \quad (43)$$

This shows that the displacement of a point P (fig. 13) is produced by a rotation of the system through a right-handed angle Ti, round the line of which the equation is

$$\rho = V\epsilon i^{-1} + ti,$$

(where t is a variable scalar) accompanied by a translation parallel to i and equal to $S\epsilon i^{-1}$.

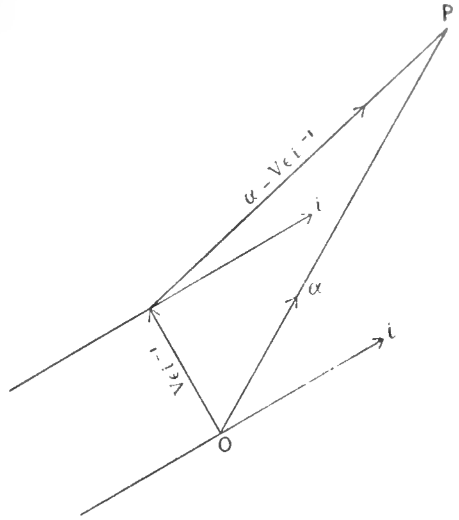

FIG. 13.

The following fundamental principle is well known in quaternions†:—

Let β and $-\beta$ be a pair of vectors coincident with the lines of action of the two forces of a couple PP' and QQ' respectively. Let $T\beta$ be the magnitude of the force on PP' or on QQ'. Let α be a vector drawn from any point on PP' to any point on QQ', then the couple is completely represented by $V\beta\alpha$. For the couple is right-handed about $V\beta\alpha$, and $TV\beta\alpha$ is the moment of the couple. Thus everything about the couple is expressed by $V\beta\alpha$.

Whatever be the forces applied to a rigid body, they may be completely expressed with regard to a given origin O by two vectors λ, μ. The first vector λ represents the resultant of all the forces when transferred in parallel directions to O. The second vector μ expresses the resultant of all the couples introduced by transferring the forces to O.

If (μ, λ) be the vector-moment and force of a system of forces with respect to a point O, then at a point O', such that $OO' = \rho$, the vector-moment and force of the same system will be $\mu + V\lambda\rho$, λ.

The expressions just obtained lead in the simplest and most direct manner to the conception of the central axis, and from thence to the foundations of the Theory of Screws.

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* See Joly, in Hamilton's "Elements," vol. ii., p. 390.

† Hamilton's "Elements," vol. ii., p. 284.

The plane of the resultant couple will be perpendicular to the resultant force if $\mu + V\lambda\rho = p\lambda,$ (44)
where p is some scalar. In this case the moment of the resulting couple is $pT\lambda$.

The intensity of the resultant force is $T\lambda$; hence p is the ratio of the moment of the couple to the intensity of the force; i.e. p is the pitch of the screw on which the given system of forces forms a wrench.

From the equation (44) we have

$$\mu\lambda^{-1} + V\lambda\rho . \lambda^{-1} = p,$$

whence taking scalars $p = S\mu\lambda^{-1};$ (45)
and we obtain the instructive result thus stated.

If (μ, λ) be the resultant couple and resultant force of any system of forces applied to a rigid body, then the resultant wrench is on a screw of which the pitch is $S\mu\lambda^{-1}$.

We can now express the vector-perpendicular from O on the screw in question. If ρ be this vector, then the equation (44) may be written $\mu + V\lambda\rho + S\lambda\rho = p\lambda$, because $S\lambda\rho = 0$.

We thus have

$$\mu + \lambda\rho = p\lambda, \quad \text{or} \quad \lambda^{-1}\mu + \rho = p, \quad \text{or} \quad \rho = - V\lambda^{-1}\mu = V\mu\lambda^{-1}; \qquad (46)$$

we thus have another result also of the greatest importance in our present subject, which may be thus stated:—

If (μ, λ) be the resultant couple and resultant force of any system of forces applied to a rigid body and with respect to any point, then the vector from the origin perpendicular to the screw on which the system of forces forms a wrench is expressed by $V\mu\lambda^{-1}$. This result, as well as the corresponding value of the pitch, (45) is due to Joly,* though they are essentially deductions from Hamilton's quaternion expression for a system of forces.†

The coordinates (μ, λ) define not merely a screw, they define a vector-screw; for $U\lambda$ will indicate which of the two vector-screws on the same axis is to be understood; and $T\lambda$ expresses the intensity of the dyname of which the vector-screw is the site. Thus the completeness of the quaternion representation of the dyname by the two coordinates (μ, λ) leaves nothing more to be desired.

We can now obtain the quaternion equation of the screw on which the dyname with coordinates (μ, λ) is situated. As the screw is parallel to λ and as $V\mu\lambda^{-1}$ is a point on the screw, we must have for the vector ρ to any point on the screw $\rho = V\mu\lambda^{-1} + t\lambda$ (47)
where t is a variable scalar.

* "Manual," p. 156. † "Elements," vol. ii., p. 285.

We might have obtained this result by immediate solution for ρ from formula (44), which may be written

$$\mu - \rho\lambda + S\rho\lambda = p\lambda, \tag{48}$$

and multiplying into λ^{-1}

$$\mu\lambda^{-1} - \rho + \lambda^{-1}S\lambda\rho = p\,; \tag{49}$$

taking the vector and denoting the scalar $S\rho\lambda^{-1}$ by t we have the desired form.

The equation (42) may be written

$$\delta a = \epsilon + Vi\eta + Vi\,(a - \eta). \tag{50}$$

Thus we see that the displacement of the system may be represented by a small right-handed rotation about the vector i drawn through any point η if accompanied by the translation $\epsilon + Vi\eta$.

If μ, λ be each increased in the ratio of a given scalar m so as to become $m\mu$ and $m\lambda$, the pitch $S\mu\lambda^{-1}$ and the vector-perpendicular $V\mu\lambda^{-1}$ from the origin on the screw are alike unaltered. Each different value of m corresponds to one of the singly infinite number of wrenches which may have one and the same screw as their site.

Of course, where μ, λ are both known, not only is the screw determined (which requires 5 data), but also the intensity of the wrench is known. Thus a knowledge of μ and λ gives six data, expressing everything about the force system.

Perhaps the most useful theorem in the application of quaternions to the theory of screws is that which is enunciated as follows* :—

If a rigid system acted upon by a wrench, represented by the pair of vectors (μ_1, λ_1), receive a small twist, represented by the pair of vectors (μ_2, λ_2), then the work done is

$$- S\,(\mu_1\lambda_2 + \mu_2\lambda_1). \tag{51}$$

The following proof of this important expression of the virtual moment may be given :—

A wrench (μ, λ) can in an infinite number of ways be replaced by two forces β_1 and β_2 (fig. 14) acting at points a_1 and a_2 respectively; β_1 may be transferred to the origin with the introduction of the couple represented by the vector $Va_1\beta_1$. In like manner we can transfer β_2 to the origin with the introduction of the couple $Va_2\beta_2$. We thus have

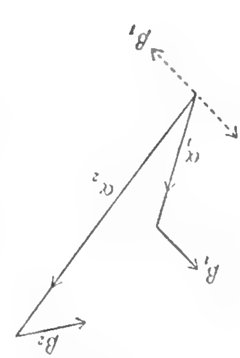

FIG. 14.

$$\beta_1 + \beta_2 = \lambda_1, \tag{52}$$

$$Va_1\beta_1 + Va_2\beta_2 = \mu_1. \tag{53}$$

* Joly, in Hamilton's "Elements," vol. ii., p. 390; also "Manual," p. 204.

The twist will move the point indicated by a_1 through the vector $\mu_2 + V\lambda_2 a_1$, and the virtual moment of this displacement and β_1 is

$$- S\beta_1 (\mu_2 + V\lambda_2 a_1) = - S\mu_2\beta_1 - S\lambda_2 Va_1\beta_1. \qquad (54)$$

In like manner the work done by β_2 is

$$- S\beta_2 (\mu_2 + V\lambda_2 a_2) = - S\mu_2\beta_2 - S\lambda_2 Va_2\beta_2. \qquad (55)$$

Hence the total work done by the wrench (μ_1, λ_1) in the course of the twist $(\mu_2\lambda_2)$ is

$$- S\mu_2 (\beta_1 + \beta_2) - S\lambda_2 (Va_1\beta_1 + Va_2\beta_2) = - S(\mu_1\lambda_2 + \mu_2\lambda_1). \qquad (56)$$

This expression for the virtual moment of a twist and a wrench may be transformed as follows:—

We have, in general,

$$\rho = \rho a^{-1} a \qquad (57)$$

$$= (S\rho a^{-1} + V\rho a^{-1}) a$$

$$= aS\rho a^{-1} + V\rho a^{-1} . a. \qquad (58)$$

We shall now make

$$p_1 = S\mu_1\lambda_1^{-1}, \quad \omega_1 = V\mu_1\lambda_1^{-1}, \qquad (59)$$

$$p_2 = S\mu_2\lambda_2^{-1}, \quad \omega_2 = V\mu_2\lambda_2^{-1}; \qquad (60)$$

whence

$$\mu_1 = p_1\lambda_1 + \omega_1\lambda_1, \quad \mu_2 = p_2\lambda_2 + \omega_2\lambda_2, \qquad (61)$$

and

$$- S(\mu_1\lambda_2 + \mu_2\lambda_1) = - S(p_1\lambda_1 + \omega_1\lambda_1)\lambda_2 - S(p_2\lambda_2 + \omega_2\lambda_2)\lambda_1$$

$$= - (p_1 + p_2) S\lambda_1\lambda_2 + S(\omega_2 - \omega_1)\lambda_1\lambda_2$$

$$= - (p_1 + p_2) S\lambda_1\lambda_2 + S(\omega_2 - \omega_1) V\lambda_1\lambda_2. \qquad (62)$$

We have now to substitute in this expression as follows:—

$$S\lambda_1\lambda_2 = - T\lambda_1 T\lambda_2 \cos\theta, \qquad (63)$$

$$S(\omega_2 - \omega_1)\lambda_1\lambda_2 = - T\lambda_1 T\lambda_2 . d . \sin\theta, \qquad (64)$$

where θ is the right-handed angle between the two screws, and d the shortest distance between them.

The first of these equations is obvious. As to the second, we may observe that without any loss of generality in the expression $S(\omega_2 - \omega_1)\lambda_1\lambda_2$, we may take ω_2 and ω_1 to correspond to the points in which the two screws are intersected by their common perpendicular, so that $\omega_2 - \omega_1$ = the product of d into a unit vector directed from screw 1 to screw 2. If the two screws form a right pair, this vector coincides in direction with $V\lambda_1\lambda_2$, and

$$S(\omega_2 - \omega_1)\lambda_1\lambda_2 = S(\omega_2 - \omega_1) V\lambda_1\lambda_2$$

is a negative quantity, and $\sin\theta$ is positive, as of course it should be; for in this case the right-handed angle is > 180°. But if the two screws form a left pair then $\omega_2 - \omega_1$ and $V\lambda_1\lambda_2$, though on the same axis, are in opposite directions, and accordingly $\sin\theta$ is negative.

With this substitution,

$$-S(\mu_1\lambda_2+\lambda_2\mu_1)=T\lambda_1T\lambda_2\{(p_1+p_2)\cos\theta-d\sin\theta\}. \qquad (65)$$

Hence we have the quaternion proof that in all cases

$$\tfrac{1}{2}\{(p_1+p_2)\cos\theta-d\sin\theta\} \qquad (66)$$

is the virtual coefficient of two vector-screws of pitches p_1, p_2, and distance d, where θ is the right-handed angle between them.*

The condition that two screws $(\mu_1\lambda_1)$, $(\mu_2\lambda_2)$ shall be reciprocal is now very simply expressed by stating that their virtual coefficient vanishes or

$$S(\mu_1\lambda_2+\mu_2\lambda_1)=0. \qquad (67)$$

We have from this the quaternion proof of the well-known property thus stated.

If a screw $(\mu\lambda)$ be reciprocal to two screws $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$, it is reciprocal to every screw on the cylindroid which passes through $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$.

For, if k_1 and k_2 be any two scalars, we may represent the typical screw on the cylindroid by

$$(k_1\mu_1+k_2\mu_2), \quad (k_1\lambda_1+k_2\lambda_2);$$

and if

$$S(\mu\lambda_1+\mu_1\lambda)=0, \quad \text{and} \quad S(\mu\lambda_2+\mu_2\lambda)=0,$$

then

$$S\{\mu(k_1\lambda_1+k_2\lambda_2)+\lambda(k_1\mu_1+k_2\mu_2)\}=0.$$

More generally, we have the following theorem:—

If a screw (μ, λ) be reciprocal to each of the n screws

$$(\mu_1, \lambda_1);\ (\mu_2, \lambda_2);\ \ldots\ (\mu_n, \lambda_n),$$

it will then be reciprocal to all screws of the group

$$(k_1\mu_1+k_2\mu_2\ \ldots\ k_n\mu_n), \quad (k_1\lambda_1+k_2\lambda_2\ \ldots + k_n\lambda_n),$$

whatever $k_1k_2\ \ldots$ may be.

We may enunciate the same principle in a still more general manner which includes the whole theory of reciprocal screw systems as follows:—

If each of the m screws

$$(\mu_1, \lambda_1),\ (\mu_2, \lambda_2)\ \ldots\ (\mu_m, \lambda_m)$$

is reciprocal to all of the n screws

$$(\mu_1', \lambda_1');\ (\mu_2', \lambda_2');\ \ldots\ (\mu_m', \lambda_n'),$$

then all screws of the type

$$(k_1\mu_1+k_2\mu_2\ \ldots + k_m\mu_m),\ (k_1\lambda_1+k_2\lambda_2\ \ldots + k_m\lambda_m)$$

will be reciprocal to all possible screws of the type

$$(k_1'\mu_1'+k_2'\mu_2'\ \ldots + k_m'\mu_m'),\ (k_1'\lambda_1'+k_2'\lambda_2'\ \ldots + k_m'\lambda_m'),$$

whatever may be the values of the scalars

$$k_1,\ k_2\ \ldots\ k_m,\ k_1',\ k_2'\ \ldots\ k_m'.$$

* See Joly, in Hamilton's "Elements," vol. ii., p. 391.

A pair of screws (μ_1, λ_1) and (μ_2, λ_2) will of course completely determine the cylindroid which passes through them. We now propose to determine ρ the vector from the origin O to C, the centre of the cylindroid.

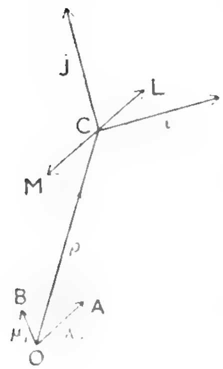

FIG. 15.

Let i, j be vectors along the two principal screws of the cylindroid through C. Let a, b be the pitches of these screws, and p_1, q_1 the intensities of the two wrenches upon them which are equivalent to λ_1, μ_1.

We have now to express that the force λ_1 at O, and the couple μ_1 are equivalent to wrenches of intensities p_1 and q_1 respectively on i and j.

Draw CL (fig. 15) equal, parallel, and in the same direction as OA, and draw CM equal and opposite to CL. Then OA is equivalent to CL, and the couple whose vector is $V\lambda_1\rho$. We thus have

$$\mu_1 + V\lambda_1\rho = p_1ai + q_1bj. \tag{68}$$

$$\lambda_1 = p_1i + q_1j. \tag{69}$$

If in like manner wrenches of intensities p_2, q_2 on the two principal screws of the cylindroid are equivalent to $\mu_2\lambda_2$, we must have

$$\mu_2 + V\lambda_2\rho = p_2ai + q_2bj. \tag{70}$$

$$\lambda_2 = p_2i + q_2j. \tag{71}$$

From (69) and (71) we see that $i, j, \lambda_1, \lambda_2$ are coplanar; whence multiplying (68) and (70) by $V\lambda_1\lambda_2$, and taking the scalars, we have

$$S\lambda_1\lambda_2\mu_1 + S(V\lambda_1\lambda_2 \,.\, \lambda_1 \,.\, \rho) = 0. \tag{72}$$

$$S\lambda_1\lambda_2\mu_2 + S(V\lambda_1\lambda_2 \,.\, \lambda_2 \,.\, \rho) = 0. \tag{73}$$

A third equation is obtained thus. By multiplying (68) and (71)

$$\lambda_2\mu_1 + \lambda_2V\lambda_1\rho = (p_2i + q_2j)(p_1ai + q_1bj),$$

whence taking scalars

$$S\lambda_2\mu_1 - S\lambda_1\lambda_2\rho = -ap_1p_2 - bq_1q_2. \tag{74}$$

By multiplying (69) and (70),

$$\lambda_1\mu_2 + \lambda_1V\lambda_2\rho = (p_1i + q_1j)(p_2ai + q_2bj)$$

whence as before

$$S\lambda_1\mu_2 + S\lambda_1\lambda_2\rho = -ap_1p_2 - bq_1q_2; \tag{75}$$

and by subtracting (75) from (74),

$$\tfrac{1}{2}(S\lambda_2\mu_1 - S\lambda_1\mu_2) = S\lambda\lambda'\rho. \tag{76}$$

In the fundamental quaternion formula

$$\rho S\alpha\beta\gamma = \alpha S\rho\beta\gamma + \beta S\alpha\rho\gamma + \gamma S\alpha\beta\rho,$$

we now write

$$\alpha = \lambda_1, \quad \beta = \lambda_2, \quad \gamma = V\lambda_1\lambda_2,$$

and

$$\rho S\lambda_1\lambda_2 V\lambda_1\lambda_2 = \lambda_1 S(\rho\lambda_2 V\lambda_1\lambda_2) + \lambda_2 S(\lambda_1\rho V\lambda_1\lambda_2) + V\lambda_1\lambda_2 S\lambda_1\lambda_2\rho,$$

whence from (72), (73), (76) we obtain

$$\rho(V\lambda_1\lambda_2)^2 = \lambda_1 S\lambda_1\lambda_2\mu_2 - \lambda_2 S\lambda_1\lambda_2\mu_1 + \tfrac{1}{2}(S\lambda_2\mu_1 - S\lambda_1\mu_2)V\lambda_1\lambda_2; \qquad (77)$$

and thus ρ, the required vector from the origin to the centre of the cylindroid, has been determined.

In the deduction of the equations (72) and (73) it will be noticed that no use has been made of the fact that the screws on i and j are at right angles. So far as these two equations are concerned, ρ might be the vector to any point of intersection of two screws, i.e. to any point on the axis of the cylindroid.

If, therefore, t be a variable scalar,

$$\rho(V\lambda_1\lambda_2)^2 = \lambda_1 S\lambda_1\lambda_2\mu_2 - \lambda_2 S\lambda_1\lambda_2\mu_1 + tV\lambda_1\lambda_2 \qquad (78)$$

is the equation to the axis of the cylindroid defined by $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$, and the origin will lie on the axis if $S\lambda_1\lambda_2\mu_2 = 0$ and $S\lambda_1\lambda_2\mu_1 = 0$.

To complete the account of the cylindroid defined by $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$ it remains to find the values of the pitches of the principal screws. These are obtained as follows:—

If x be a variable scalar, a screw on the cylindroid will be represented by $(\mu_1 + x\mu_2)$, $(\lambda_1 + x\lambda_2)$, and its pitch p will be $S(\mu_1 + x\mu_2)(\lambda_1 + x\lambda_2)^{-1}$; from which we easily find

$$p = \frac{S\mu_1\lambda_1 + x(S\mu_2\lambda_1 + S\mu_1\lambda_2) + x^2 S\mu_2\lambda_2}{\lambda_1^2 + 2xS\lambda_1\lambda_2 + x^2\lambda_2^2}, \qquad (79)$$

but the pitches of the two principal screws are a maximum and a minimum, and accordingly we find for p the two values $p_0 + m$ and $p_0 - m$, where

$$p_0 = \frac{1}{2(V\lambda_1\lambda_2)^2}\{S\lambda_1\lambda_2(S\mu_1\lambda_2 + S\mu_2\lambda_1) - \lambda_1^2 S\mu_2\lambda_2 - \lambda_2^2 S\mu_1\lambda_1\}, \qquad (80)$$

$$m^2 = \frac{1}{4\lambda_1^2\lambda_2^2(V\lambda_1\lambda_2)^4}\{S\lambda_1\lambda_2(\lambda_1^2 S\mu_2\lambda_2 + \lambda_2^2 S\mu_1\lambda_1) - \lambda_1^2\lambda_2^2(S\mu_1\lambda_2 + S\mu_2\lambda_1)\}^2$$
$$- \frac{1}{4\lambda_1^2\lambda_2^2(V\lambda_1\lambda_2)^2}(\lambda_2^2 S\mu_1\lambda_1 - \lambda_1^2 S\mu_2\lambda_2)^2. \qquad (81)$$

The length of the axis of the cylindroid is $2m$; and the condition that the cylindroid shall be canonical, i.e. that the screws of zero-pitch shall be the bounding-screws of the surface, is found by equating the value just found for p_0 to zero.

If the cylindroid reduce to a plane, then $m = 0$. But if this is the case, both of the terms in the expression of m^2 must be zero; for as $(V\lambda_1\lambda_2)^2$ is negative, neither of the terms can ever be negative. Hence, we must have

$$S\lambda_1\lambda_2 (\lambda_1^2 S\mu_2\lambda_2 + \lambda_2^2 S\mu_1\lambda_1) - \lambda_1^2\lambda_2^2 (S\mu_1\lambda_2 + S\mu_2\lambda_1) = 0, \tag{82}$$

$$\lambda_2^2 S\mu_1\lambda_1 - \lambda_1^2 S\mu_2\lambda_2 = 0. \tag{83}$$

The first of these means that $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$ must intersect, and the second means that their pitches are equal.

If $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$ be a pair of screws which determine a canonical cylindroid, then from the formulæ already given it is easy to show that the length of the axis of the cylindroid is

$$\left\{\frac{4 S\mu_1\lambda_1 S\mu_2\lambda_2 (V\lambda_1\lambda_2)^2 - (\lambda_1^2 S\mu_2\lambda_2 - \lambda_2^2 S\mu_1\lambda_1)^2}{(V\lambda_1\lambda_2)^2 (S\lambda_1\lambda_2)^2}\right\}^{\frac{1}{2}}. \tag{84}$$

It may be here remarked that in general any two cylindroids can be so placed that all the screws on either are reciprocal to all the screws on the other.

This condition will be secured if each of the two screws of zero-pitch on one of the cylindroids intersects both of the two screws of zero-pitch on the other, for as two intersecting zero-pitch screws are reciprocal, the condition stated provides that each cylindroid shall contain two screws reciprocal to the other.

V.—*Use of Quaternions in the Theory of Reflected Screws.*

The subject of reflected screws has been already discussed in these memoirs,* so I need here only repeat that if a standard plane be taken, and if to the reflection of any screw from that plane a pitch be assigned equal in magnitude but opposite in sign to the pitch of the original screw, then the screw so formed is said to be the reflection of the original screw.

The methods of quaternions present the vector coordinates of a pair of reflected screws with extreme simplicity, as is shown by the following statement:—

If (μ, λ) be the vector coordinates of a screw, then the reflection of that screw from the plane $S\rho i = 0$ has (μ', λ') for its vector coordinates where

$$\mu' = -i\mu i \quad \text{and} \quad \lambda' = i\lambda i.$$

We first observe that if two lines intersect at right angles their reflections will also intersect at right angles, for as the distance between two points is

* Trans. Roy. Ir. Acad., vol. xxxii., pp. 119–127.

equal to the distance between their reflections, a right-angled triangle will reflect into a right-angled triangle, and accordingly, the right angle has not been altered by reflection.

We may see this otherwise by observing that, as shown in the paper already referred to, any two reciprocal screws reflect into reciprocal screws. But two screws intersecting at right angles are reciprocal whatever be their pitches.

It is hence plain that, if the origin lies in the plane of reflection, the perpendicular from the origin on a screw will reflect into the perpendicular from the origin on the reflected screw.

We know that $V\mu'/\lambda'$, $V\mu/\lambda$ are respectively the perpendicular vectors from the origin on the reflected screw and the original screw; and accordingly from the well-known quaternion relation of a vector and its reflection where i is the unit vector

$$V\frac{\mu'}{\lambda'} = i \,.\, V\frac{\mu}{\lambda} \,.\, i = Vi\mu\lambda^{-1}i$$

$$= -\, Vi\mu\lambda^{-1}i^{-1} = -\, Vi\mu ii^{-1}\lambda^{-1}i^{-1} = -\, V\frac{i\mu i}{i\lambda i}.$$

As the pitch of a screw is equal and opposite to the pitch of its reflection,

$$S\frac{\mu'}{\lambda'} = -\, S\frac{\mu}{\lambda} = Si^2\mu\lambda^{-1} = Si\mu\lambda^{-1}i$$

$$= -\, Si\mu ii\lambda^{-1}i = -\, Si\mu ii^{-1}\lambda^{-1}i^{-1} = -\, S\frac{i\mu i}{i\lambda i};$$

whence

$$\frac{\mu'}{\lambda'} = V\frac{\mu'}{\lambda'} + S\frac{\mu'}{\lambda'} = -\, V\frac{i\mu i}{i\lambda i} - S\frac{i\mu i}{i\lambda i} = -\frac{i\mu i}{i\lambda i};$$

but $\lambda' = i\lambda i,$

and consequently $\mu' = -\, i\mu i.$ (85)

It is easy to verify that the virtual coefficient of a pair of screws (μ_1, λ_1) and (μ_2, λ_2) is equal in magnitude but opposite in sign to the virtual coefficient of their reflections.

The virtual coefficient of the two screws is $\frac{1}{2}S(\mu_1\lambda_2 + \mu_2\lambda_1)$, and the virtual coefficient of their two reflections is

$$-\, \tfrac{1}{2}S(i\mu_1 ii\lambda_2 i + i\mu_2 ii\lambda_1 i) = -\, \tfrac{1}{2}S(\mu_1\lambda_2 + \mu_2\lambda_1).$$

The screw whose equation is

$$\rho = V\frac{\mu}{\lambda} + x\lambda$$

pierces the plane $S\rho i = 0$ at the point whose vector is

$$\rho = V\frac{\mu}{\lambda} - \frac{S\lambda^{-1}i}{S\lambda i} \,.\, \lambda,$$

as this vector coincides with its reflection $i\rho i = \rho$, or

$$\rho = iV\frac{\mu}{\lambda}i - \frac{S\mu\lambda^{-1}i}{S\lambda i}i\lambda i = -V\frac{i\mu i}{i\lambda i} - \frac{S\mu\lambda^{-1}i}{S\lambda i}i\lambda i,$$

thus verifying that the two screws intersect in the plane of reflection at the point whose vector is ρ.

We may note that the reflection of a canonical cylindroid is also a canonical cylindroid.

This is obvious from the fact that in the canonical cylindroid the bounding screws are the screws of zero pitch, and that the reflection of a screw of zero pitch is also a screw of zero pitch.

But it may be useful to verify this from the expressions previously obtained for the coordinates of a reflected screw. We have already found that, if $(\lambda_1\mu_1)$ and $(\lambda_2\mu_2)$ be the coordinates of two screws, the cylindroid they define will be canonical if

$$S\lambda_1\lambda_2(S\mu_1\lambda_2 + S\mu_2\lambda_1) - \lambda_1^2 S\mu_2\lambda_2 - \lambda_2^2 S\mu_1\lambda_1 = 0.$$

As to $S(\mu_1\lambda_2 + \mu_2\lambda_1)$, we have already seen that the effect of substituting the coordinates of the reflected screw is merely to change its sign. $S\lambda_1\lambda_2$ is unaltered, and $-\lambda_1^2 S\mu_2\lambda_2$ and $-\lambda_2^2 S\mu_1\lambda_1$ both change sign, so that the equation is satisfied by the reflected cylindroid if satisfied by the original cylindroid. The cylindroid determined by the two pairs of screws $(\mu_1\lambda_1)$ and $(\mu_2\lambda_2)$ will be altered by reflection from any plane into another cylindroid which will be identical with the original cylindroid (though, of course, differently placed) if the pitch of every screw on the reflected cylindroid be augmented by the common quantity

$$\frac{1}{(V\lambda_1\lambda_2)^2}\{S\lambda_1\lambda_2(S\lambda_1\mu_2 + S\lambda_2\mu_1) - \lambda_1^2 S\lambda_2\mu_2 - \lambda_2^2 S\lambda_1\mu_1\}.$$

For the two principal screws of a cylindroid are reflected into the two principal screws of the reflected cylindroid. The original pitches were $p_0 + m$ and $p_0 - m$. The corresponding pitches in the reflected screws are $-p_0 - m$ and $-p_0 + m$. The addition of $2p_0$ to these will bring the reflected pitches to the original pitches. Note, however, that the screw of maximum pitch reflects into the screw of minimum pitch. With this is connected the fact that the screw of maximum pitch is left-handed with regard to every other screw on the cylindroid. But reflection changes a left-handed pair into a right-handed pair, so that the maximum pitch must reflect into the minimum.

If μ, λ be the vector coordinates of a screw before its reflection from the plane defined by the equation $Si(\rho - a) = 0$, then, after reflection, the coordinates of the screw become

$$-\{(i\mu i + 2Sai \,.\, V\lambda i),\ i\lambda i\}.$$

For if O be the origin, and O' the point indicated by the vector a, then the coordinates of the screw with respect to the origin O' are $\{(\mu + V\lambda a),\ \lambda\}$. Hence the coordinates of the reflected screw with regard to O' are $-i(\mu + V\lambda a)i,\ i\lambda i$. We have now to transfer these coordinates back to the original origin O; and we have

$$\mu' = -i(\mu + V\lambda a)i - Vi\lambda ia = -i\mu i - i(V\lambda a)i - Vi\lambda ia$$
$$= -i\mu i - Vi\lambda ai - Vi\lambda ia = -i\mu i + 2\,Sai\,V\lambda i$$
$$\lambda' = i\lambda i.$$

It is easy to verify this by showing that the reflected screw again reflected reverts to the original screw.

VI.—*Quaternion Investigation of the Screw reciprocal to five given Screws.*

If $\mu_1, \lambda_1;\ \mu_2, \lambda_2;\ \mu_3, \lambda_3;\ \mu_4, \lambda_4$ be the coordinates of four screws, and if x_1, x_2, x_3, x_4 be any four scalars, then the four-system defined by the four screws will consist of all screws with the coordinates

$$(x_1\mu_1 + x_2\mu_2 + x_3\mu_3 + x_4\mu_4);\ (x_1\lambda_1 + x_2\lambda_2 + x_3\lambda_3 + x_4\lambda_4),$$

where x_1, x_2, x_3, x_4 have all possible values.

Let μ, λ be any screw on the cylindroid reciprocal to the four-system; then, since this must be reciprocal to every individual screw, we must have for all scalar values of x_1, x_2, x_3, x_4 and for every screw (μ, λ) on the reciprocal cylindroid

$$S[\lambda(x_1\mu_1 + x_2\mu_2 + x_3\mu_3 + x_4\mu_4) + \mu(x_1\lambda_1 + x_2\lambda_2 + x_3\lambda_3 + x_4\lambda_4)] = 0. \quad (86)$$

As this is to be true for all values of x_1, x_2, x_3, x_4, it will be true if

$$x_1 = S\lambda_2\lambda_3\lambda_4;\ x_2 = -S\lambda_3\lambda_4\lambda_1;\ x_3 = S\lambda_4\lambda_1\lambda_2;\ x_4 = -S\lambda_1\lambda_2\lambda_3.$$

It is, however, a well-known formula in Quaternions that if $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ be any four vectors, then

$$\lambda_1 S\lambda_2\lambda_3\lambda_4 - \lambda_2 S\lambda_3\lambda_4\lambda_1 + \lambda_3 S\lambda_4\lambda_1\lambda_2 - \lambda_4 S\lambda_1\lambda_2\lambda_3 = 0. \quad (87)$$

Accordingly the equation (86) becomes

$$S\lambda(\mu_1 S\lambda_2\lambda_3\lambda_4 - \mu_2 S\lambda_3\lambda_4\lambda_1 + \mu_3 S\lambda_4\lambda_1\lambda_2 - \mu_4 S\lambda_1\lambda_2\lambda_3) = 0.$$

Thus we prove that each generator of the reciprocal cylindroid must be at right angles to the vector

$$\mu_1 S\lambda_2\lambda_3\lambda_4 - \mu_2 S\lambda_3\lambda_4\lambda_1 + \mu_3 S\lambda_4\lambda_1\lambda_2 - \mu_4 S\lambda_1\lambda_2\lambda_3, \quad (88)$$

and consequently this vector must be parallel to the axis of the cylindroid reciprocal to the four screws $(\mu_1\lambda_1), (\mu_2\lambda_2), (\mu_3\lambda_3), (\mu_4\lambda_4)$.

If (μ, λ) be also reciprocal to a fifth screw μ_5, λ_5, then it must be at right angles, not only to the vector (88), but also to any similar vector (89) obtained by taking any other combination of four screws out of the five, for example,

$$\mu_2 S\lambda_3\lambda_4\lambda_5 - \mu_3 S\lambda_4\lambda_5\lambda_2 + \mu_4 S\lambda_5\lambda_2\lambda_3 - \mu_5 S\lambda_2\lambda_3\lambda_4. \quad (89)$$

Hence, λ must be parallel to the vector part of the product of these two vectors X and Y, for which we have the expression

$$\left.\begin{array}{l} V_{\mu_1\mu_2}(234)(345) \\ V_{\mu_2\mu_3}(341)(452)-(345)(412) \\ V_{\mu_3\mu_4}(412)(523)-(123)(452) \\ V_{\mu_4\mu_5}(234)(123) \\ V_{\mu_5\mu_1}(234)(234) \\ V_{\mu_1\mu_3}(234)(425) \\ V_{\mu_3\mu_5}(234)(421) \\ V_{\mu_5\mu_2}(234)(314) \\ V_{\mu_2\mu_4}(314)(523)-(123)(354) \\ V_{\mu_4\mu_1}(234)(532) \end{array}\right\}, \qquad (90)$$

where for brevity (234) is written instead of $S\lambda_2\lambda_3\lambda_4$.

In its present form this expression is not symmetrical, though it is obvious that the vector parallel to the screw reciprocal to five screws should be symmetrical with regard to these five screws. The desired form can be obtained by the following formulæ easily verified by well-known rules in vector manipulation:—

$$S\lambda_5\lambda_4\lambda_1 \,.\, S\lambda_4\lambda_3\lambda_2 - S\lambda_5\lambda_4\lambda_3 \,.\, S\lambda_4\lambda_1\lambda_2 = S\lambda_2\lambda_3\lambda_4 \,.\, S\lambda_5\lambda_1\lambda_4,$$

$$S\lambda_4\lambda_1\lambda_2 \,.\, S\lambda_5\lambda_2\lambda_3 - S\lambda_1\lambda_2\lambda_3 \,.\, S\lambda_4\lambda_5\lambda_2 = S\lambda_2\lambda_3\lambda_4 \,.\, S\lambda_5\lambda_1\lambda_2,$$

$$S\lambda_3\lambda_1\lambda_4 \,.\, S\lambda_5\lambda_2\lambda_3 - S\lambda_5\lambda_3\lambda_4 \,.\, S\lambda_1\lambda_2\lambda_3 = S\lambda_2\lambda_3\lambda_4 \,.\, S\lambda_1\lambda_2\lambda_5.$$

Introducing these values into (90) and rejecting the factor $S\lambda_2\lambda_3\lambda_4$, because we assume that the problem has not degenerated by having three of the five screws parallel to a plane, we obtain the symmetrical expression

$$\lambda = \left.\begin{array}{l} +\,V_{\mu_1\mu_2} \,.\, S\lambda_3\lambda_4\lambda_5 \\ +\,V_{\mu_2\mu_3} \,.\, S\lambda_4\lambda_5\lambda_1 \\ +\,V_{\mu_3\mu_4} \,.\, S\lambda_5\lambda_1\lambda_2 \\ +\,V_{\mu_4\mu_5} \,.\, S\lambda_1\lambda_2\lambda_3 \\ +\,V_{\mu_5\mu_1} \,.\, S\lambda_2\lambda_3\lambda_4 \\ -\,V_{\mu_1\mu_3} \,.\, S\lambda_5\lambda_2\lambda_4 \\ -\,V_{\mu_3\mu_5} \,.\, S\lambda_2\lambda_4\lambda_1 \\ -\,V_{\mu_5\mu_2} \,.\, S\lambda_4\lambda_1\lambda_3 \\ -\,V_{\mu_2\mu_4} \,.\, S\lambda_1\lambda_3\lambda_5 \\ -\,V_{\mu_4\mu_1} \,.\, S\lambda_3\lambda_5\lambda_2 \end{array}\right\}. \qquad (91)$$

The order of the suffixes in the several terms in λ will be seen as follows:—

Writing the digits 1, 2, 3, 4, 5 round the circumference of a circle consecutively we notice that in each of the five positive terms the five digits succeed each other simply as written round the circle; e.g. in the third, the suffices are 3, 4, 5, 1, 2. Thus the positive terms can be written down at once.

The terms with negative signs are obtained by omitting every alternate digit on the circumference; e.g., commencing with 3, we omit 4; take 5, omit 1; take 2, omit 3; take 4, omit 5; take 1, and obtain 35241, the sequence in the suffices in the seventh term of the expression for λ.

We can find the value of μ in like manner, and obtain (92).

$$\left.\begin{aligned}\mu = &- V\lambda_1\lambda_2\, S\mu_3\mu_4\mu_5\\ &- V\lambda_2\lambda_3\, S\mu_4\mu_5\mu_1\\ &- V\lambda_3\lambda_4\, S\mu_5\mu_1\mu_2\\ &- V\lambda_4\lambda_5\, S\mu_1\mu_2\mu_3\\ &- V\lambda_5\lambda_1\, S\mu_2\mu_3\mu_4\\ &+ V\lambda_1\lambda_3\, S\mu_5\mu_2\mu_4\\ &+ V\lambda_3\lambda_5\, S\mu_2\mu_4\mu_1\\ &+ V\lambda_5\lambda_2\, S\mu_4\mu_1\mu_3\\ &+ V\lambda_2\lambda_4\, S\mu_1\mu_3\mu_5\\ &+ V\lambda_4\lambda_1\, S\mu_3\mu_5\mu_2\end{aligned}\right\}. \qquad (92)$$

If, indeed, we could have written down the expressions of λ and μ, the proof that they were the coordinates of the screw reciprocal to the five given screws would have been merely a verification of the condition of reciprocity; for example, using the values of μ and λ in the expression $S(\mu_4\lambda + \mu\lambda_4)$, we obtain

$$\begin{aligned}&S\mu_4\mu_1\mu_2\, S\lambda_3\lambda_4\lambda_5 + S\mu_4\mu_2\mu_3\, S\lambda_4\lambda_5\lambda_1 + S\mu_4\mu_5\mu_1\, S\lambda_2\lambda_3\lambda_4\\ &- S\mu_4\mu_1\mu_3\, S\lambda_5\lambda_2\lambda_4 - S\mu_4\mu_3\mu_5\, S\lambda_2\lambda_4\lambda_1 - S\mu_4\mu_5\mu_2\, S\lambda_4\lambda_1\lambda_3\\ &- S\lambda_4\lambda_1\lambda_2\, S\mu_3\mu_4\mu_5 - S\lambda_4\lambda_2\lambda_3\, S\mu_4\mu_5\mu_1 - S\lambda_4\lambda_5\lambda_1\, S\mu_2\mu_3\mu_4\\ &+ S\lambda_4\lambda_1\lambda_3\, S\mu_5\mu_2\mu_4 + S\lambda_4\lambda_3\lambda_5\, S\mu_2\mu_4\mu_1 + S\lambda_4\lambda_5\lambda_2\, S\mu_4\mu_1\mu_3,\end{aligned}$$

which vanishes identically. In like manner it can be shown that $\mu\lambda$ is reciprocal to each of the four other screws. We have thus obtained the quaternion solution of the problem of finding that one screw which is reciprocal to five given screws.*

If the five screws belonged to a system of lower dimensions than five, the screw reciprocal to them would be indeterminate. For instance, if they all belonged to a 4-system, then any screw on a cylindroid reciprocal to four of the screws would also be reciprocal to the fifth. We thus see that $\lambda = 0$, and $\mu = 0$ must always be satisfied if

$$(\mu_1, \lambda_1);\ (\mu_2, \lambda_2);\ (\mu_3, \mu_3);\ (\mu_4, \lambda_4);\ (\mu_5, \lambda_5)$$

belong to a system of the fourth or any lower order.

* This result, and certain other developments (not here reproduced), were communicated by me to the Australasian Association for the Advancement of Science, and published in their Report (1909), p. 52.

We can also obtain from (91) and (92) the conditions that must be satisfied if μ, λ be the coordinates of any screw of an n-system. For convenience, we shall take the case of a 3-system, and proceed as follows:—

Being given the three screws which determine the 3-system, we take three screws of the reciprocal system, and let these last be defined by the coordinates (μ_1, λ_1); (μ_2, λ_2); (μ_3, λ_3). We now take μ_4, λ_4; μ_5, λ_5 as any vectors whatever; then, as μ, λ are given by equations (91) and (92), the screw $\mu\lambda$ must be reciprocal to (μ_1, λ_1); (μ_2, λ_2); (μ_3, λ_3): and must therefore belong to the original 3-system: and, by giving proper values to μ_4, λ_4; μ_5, λ_5, we can obtain the coordinates of any one of the screws of the system.

Thus we are able to obtain the quaternion condition to be satisfied if six screws belong to a 5-system; in other words, we are to find the condition that must be satisfied by six screws so related that a body with simultaneous twist velocities about these six screws shall still be at rest. In this case, the six screws must all be reciprocal to one screw. We therefore have merely to write the condition that the sixth screw (μ_6, λ_6) shall be reciprocal to (μ, λ), which we have already found as the screw reciprocal to

$$(\mu_1, \lambda_1);\ (\mu_2, \lambda_2);\ (\mu_3, \lambda_3);\ (\mu_4, \lambda_4);\ (\mu_5, \lambda_5).$$

We have therefore merely to substitute for μ and λ in the equation

$$S(\mu_6\lambda + \mu\lambda_6) = 0;$$

the result is accordingly

$$\left.\begin{aligned}
&- S\lambda_4\lambda_5\lambda_6 . S\mu_1\mu_2\mu_3 + S\mu_4\mu_5\mu_6 . S\lambda_1\lambda_2\lambda_3 = 0. \\
&- S\lambda_3\lambda_4\lambda_6 . S\mu_1\mu_2\mu_5 + S\mu_3\mu_4\mu_6 . S\lambda_1\lambda_2\lambda_5 \\
&- S\lambda_2\lambda_3\lambda_6 . S\mu_1\mu_4\mu_5 + S\mu_2\mu_3\mu_6 . S\lambda_1\lambda_4\lambda_5 \\
&- S\lambda_1\lambda_2\lambda_6 . S\mu_3\mu_4\mu_5 + S\mu_1\mu_2\mu_6 . S\lambda_3\lambda_4\lambda_5 \\
&- S\lambda_2\lambda_5\lambda_6 . S\mu_1\mu_3\mu_4 + S\mu_2\mu_5\mu_6 . S\lambda_1\lambda_3\lambda_4 \\
&+ S\lambda_1\lambda_5\lambda_6 . S\mu_2\mu_3\mu_4 - S\mu_1\mu_5\mu_6 . S\lambda_2\lambda_3\lambda_4 \\
&+ S\lambda_1\lambda_3\lambda_6 . S\mu_2\mu_4\mu_5 - S\mu_1\mu_3\mu_6 . S\lambda_2\lambda_4\lambda_5 \\
&+ S\lambda_3\lambda_5\lambda_6 . S\mu_1\mu_2\mu_4 - S\mu_3\mu_5\mu_6 . S\lambda_1\lambda_2\lambda_4 \\
&+ S\lambda_2\lambda_4\lambda_6 . S\mu_1\mu_3\mu_5 - S\mu_2\mu_4\mu_6 . S\lambda_1\lambda_3\lambda_5 \\
&+ S\lambda_2\lambda_3\lambda_5 . S\mu_1\mu_4\mu_6 - S\mu_2\mu_3\mu_5 . S\lambda_1\lambda_4\lambda_6
\end{aligned}\right\} \qquad (93)$$

This is the formula for the sexiant obtained in a different manner by Joly (see Hamilton's *Elements*, vol. ii, p. 393). It is of course the Quaternion equivalent of the formula already given in Equation (41) in one form, and in *Treatise*, pp. 37, 248 in another.

It is worth while to note that the vector coordinates of five screws satisfy certain other formulæ which are, no doubt, merely properties of five pairs of vectors quite unrelated. The proofs of these formulæ will be derived at once from the theory of screws; but we commence by defining four vector-functions A, B, C, D which are given by the following relations:—

$$\left.\begin{aligned}
A \equiv &+ V(\lambda_1\mu_2 + \mu_1\lambda_2)S\lambda_3\lambda_4\lambda_5 = 0.\\
&+ V(\lambda_2\mu_3 + \mu_2\lambda_3)S\lambda_4\lambda_5\lambda_1\\
&+ V(\lambda_3\mu_4 + \mu_3\lambda_4)S\lambda_5\lambda_1\lambda_2\\
&+ V(\lambda_4\mu_5 + \mu_4\lambda_5)S\lambda_1\lambda_2\lambda_3\\
&+ V(\lambda_5\mu_1 + \mu_5\lambda_1)S\lambda_2\lambda_3\lambda_4\\
&- V(\lambda_1\mu_3 + \mu_1\lambda_3)S\lambda_5\lambda_2\lambda_4\\
&- V(\lambda_3\mu_5 + \mu_3\lambda_5)S\lambda_2\lambda_4\lambda_1\\
&- V(\lambda_5\mu_2 + \mu_5\lambda_2)S\lambda_4\lambda_1\lambda_3\\
&- V(\lambda_2\mu_4 + \mu_2\lambda_4)S\lambda_1\lambda_3\lambda_5\\
&- V(\lambda_4\mu_1 + \mu_4\lambda_1)S\lambda_3\lambda_5\lambda_2
\end{aligned}\right\} \qquad (94)$$

$$\left.\begin{aligned}
B \equiv &+ V\lambda_1\lambda_2\,S\lambda_3\lambda_4\lambda_5 = 0.\\
&+ V\lambda_2\lambda_3\,S\lambda_4\lambda_5\lambda_1\\
&+ V\lambda_3\lambda_4\,S\lambda_5\lambda_1\lambda_2\\
&+ V\lambda_4\lambda_5\,S\lambda_1\lambda_2\lambda_3\\
&+ V\lambda_5\lambda_1\,S\lambda_2\lambda_3\lambda_4\\
&- V\lambda_1\lambda_3\,S\lambda_5\lambda_2\lambda_4\\
&- V\lambda_3\lambda_5\,S\lambda_2\lambda_4\lambda_1\\
&- V\lambda_5\lambda_2\,S\lambda_4\lambda_1\lambda_3\\
&- V\lambda_2\lambda_4\,S\lambda_1\lambda_3\lambda_5\\
&- V\lambda_4\lambda_1\,S\lambda_3\lambda_5\lambda_2
\end{aligned}\right\} \qquad (95)$$

$$\left.\begin{aligned}
C \equiv &- V\lambda_1\lambda_2(S\lambda_3\lambda_4\mu_5 + S\lambda_3\mu_4\lambda_5 + S\mu_3\lambda_4\lambda_5) = 0.\\
&- V\lambda_2\lambda_3(S\lambda_4\lambda_5\mu_1 + S\lambda_4\mu_5\lambda_1 + S\mu_4\lambda_5\lambda_1)\\
&- V\lambda_3\lambda_4(S\lambda_5\lambda_1\mu_2 + S\lambda_5\mu_1\lambda_2 + S\mu_5\lambda_1\lambda_2)\\
&- V\lambda_5\lambda_1(S\lambda_2\lambda_3\mu_4 + S\lambda_2\mu_3\lambda_4 + S\mu_2\lambda_3\lambda_4)\\
&- V\lambda_4\lambda_5(S\lambda_1\lambda_2\mu_3 + S\lambda_1\mu_2\lambda_3 + S\mu_1\lambda_2\lambda_3)\\
&+ V\lambda_1\lambda_3(S\lambda_5\lambda_2\mu_4 + S\lambda_5\mu_2\lambda_4 + S\mu_5\lambda_2\lambda_4)\\
&+ V\lambda_3\lambda_5(S\lambda_2\lambda_4\mu_1 + S\lambda_2\mu_4\lambda_1 + S\mu_2\lambda_4\lambda_1)\\
&+ V\lambda_5\lambda_2(S\lambda_4\lambda_1\mu_3 + S\lambda_4\mu_1\lambda_3 + S\mu_4\lambda_1\lambda_3)\\
&+ V\lambda_2\lambda_4(S\lambda_1\lambda_3\mu_5 + S\lambda_1\mu_3\lambda_5 + S\mu_1\lambda_3\lambda_5)\\
&+ V\lambda_4\lambda_1(S\lambda_3\lambda_5\mu_2 + S\lambda_3\mu_5\lambda_2 + S\mu_3\lambda_5\lambda_2)
\end{aligned}\right\} \qquad (96)$$

$$\left.\begin{aligned}
D \equiv &+ V\lambda_1\lambda_2(S\lambda_3\mu_4\mu_5 + S\mu_3\lambda_4\mu_5 + S\mu_3\mu_4\lambda_5) = \lambda.\\
&+ V\lambda_2\lambda_3(S\lambda_4\mu_5\mu_1 + S\mu_4\lambda_5\mu_1 + S\mu_4\mu_5\lambda_1)\\
&+ V\lambda_3\lambda_4(S\lambda_5\mu_1\mu_2 + S\mu_5\lambda_1\mu_2 + S\mu_5\mu_1\lambda_2)\\
&+ V\lambda_4\lambda_5(S\lambda_1\mu_2\mu_3 + S\mu_1\lambda_2\mu_3 + S\mu_1\mu_2\lambda_3)\\
&+ V\lambda_5\lambda_1(S\lambda_2\mu_3\mu_4 + S\mu_2\lambda_3\mu_4 + S\mu_2\mu_3\lambda_4)\\
&- V\lambda_1\lambda_3(S\lambda_5\mu_2\mu_4 + S\mu_5\lambda_2\mu_4 + S\mu_5\mu_2\lambda_4)\\
&- V\lambda_3\lambda_5(S\lambda_2\mu_4\mu_1 + S\mu_2\lambda_4\mu_1 + S\mu_2\mu_4\lambda_1)\\
&- V\lambda_5\lambda_2(S\lambda_4\mu_1\mu_3 + S\mu_4\lambda_1\mu_3 + S\mu_4\mu_1\lambda_3)\\
&- V\lambda_2\lambda_4(S\lambda_1\mu_3\mu_5 + S\mu_1\lambda_3\mu_5 + S\mu_1\mu_3\lambda_5)\\
&- V\lambda_4\lambda_1(S\lambda_3\mu_5\mu_2 + S\mu_3\lambda_5\mu_2 + S\mu_3\mu_5\lambda_2)
\end{aligned}\right\} \qquad (97)$$

The desired relations are proved by making use of the well-known property that the screw θ reciprocal to five screws, α, β, γ, δ, ϵ, will retain the same relation to α, β, γ, δ, ϵ if, instead of p_θ, the pitch of θ, we write $p_\theta - k$; while, instead of $p_\alpha, p_\beta, p_\gamma, p_\delta, p_\epsilon$, we write $p_\alpha + k, p_\beta + k, p_\gamma + k, p_\delta + k, p_\epsilon + k$ respectively, where k is any scalar; this follows at once from the fact that, if θ is reciprocal to α,

$$(p_\theta + p_\alpha) \cos \theta_\alpha - d \sin \theta_\alpha = 0,$$

where θ_α is the right-handed angle between θ and α; but of course this equation may equally be written thus

$$\{(p_\theta - k) + (p_\alpha + k)\} \cos \theta_\alpha - d \sin \theta_\alpha = 0.$$

If the pitch of the screw with vector coordinates (μ, λ) be increased by k, but without any other change, then the coordinates merely become $\{(\mu + k\lambda), \lambda\}$. This is obvious from the fact that

$$V(\mu + k\lambda)/\lambda = V\mu/\lambda \quad \text{and} \quad S(\mu + k\lambda)/\lambda = S\mu/\lambda + k.$$

If the pitches of the five screws be increased by k, but no other change is made, then their vector coordinates become

$$\{(\mu_1 + k\lambda_1), \lambda_1\}; \; . \; . \; . \; \{(\mu_5 + k\lambda_5), \lambda_5\}.$$

If we substitute $(\mu_1 + k\lambda_1) \; . \; . \; . \; (\mu_5 + k\lambda_5)$ for $\mu_1 \; . \; . \; . \; \mu_5$ in the expression for λ in (91), and denote by λ_k the value which λ then assumes, we have, as is easily seen,

$$\lambda_k = \lambda + kA + k^2B, \tag{98}$$

where A and B are the vectors in (95) and (96).

In like manner when the same substitutions are made in (92) we have for μ_k the value which μ then assumes

$$\mu_k = \mu - Dk + Ck^2 - Bk^3. \tag{99}$$

But, as just pointed out, the screw (μ_k, λ_k) can only differ from the screw (μ, λ) in that the pitch of the second is k less than the pitch of the first. It follows that $\{(\mu_k - k\lambda_k), \lambda_k\}$ is a screw identical with (μ, λ). Thus (μ, λ) and $\{\{\mu + k(\lambda - D) + k^2(A + C)\}, (\lambda + kA + k^2B)\}$ must be the vector coordinates of one and the same screw whatever be the value of k. Hence we must have

$$A = 0, \; B = 0, \; C = 0, \; D = \lambda.$$

These properties of the vector expressions are of course easily verified by direct calculation.

We see that $A = 0$ by writing separately the terms involving μ_1, which are

$$V\mu_1(\lambda_2 S\lambda_3\lambda_4\lambda_5 - \lambda_3 S\lambda_5\lambda_2\lambda_4 + \lambda_4 S\lambda_3\lambda_5\lambda_2 - \lambda_5 S\lambda_2\lambda_3\lambda_4).$$

But from te known quaternion formula the quantity in the bracket is zero. In like manner each of the other groups of terms is zero. Thus A is verified, and this includes $B = 0$ by interchanging μ and λ.

To verify $C = 0$ we may take the group of terms involving μ_5; they are

$$- S\mu_5\lambda_3\lambda_4 V\lambda_1\lambda_2 - S\mu_5\lambda_1\lambda_4 V\lambda_2\lambda_3 - S\mu_5\lambda_1\lambda_2 V\lambda_3\lambda_4$$
$$+ S\mu_5\lambda_2\lambda_4 V\lambda_1\lambda_3 + S\mu_5\lambda_1\lambda_3 V\lambda_2\lambda_4 + S\mu_5\lambda_2\lambda_3 V\lambda_4\lambda_1.$$

If we substitute for λ_4 the expression $a\lambda_1 + b\lambda_2 + c\lambda_3$ where a, b, c are scalars, this expression is seen to vanish identically. In like manner for the terms involving μ_1, μ_2, μ_3, μ_4.

The last identity $D = \lambda$ (97) is somewhat remarkable. If we take the terms only involving μ_6 in λ, we have

$$\lambda = V\mu_4\mu_5 S\lambda_1\lambda_2\lambda_3 + V\mu_5\mu_1 S\lambda_2\lambda_3\lambda_4 - V\mu_3\mu_5 S\lambda_2\lambda_4\lambda_1 - V\mu_5\mu_2 S\lambda_4\lambda_1\lambda_3.$$

The terms involving μ_5 in D are in number 12, of which three are

$$V\lambda_1\lambda_2 S\lambda_3\mu_4\mu_5 + V\lambda_2\lambda_3 S\lambda_1\mu_4\mu_5 + V\lambda_3\lambda_1 S\lambda_2\mu_4\mu_5;$$

but this is equal to $V\mu_4\mu_5 S\lambda_1\lambda_2\lambda_3$, because from a known vector formula

$$\alpha S\lambda_1\lambda_2\lambda_3 = V\lambda_1\lambda_2 \, . \, S\lambda_3\alpha + V\lambda_2\lambda_3 \, . \, S\lambda_1\alpha + V\lambda_3\lambda_1 S\lambda_2\alpha.$$

Thus we show that each term in λ equals the sum of three terms in D; and the verification is complete.

VII.—*Representation of Screw Systems of the third order by Linear Vector Functions.*

There is, perhaps, no part of the theory of quaternions of greater interest to the student of mathematical physics than the theory of linear vector functions introduced by Sir William Hamilton.* This beautiful theory exhibits in the most lucid manner the geometrical element common to many investigations in varied branches of mathematical inquiry. It is known that the strain of an elastic body displaces any vector of that body into another vector which is a linear vector function of the original vector. It is also known that the vector expressing the impulsive moment applied to a rigid body free to move about a point generates a twist velocity which is a linear vector function of the original impulsive moment. These are elementary applications; and, as instances of more recondite uses of the linear vector function, we may mention its employment by the late Professor Willard Gibbs, and, more recently, in the important investigations of Professor Conway in molecular mechanics.

Of course, to speak strictly, the theory of linear vector functions does not

* "Elements," vol. i., p. 485.

exactly come under the head of *quaternions.* The notion of a quaternion as the quotient of two vectors is not immediately involved in the theory of linear vector functions; but it will probably be agreed that there is hardly any part of Hamilton's wonderful "Elements of Quaternions" more instructive and more useful than the chapters dealing with the functions of which we are now speaking.

After the lamented Professor Charles J. Joly had acquired that mastery of quaternions which made him so appropriate an editor of Hamilton's book, his attention was turned to the theory of screws, with results to which reference has already been made several times in the present paper. In his many writings, and in his correspondence with the present writer, he has developed with abundant illustrations the intimate connexion between quaternions and the theory of screws. Probably the most important and instructive part of this work has been his exposition of the relations of the screws of a system of the third order to a linear vector function. He has shown how these theories are coextensive, and how every theorem with regard to the screws of a 3-system has as its counterpart a theorem with regard to a linear vector function. The perfection of this analogy lies in the circumstance that in each case the theory is of the most general type. The theory of a system of screws of the third order of the most general type corresponds to the theory of a linear vector function of the most general type. The significance of this circumstance will be appreciated if we remark that in the case of the impulsive vector and the instantaneous vector already referred to, the linear vector function which arises is *not* of the most general type. It is of that special form which is known as self-conjugate. It seems therefore reasonable to point out that the screw system of the third order is a geometrical equivalent coextensive under all circumstances with the linear vector function.

In illustration of this statement, we may recall that nine data are required for the complete specification of a 3-system; for example, three data are required for the centre of the pitch quadric, three more for the directions of its axes, and three more for the pitches of its three principal screws. That nine data are also required for the definition of a linear vector function is also well known. Indeed the name of *nonion* has been proposed for this function in consequence of the significance of this circumstance.

Let (λ_1, μ_1); (λ_2, μ_2); (λ_3, μ_3) be three pairs of vectors defining three screws of a 3-system, and let x_1, x_2, x_3 be any three scalars: then μ, λ will represent another screw of the same system if

$$\lambda = x_1\lambda_1 + x_2\lambda_2 + x_3\lambda_3$$

$$\mu = x_1\mu_1 + x_2\mu_2 + x_3\mu_3.$$

Multiplying the first by $V\lambda_2\lambda_3$, $V\lambda_3\lambda_1$, and $V\lambda_1\lambda_2$ respectively, and taking the scalar,

$$S\lambda\lambda_2\lambda_3 = x_1 S\lambda_1\lambda_2\lambda_3,$$
$$S\lambda\lambda_3\lambda_1 = x_2 S\lambda_1\lambda_2\lambda_3,$$
$$S\lambda\lambda_1\lambda_2 = x_3 S\lambda_1\lambda_2\lambda_3;$$

whence

$$\mu = \mu_1 \frac{S\lambda\lambda_2\lambda_3}{S\lambda_1\lambda_2\lambda_3} + \mu_2 \frac{S\lambda_1\lambda\lambda_3}{S\lambda_1\lambda_2\lambda_3} + \mu_3 \frac{S\lambda_1\lambda_2\lambda}{S\lambda_1\lambda_2\lambda_3}. \qquad (100)$$

But the expression on the right hand is a linear vector function of λ of the most general type.* If we denote it by $\phi\lambda$, we have

$$\mu = \phi\lambda. \qquad (101)$$

Another proof of this important theorem may be noted as follows:—

If $\mu\lambda$ be a screw reciprocal to the three screws $(\mu_1\lambda_1)$, $(\mu_2\lambda_2)$, $(\mu_3\lambda_3)$, we have

$$S(\mu\lambda_1 + \lambda\mu_1) = 0, \quad S(\mu\lambda_2 + \lambda\mu_2) = 0, \quad S(\mu\lambda_3 + \lambda\mu_3) = 0.$$

But, by a fundamental quaternion formula,

$$\mu S\lambda_1\lambda_2\lambda_3 = V\lambda_2\lambda_3 \,.\, S\lambda_1\mu + V\lambda_3\lambda_1 \,.\, S\lambda_2\mu + V\lambda_1\lambda_2 \,.\, S\lambda_3\mu.$$

Whence from the three equations of reciprocity just written, we have

$$\mu S\lambda_1\lambda_2\lambda_3 = V\lambda_3\lambda_2 S\mu_1\lambda + V\lambda_1\lambda_3 S\mu_2\lambda + V\lambda_2\lambda_1 S\mu_3\lambda, \qquad (102)$$

again showing that μ is a linear vector function of λ.

Being given any linear vector function ϕ, then by taking different vectors λ, the pair of coordinates $(\phi\lambda, \lambda)$ will trace out the screws of the 3-system corresponding to ϕ. This theorem is due to Joly,† and it is a discovery of much importance in the theory, inasmuch as it shows the perfect correspondence between the 3-system and the linear vector function.

When λ is given, then $\mu = \phi(\lambda)$ is known; and thus we see that in a 3-system there is always one screw parallel to any given direction. The pitch of the screw is $S\phi\lambda \,.\, \lambda^{-1}$, and the perpendicular from the origin on the screw is $V\phi\lambda \,.\, \lambda^{-1}$. The equation of any screw of the 3-system is

$$\rho = V\phi\lambda \,.\, \lambda^{-1} + x\lambda.$$

Joly‡ has also shown that if $(\phi\lambda, \lambda)$ represents a 3-system, then $(-\phi'\lambda, \lambda)$ represents the reciprocal 3-system, where as usual $\phi'\lambda$ is the function conjugate to $\phi\lambda$. This beautiful theorem shows the intimate connexion between the theory of reciprocal screw systems of the third order and the properties of the linear vector function.

In conclusion I add a few illustrations to show how the Theory of Screws responds to treatment by the methods of Quaternions. I shall assume that

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* See Report of the British Association for the Advancement of Science. Dublin, 1908, p. 611.

† Hamilton's "Elements," vol. ii., Appendix, p. 391.

‡ *Ibid.*, p. 392.

the reader is acquainted with the principal properties of linear vector functions and also with the geometrical properties of the 3-system.*

We shall first prove the following general proposition :—

If ϕ be a linear vector function, then

$$\rho = \tfrac{1}{2}(V\phi\lambda \,.\, \lambda^{-1} - V\phi'\lambda \,.\, \lambda^{-1}) + x\lambda$$

is the equation to a diameter of the pitch-quadric of the 3-system defined by the function ϕ.

A screw η parallel to λ can of course be found in the 3-system S and its pitch p is $S\phi\lambda \,.\, \lambda^{-1}$. A screw ξ parallel to λ can also be found in the reciprocal 3-system S', and its pitch is

$$-S\phi'\lambda \,.\, \lambda^{-1} = -S\phi\lambda \,.\, \lambda^{-1}.$$

Hence the pitches of the screws parallel to λ in the 3-system and its reciprocal 3-system differ merely in sign. These two screws are therefore parallel generators of the hyperboloid which expresses the locus of the screws of pitch p contained in the system S. A parallel to these generators drawn through the point midway between them must therefore be a diameter of the p-pitch-quadric, and therefore of the zero pitch-quadric, for, whatever p may be the p-pitch-quadric is concentric with the zero pitch-quadric.

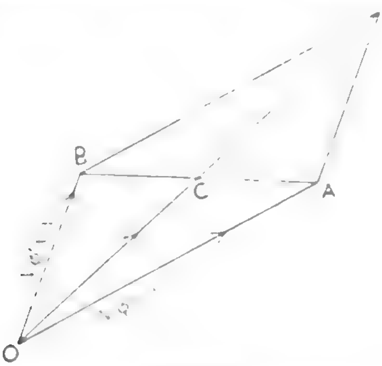

Fig. 16.

Let the plane of the paper pass through the origin O and be perpendicular to the two screws η and ξ which meet the plane in A, B respectively (fig. 16). The point C bisects AB, and the line through C perpendicular to the plane of the paper is therefore a diameter of the zero pitch-quadric. As OA is the perpendicular from the origin on η, we must have the vector OA equal to $V\phi\lambda \,.\, \lambda^{-1}$. In like manner OB is $-V\phi'\lambda \,.\, \lambda^{-1}$; and by completing the parallelogram, we have for the vector OC

$$OC = \tfrac{1}{2}(V\phi\lambda \,.\, \lambda^{-1} - V\phi'\lambda \,.\, \lambda^{-1}),$$

and this is the vector from the origin perpendicular upon that diameter of the

* See "Treatise," pp. 170–194.

pitch-quadric which is parallel to λ. Hence ρ, the vector to any point on the diameter, is given by the equation

$$\rho = \tfrac{1}{2}(V\phi\lambda\,.\,\lambda^{-1} - V\phi'\lambda\,.\,\lambda^{-1}) + x\lambda, \qquad (103)$$

where x is a variable scalar.

It is easy to see that this may be written in the more concise form

$$\rho = \tfrac{1}{2}\lambda^{-1}(\phi'\lambda - \phi\lambda) + x\lambda.$$

Multiplying by λ and taking the scalars, and supposing λ to be a unit vector, we have $x = -S\rho\lambda$.

If therefore i, j, k have their usual signification as any three unit-vectors which are mutually rectangular, and if ρ be the vector to the centre of the pitch-quadric, then

$$\rho = \tfrac{1}{2}i(\phi i - \phi' i) - iS\rho i,$$
$$\rho = \tfrac{1}{2}j(\phi j - \phi' j) - jS\rho j,$$
$$\rho = \tfrac{1}{2}k(\phi k - \phi' k) - kS\rho k.$$

Adding these three equations, and remembering the well-known quaternion formula

$$\rho = -iS\rho i - jS\rho j - kS\rho k,$$

we have

$$\begin{aligned}2\rho &= \tfrac{1}{2}(i\phi i + j\phi j + k\phi k) - \tfrac{1}{2}(i\phi' i + j\phi' j + k\phi' k)\\ &= \tfrac{1}{2}V(i\phi i + j\phi j + k\phi k) - \tfrac{1}{2}V(i\phi' i + j\phi' j + k\phi' k). \qquad (104)\end{aligned}$$

We now make the following characteristic transformation, derived, of course, from the wonderful manipulations of his symbols introduced by Hamilton:—

$$\begin{aligned}&-\tfrac{1}{2}V(i'\phi i + j\phi' j + k\phi' k)\\ &= \tfrac{1}{2}V(kj\phi' i + ik\phi' j + ji\phi' k) = \tfrac{1}{2}V(\phi' i\,Vjk + \phi' j\,Vki + \phi' k\,Vij)\\ &= \tfrac{1}{2}kSj\phi' i - \tfrac{1}{2}jSk\phi' i + \tfrac{1}{2}iSk\phi' j - \tfrac{1}{2}kSi\phi' j + \tfrac{1}{2}jSi\phi' k - \tfrac{1}{2}iSj\phi' k\\ &= \tfrac{1}{2}kSi\phi j - \tfrac{1}{2}jSi\phi k + \tfrac{1}{2}iSj\phi k - \tfrac{1}{2}kSj\phi i + \tfrac{1}{2}jSk\phi i - \tfrac{1}{2}iSk\phi j\\ &= \tfrac{1}{2}(jSk\phi i - kSj\phi i) + \tfrac{1}{2}(kSi\phi j - iSk\phi j) + \tfrac{1}{2}(iSj\phi k - jSi\phi k)\\ &= \tfrac{1}{2}Vjk\phi i + \tfrac{1}{2}Vki\phi j + \tfrac{1}{2}Vij\phi k = \tfrac{1}{2}V(i\phi i + j\phi j + k\phi k).\end{aligned}$$

Hence we obtain from (104) the result*

$$\rho = \tfrac{1}{2}V(i\phi i + j\phi j + k\phi k). \qquad (105)$$

This shows how the vector from the origin to the centre of the pitch-quadric, or rather of the system of p-pitch-quadrics, is expressed in terms of the linear vector function.

It is easily seen that if λ, μ, ν be any other set of unit vectors at right angles,

$$S(i\phi i + j\phi j + k\phi k) = S(\lambda\phi\lambda + \mu\phi\mu + \nu\phi\nu). \qquad (106)$$

* Joly, "Manual," pp. 97–159.

This proves that the sum of the pitches of three mutually rectangular screws in a 3-system is constant. Of course this can be easily shown by the ordinary geometrical theory of the 3-system, as given in "Treatise," p. 170. I would, however, like to state that I had never noticed this theorem until it recently presented itself as the natural geometrical meaning of the constancy of $S(i\phi i + j\phi j + k\phi k)$. In general we may state that $-S(i\phi i + j\phi j + k\phi k)$ is not only the sum of the pitches of three screws that are at right angles, but it is also the sum of the pitches of three screws which can be drawn through a point. That this is constant is a well-known property of the 3-system.*

The fundamental theorem which expresses the relation of the system of pitch-hyperboloids to the linear vector function has been given virtually by Joly;† but the following demonstration may be noted:—

Let ρ be the vector from the centre of the system to some point on the p-pitch-quadric, where p is the variable scalar expressing the pitch of a screw of the system, and where ϕ is the linear vector function by which the system is defined.

Through any point ρ on the p-pitch-quadric two generators can be drawn; and we shall suppose them parallel to vectors λ and μ respectively. The first of these with pitch p belongs to the original 3-system, and the second when it receives the pitch $-p$ is a screw of the reciprocal 3-system.

The equation of the generator parallel to λ is

$$\rho = V\phi\lambda . \lambda^{-1} + x\lambda,$$

where x is a variable scalar.

This may be written

$$\rho = \phi\lambda . \lambda^{-1} - S\phi\lambda . \lambda^{-1} + x\lambda,$$

$$= \phi\lambda . \lambda^{-1} - p + x\lambda,$$

or

$$\rho\lambda = \phi\lambda - p\lambda + x\lambda^2,$$

whence

$$V\rho\lambda = (\phi - p)\lambda. \tag{107}$$

This is another form of the equation of the generator parallel to λ.

To find the corresponding equation of the generator parallel to μ which belongs to the reciprocal system, we are to note that as the origin is now at the centre, the function ϕ is self-conjugate, and accordingly we have

$$\rho = - V\phi\mu . \mu^{-1} + y\mu, \tag{108}$$

$$= - \phi\mu . \mu^{-1} + S\phi\mu . \mu^{-1} + y\mu,$$

$$= - \phi\mu . \mu^{-1} + p + y\mu;$$

whence

$$- V\rho\mu = (\phi - p)\mu. \tag{109}$$

As $\phi - p$ is an operator which produces a self-conjugate linear vector-

* "Treatise," p. 176. † Joly, "Manual," p. 165.

function, we have in general by the known properties of self-conjugate linear vector-functions

$$(\phi - p)\{V(\phi - p)\lambda(\phi - p)\mu\} = m_p V\lambda\mu, \qquad (110)$$

where m_p is a constant, so far as λ and μ are concerned, depending only on p, and the coefficients of the latent cubic appropriate to ϕ. The actual value of m_p is thus found. Multiply (110) by any vector ν and take the scalar. Then the first side of (110) becomes

$$\begin{aligned} S(\phi - p)\{V(\phi - p)\lambda\ (\phi - p)\mu\}\nu &= S(\phi - p)\ \nu\{V(\phi - p)\lambda\ (\phi - p)\mu\} \\ &= S(\phi - p)\lambda\,.\,(\phi - p)\mu\,.\,(\phi - p)\nu. \end{aligned}$$

The second side of (110) becomes when the scalar is taken

$$m_p SV\lambda\mu\,.\,\nu = m_p S\lambda\mu\nu.$$

Thus we have

$$m_p = \frac{S(\phi - p)\lambda\,.\,(\phi - p)\mu\,.\,(\phi - p)\nu}{S\lambda\mu\nu} = \frac{S(\phi - p)\,i\,(\phi - p)\,j\,(\phi - p)\,k}{Sijk}, \qquad (111)$$

because of the very remarkable property of linear vector functions which affirms that m_p is unchanged whatever three vectors be chosen as $\lambda\mu\nu$.

Substituting for (107) and (108) in (110) we have

$$(\phi - p)\,VV\rho\lambda\,.\,V\rho\mu = -\,m_p V\lambda\mu\,;$$

but $$VV\rho\lambda\,.\,V\rho\mu = -\,\rho S\lambda\mu\rho,$$

and consequently $$(\phi - p)\rho S\lambda\mu\rho = m_p V\lambda\mu,$$

whence multiplying by ρ and taking the scalar

$$S\rho(\phi - p)\rho = m_p. \qquad (112)$$

It is indeed astonishing to find that so concise a formula as this should contain the theory of the 3-system of screws.

Much further development no doubt awaits the investigation of the relations of the Theory of Screws to Quaternions.

BIBLIOGRAPHICAL NOTES.

In the Treatise on the Theory of Screws, Cambridge, 1900, I have given an Appendix of Bibliographical Notes on works known to me which bear on the Theory of Screws. I add here a few later references, though I know the list is very incomplete.

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(2) "Sir Robert S. Ball's lineare Schraubengebiete." Von A. Grünwald in Prag-Bubentsch. Zeitschrift für Mathematik und Physik, 48 Band, 1902, 1 Heft, pp. 49–108.

(3) "Zur Veranschaulichung des Schraubenbündels." Von Anton Grünwald in Prag-Bubentsch. Zeitschrift für Mathematik und Physik, 49 Band, 1903, 2 Heft, pp. 211–245.

(4) "Darstellung aller Elementarbewegungen eines starren Körpers von beliebigem Freiheitsgrad." Von Anton Grünwald in Bubentsch bei Prag. Zeitschrift für Mathematik und Physik, 52 Band, 1905, 3 Heft, pp. 229–275.

(5) "Geometrie der Krafte." Von H. E. Timerding, Professor at the University of Strassburg. Leipzig, B. G. Teubner. 1908. pp. i–xi and 1–381.

(6) In the Encyklopadie der Mathematischen Wissenschaften (Leipzig) reference may be made to Professor H. E. Timerding's section entitled "Die ersten Sätze der Kinematik des starren Körpers und die Ballschen Schrauben." Band IV., 1 Teil, pp. 142–158.

III.

THE SYMBOLICAL EXPRESSION OF ELIMINANTS.

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The object of this paper is to show how the eliminant of any two binary quantics may be expressed in a symbolical form by the aid of certain operators.

Let u and v be the two quantics whose eliminant we desire to express symbolically, and let us suppose that u is of the m^{th} degree, and v of the n^{th} in x and y; and further, let the roots of the equation $u = 0$, be x_1/y_1, x_2/y_2, . . . x_m/y_m; and those of $v = 0$, be ξ_1/η_1, ξ_2/η_2, . . . ξ_n/η_n we may then write

(1) $$u(x, y) \equiv A_0x^m + A_1x^{m-1}y + \ldots + A_my_m \equiv (xy_1 - yx_1)(xy_2 - yx_2)\ldots(xy_m - yx_m),$$

(2) $$v(x, y) \equiv B_0x^n + B_1x^{n-1}y + \ldots + B_ny^n \equiv (x\eta_1 - y\xi_1)(x\eta_2 - y\xi_2)\ldots(x\eta_n - y\xi_n),$$

where u and v are written without binomial coefficients.

It is well known that a binary quantic or a covariant quantic can be derived from a certain term called the source of the quantic as well as from the leading term of the quantic by certain operative processes, which we now proceed to discuss.

If we write

(3) $$\begin{cases} -\delta \equiv y_1\dfrac{d}{dx_1} + y_2\dfrac{d}{dx_2} + \ldots + y_m\dfrac{d}{dx_m} + \eta_1\dfrac{d}{d\xi_1} + \eta_2\dfrac{d}{d\xi_2} + \ldots + \eta_n\dfrac{d}{d\xi_n}, \\ -\Delta = x_1\dfrac{d}{dy_1} + x_2\dfrac{d}{dy_2} + \ldots + x_m\dfrac{d}{dy_m} + \xi_1\dfrac{d}{d\eta_1} + \xi_2\dfrac{d}{d\eta_2} + \ldots + \xi_n\dfrac{d}{d\eta_n}, \end{cases}$$

thus giving to the well-known operative symbols a wider meaning than that usually attaching to them, and consequently a wider application, the reader will readily perceive the truth of the following equations:

(4) $$\begin{cases} \partial A_r = (m + 1 - r)A_{r-1}, \quad \partial B_s = (n + 1 - s)B_{s-1}, \quad \partial A_0 = 0, \quad \partial B_0 = 0, \\ \Delta A_r = (r + 1)A_{r+1}, \quad \Delta B_s = (s + 1)B_{s+1}, \quad \Delta A_m = 0, \quad \Delta B_n = 0. \end{cases}$$

It then appears that $u(x, y)$ can be written in the following forms:

$$(5)\quad \begin{cases} u(x,y) = y^m \left\{ A_m + \dfrac{x}{y}\delta A_m + \dfrac{x^2}{y^2}\dfrac{\delta^2 A_m}{1.2} + \ldots + \dfrac{x^m}{y^m}\dfrac{\partial^m A_m}{m!} \right\} = y^m e^{\frac{x}{y}\delta} A_m, \\ u(x,y) = x^m \left\{ A_0 + \dfrac{y}{x}\Delta A_0 + \dfrac{y^2}{x^2}\dfrac{\Delta^2 A_0}{1.2} + \ldots + \dfrac{y^m}{x^m}\dfrac{\Delta^m A_0}{m!} \right\} = x^m e^{\frac{y}{x}\Delta} A_0. \end{cases}$$

In like manner we may write

$$(6)\qquad v(x, y) = y^n e^{\frac{x}{y}\delta} B_n = x^n e^{\frac{y}{x}\Delta} B_0.$$

The quantities u and v being then completely defined by and derivable from their respective sources, we may denote the eliminant of u and v by the symbol $E(A_m, B_n)$, and write

$$(7)\quad \begin{cases} E(A_m, B_n) = u(\xi_1, \eta_1)\, u(\xi_2, \eta_2) \ldots u(\xi_n, \eta_n), \\ E(B_n, A_m) = v(x_1, y_1)\, v(x_2, y_2) \ldots v(x_m, y_m). \end{cases}$$

Substituting now in the above results for $u(\xi_1, \eta_1)$ and $v(x_1, y)$, and their values in terms of x_1, y_1; $x_2, y_2 \ldots x_m, y_m$; ξ_1, η_1; ξ_2, η_2; $\ldots \xi_n, \mu_n$; it is evident, on inspection, that

$$(8)\qquad E(A_m, B_n) = (-1)^{mn} E(B_n, A_m).$$

We now write

$$\begin{aligned} E(A_m, B_n) = {} & \{A_m\eta_1^m + A_{m-1}\eta_1^{m-1}\xi_1 + A_{m-2}\eta_1^{m-2}\xi_1^2 + \ldots + A_0\xi_1^m\} \\ \times {} & \{A_m\eta_2^m + A_{m-1}\eta_2^{m-1}\xi_2 + A_{m-2}\eta_2^{m-2}\xi_2^2 + \ldots + A_0\xi_2^m\} \\ \times {} & \{A_m\eta_3^m + A_{m-1}\eta_3^{m-1}\xi_3 + A_{m-2}\eta_3^{m-3}\xi_3^2 + \ldots + A_0\xi_3^m\} \\ & \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \quad \cdot \\ \times {} & \{A_m\eta_n^m + A_{m-1}\eta_n^{m-1}\xi_n + A_{m-2}\eta_n^{m-3}\xi_n^2 + \ldots + A_0\xi_n^m\}, \end{aligned}$$

and if we agree to denote the various symmetric functions as follows:

$$(9)\quad \begin{cases} \Sigma\xi_1\eta_2\eta_3 \ldots \eta_n = \Sigma_1, \quad \Sigma\xi_1^2\eta_2^2\eta_3^2 \ldots \eta_n^2 = \Sigma_2, \\ \Sigma\xi_1\xi_2\eta_3 \ldots \eta_n = \Sigma_{1,1}, \quad \Sigma\xi_1^2\xi_2\eta_2\eta_3^2 \ldots \eta_n^2 = \Sigma_{2,1}, \ \&c., \&c., \end{cases}$$

we find readily, on expanding the above form of $E(A_m, B_n)$,

$$\begin{aligned} (10)\quad E(A_m, B_n) = {} & A_m^n B_0^m + A_m^{n-1}\{B_0^{m-1}A_{m-1}\Sigma_1 + B_0^{m-2}A_{m-2}\Sigma_2 + \ldots + A_0\Sigma_m\} \\ & + A_m^{n-2}\{B_0^{m-1}A^2_{m-1}\Sigma_{1,1} + B_0^{m-2}A_{m-2}A_{m-1}\Sigma_{2,1} + \ldots + A_0^2\Sigma_{m,m}\} \\ & + A_m^{n-3}\{B_0^{m-1}A^3_{m-1}\Sigma_{1,1,1} + B_0^{m-2}A_{m-2}A^2_{m-1}\Sigma_{2,1,1} + \ldots A_0^3\Sigma_{m,m,m}\} \\ & + \ \cdot \ \cdot \ \cdot \ \cdot \ \cdot \ \cdot \ \cdot \ \cdot \ \&c., \\ & + (-1)^n B_n E(A_{m-1}, B_n), \quad \text{since} \quad \eta_1\eta_2 \ldots \eta_n = B_0, \end{aligned}$$

and

$$\xi_1\xi_2 \ldots \eta_n = (-1)^n B_n.$$

It is evident then, that if we regard the eliminant as a homogeneous function of the As of the n^{th} order, the coefficient of any term $A_{m-r} . A_{m-s} . A_{m-t}$ will be $\Sigma_{r,s,t}$, and consequently if we know the eliminant in terms of the As and the Bs, we can find the symmetric function $\Sigma_{r,s,t}$.

We have then, in general, on expanding the eliminant in terms of A_m,

$$(11)\quad E(A_m, B_n) = A_m{}^n B_0{}^m + A_m{}^{n-1}X_1 + A_m{}^{n-2}X_2 + A_m{}^{n-3}X_3 + \ldots + A_m{}^2 X_{n-2} + A_m X_{n-1} + (-1)^n B_n E(A_{m-1}, B_n),$$

where $X_1, X_2, \ldots$ &c., are functions of the coefficients of both quantics and independent of A_m.

We now introduce two new operators, which we denote by Ω and ω, and define as follows:—

If m be equal to or greater than n, we write, where $r = m - n$,

$$(12)\quad \Omega_r = B_0 \frac{d}{dA_r} + B_1 \frac{d}{dA_{r+1}} + \ldots + B_n \frac{d}{dA_m};$$

and if n is equal to or exceeds m, we write

$$(13)\quad \omega_s = A_0 \frac{d}{dB_s} + A_1 \frac{d}{dB_{s+1}} e \ldots + A_m \frac{d}{dB_n},$$

where $s = n - m$.

It is clear that if we form the eliminant of $u + kv$ and v the result must be independent of k; hence we must have $E(A_m + kB_n, B_n)$ independent of k.

Now, the coefficient of k is evidently $\Omega_r E(A_m, B_n)$, and consequently m being greater or equal to n, we must have

$$(14)\quad \Omega_{m-n} . E(A_m, B_n) = 0.$$

If we now operate with Ω_r on the form of $E(A_m, B_n)$, given in equation (11), we obtain

$$\begin{aligned}(15)\quad \Omega_r E(A_m, B_n) &= nA_m{}^{n-1}B_nB_0{}^m + (n-1)A_m{}^{n-2}B_nX_1 + (n-2)A_m{}^{n-3}X_2 \\ &\quad + \ldots + 2A_mB_nX_{n-2} + A_m{}^{n-1}\Omega_rX_1 + A_m{}^{n-2}\Omega_rX_2 + A_m{}^{n-3}\Omega_rX_3 \\ &\quad + \ldots + A_m\Omega_rX_{n-1} + B_nX_{n-1} + \ldots + (-1)^nB_n E(A_{m-1}, B_n) \\ &= A_m{}^{n-1}(nB_nB_0{}^m + \Omega_rX_1) + A_m{}^{n-2}((n-1)B_nX_1 + \Omega_rX_2) \\ &\quad + A_m{}^{n-3}((n-2)B_nX_2 + \Omega_rX_3) + \ldots + A_m(2B_nX_{n-2} \\ &\quad + \Omega_rX_{n-1}) + B_n(X_{n-1} + (-1)^n EA_{m-1}, B_n) = 0.\end{aligned}$$

Now, since $\Omega_r E(A_m, B_n)$ is identically zero, we are led to the series of equations

$$(16)\quad \left\{\begin{aligned} X_{n-1} + (-1)^n \Omega_r E(A_{m-1}, B_n) &= 0, \\ 2B_nX_{n-2} + \Omega_rX_{n-1} &= 0, \\ 3B_nX_{n-3} + \Omega_rX_{n-2} &= 0, \\ \text{\&c.,} \qquad \text{\&c.,}& \\ (n-1)B_nX_nX_1 + \Omega X_2 &= 0, \\ nB_nB_0{}^m + \Omega_rX_1 &= 0; \end{aligned}\right.$$

and from these we easily obtain the following :—

$$
(17)\qquad \begin{cases}
X_{n-1} = -h\Omega_r E', \\
B_n X_{n-2} = h\dfrac{\Omega_r^2}{1.2}E', \\
B_n X_{n-3} = -h\dfrac{\Omega_r^3}{1.2.3}E', \\
\quad \&c., \qquad\qquad \&c., \\
B_n B_0^m = (-1)^n h\dfrac{\Omega_r^n}{n!}E' = \dfrac{\Omega_r^n E'}{n!},
\end{cases}
$$

where $h = (-1)^n$ and $E' = E(A_{m-1}, B_n)$.

If we now introduce these values into the value of $E(A_m, B_n)$, as given in (11), we obtain

$$
(18)\quad E(A_m, B_n) = hB_n\left\{E' - \frac{A_m}{B_n}\Omega_r E' + \frac{A_m^2}{B_n^2}\frac{\Omega_r^2}{1.2}E' - \frac{A_m^3}{B_n^3}\frac{\Omega_r^3 E'}{1.2.3} + \ldots \right.
$$

$$
\left. + (-1)^n\frac{A_m^n}{B_n^n}\frac{\Omega_r^n E'}{1.2\ldots n}\right\} = hB_n e^{-\frac{A_m}{B_n}\Omega_r}E',
$$

where $E' = E(A_{m-1}, B_n)$ and $h = (-1)^n$.

We have therefore determined $E(A_m, B_n)$ by the application of the operative process given above, and can write, in general,

$$
(19)\qquad E(A_m, B_n) = hB_n e^{-\frac{A_m}{B_n}\Omega_{m-n}}E(A_{m-1}, B_n).
$$

In a similar manner $E(A_{m-1}, B_n)$ is expressed by the formula

$$
(20)\qquad E(A_{m-1}, B_n) = hB_n e^{-\frac{A_{m-1}}{B_n}\Omega_{m-n-1}}E(A_{m-2}, B_n),
$$

we can consequently write

$$
(21)\qquad E(A_m, B_n) = hB_n^2 e^{-\frac{A_m}{B_n}\Omega_{m-n}}e^{-\frac{A_{m-1}}{B_n}\Omega_{m-n-1}}E(A_{m-2}, B_n);
$$

and finally $E(A_m, B_n)$ is seen to be derivable by an operative process from $E(A_m, B_n)$.

We now commence with the eliminant of two quadratics, and we shall show how all other eliminants may be derived from it. We write

$$
(22)\qquad E(A_2, B_2) = (A_2B_0)^2 - (A_1B_0)(A_2B_1),
$$

where

$$
(A_1B_0) = A_1B_0 - A_0B_1,
$$

$$
(A_2B_1) = A_2B_1 - A_1B_2,
$$

$$
(A_2B_0) = A_2B_0 - A_0B_2;
$$

and we propose to find $E(B_3, A_2)$.

Now, if $$\omega_1 \equiv A_0\frac{d}{dB_1} + A_1\frac{d}{dB_2} + A_2\frac{d}{dB_3},$$
we have, by what precedes,
$$E(B_3, A_2) = A_2 e^{-\frac{B_3}{A_2}\omega_1} E(A_2, B_2);$$
it is therefore necessary to find $\omega_1 E(A_2, B_2)$.

Now,
$$\begin{cases} \omega_1 (A_1B_0) = - A_0^2, \\ \omega_1 (A_2B_0) = - A_0A_1, \\ \omega_1 (A_2B_1) = A_0A_2 - A_1^2; \end{cases}$$
hence,
$$\omega_1 E(A_2, B_2) = -2(A_2B_0)A_0A_1 - (A_1B_0)(A_0A_2 - A_1^2) + (A_2B_1)A_0A_1;$$
and consequently we find
$$(23)\quad E(B_3, A_2) = B_3^2A_0^3 - B_3\{-2(A_2B_0)A_0A_1 - (A_1B_0)(A_0A_2 - A_1^2) + (A_2B_1)(A_0A_1\} + A_2\{(A_2B_0)^2 - (A_1B_0)(A_2B_1)\}.$$
To find $E(A_3, B_3)$ we employ the formula
$$E(A_3, B_3) = - B_3 e^{-\frac{A_3}{B_3}\Omega_0} E(B_3, A_2),$$
where $$\Omega_0 \equiv B_0\frac{d}{dA_0} + B_1\frac{d}{dA_1} + B_2\frac{d}{dA_2} + B_3\frac{d}{dA_3};$$
and we now proceed to find the value of $B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_r$, where r has any integer value from 0 to 2.

We have $$B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_r = B_3\left(A_r - A_3\frac{B_r}{B_3}\right) = -(A_3B_r),$$
also
$$e^{-\frac{A_3}{B_3}\Omega_0}(A_rB_s) = (A_rB_s),$$ r and s being any two integers since $\Omega_0(A_rB_s)$ vanishes identically.

We have consequently
$$(24)\quad \begin{cases} B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_2 = -(A_3B_2), \\ B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_1 = -(A_3B_1), \\ B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_0 = -(A_3B_0), \\ e^{-\frac{A_3}{B_3}\Omega_0}(A_rB_s) = (A_rB_s). \end{cases}$$

If we now write

$$e^{\rho\Omega_0}X = X + \rho\Omega_0 X + \frac{\rho^2\Omega_0^2 X}{1.2} + \frac{\rho^3\Omega_0^3 X}{1.2.3} + \ldots \text{ \&c.,}$$

$$e^{\rho\Omega_0}Y = Y + \rho\Omega_0 Y + \frac{\rho^2\Omega_0^2 Y}{1.2} + \frac{\rho^3\Omega_0^3 Y}{1.2.3} + \ldots \text{ \&c.,}$$

we have, on multiplying $e^{\rho\Omega_0}X$ by $e^{\rho\Omega_0}Y$,

$$\{e^{\rho\Omega_0}X\}\{e^{\rho\Omega_0}Y\} = XY + \rho(Y\Omega_0 X + X\Omega_0 Y)$$

$$+ \frac{\rho}{1.2}\{Y\Omega_0^2 X + 2\Omega_0 X\Omega_0 Y + X\Omega_0^2 Y\} + \text{\&c.,} \ldots \text{\&c.,}$$

$$= (XY) + \rho\Omega_0(XY) + \frac{\rho}{1.2}\Omega_0^3(XY)c, \text{ \&c.,} \ldots$$

where X and Y are any two functions whatever; hence we see that

(25) $$(e^{\rho\Omega_0}X)(e^{\rho\Omega_0}Y) = e^{\rho\Omega_0}(XY).$$

And if we now let $\rho = -\frac{A_3}{B_3}$, it follows that we have

(26) $$\left\{\begin{aligned} &B_3^3 e^{-\frac{A_3}{B_3}\Omega_0} A_0^3 = -(A_3B_0)^3, \\ &B_3^2 e^{-\frac{A_3}{B_3}\Omega_0} (A_0A_2 - A_1^2) = (A_3B_0)(A_3B_2) - (A_3B_1)^2, \\ &B_3^2 e^{-\frac{A_3}{B_3}\Omega_0} A_0^2 = (A_3B_0)^2, \\ &B_3^2 e^{-\frac{A_3}{B_3}\Omega_0} A_0A_1 = (A_3B_0)(A_3B_1), \\ &B_3 e^{-\frac{A_3}{B_3}\Omega_0} A_0 = (A_3B_0). \end{aligned}\right.$$

We are consequently led to the following value of $E(A_3, B_3)$:—

(27) $$\begin{aligned} E(A_3, B_3) = {} & (A_3B_0)^3 + (A_3B_0)^2(A_2B_1) + (A_3B_1)^2(A_1B_0) \\ & + (A_2B_0)^2(A_3B_2) - 2(A_3B_0)(A_3B_1)(A_2B_0) \\ & - (A_1B_0)(A_3B_2)(A_3B_0) - (A_1B_0)(A_3B_2)(A_2B_1). \end{aligned}$$

The six functions $(A_3B_2)(A_3B_1)$, &c., are not independent, but are connected by the relations

(28) $$(A_3B_0)(A_2B_1) - (A_3B_1)(A_2B_0) + (A_3B_2)(A_1B_0) = 0.$$

The value of $E(A_3, B_3)$ should be such that when operated upon by δ or Δ, as defined in the earlier part of this paper, it should vanish identically; and this we find to be the case which the reader can easily verify for himself.

We can now make $E(A_3, B_3)$ a starting-point, and from it find all eliminants included in the formula $E(A_m, B_3)$ by an operative process as follows:—

$$(29)\quad \begin{cases} E(A_4, B_3) = -B_3 e^{-\frac{A_4}{B_3}\Omega_1} E(A_3, B_3), \\ E(A_5, B_3) = B_3^2 e^{-\frac{A_5}{B_3}\Omega_2} e^{-\frac{A_4}{B_3}\Omega_1} E(A_3\, B_3), \\ E(A_6, B_3) = -B_3^3 e^{-\frac{A_6}{B_3}\Omega_3} e^{-\frac{A_5}{B_3}\Omega_2} e^{-\frac{A_4}{B_3}\Omega_1} E(A_6, B_3); \end{cases}$$

and so on by the method above indicated.

In order to find $E(A_4, B_4)$, we must first find the value of $E(B_4, A_3)$, just in the same way as when seeking the value of $E(A_3, B_3)$ we first found the value of $E(B_3, A_2)$.

We have then, by a similar process of reasoning,

$$(30)\quad \begin{cases} E(B_4, A_3) = -A_3 e^{-\frac{B_4}{A_3}\omega_1} E(B_3, A_3), \\ E(A_4, B_4) = B_4 e^{-\frac{A_4}{B_4}\Omega_0} E(B_4, A_3). \end{cases}$$

$E(A_4, B_4)$ is then in its turn made a starting-point for the evaluation of all eliminants included in the formula $E(A_m, B_4)$.

The generality of the method is now obvious, and the application of it to any two given binary quantics will present no difficulty.

PROCEEDINGS

OF THE

ROYAL IRISH ACADEMY

VOLUME XXVIII

SECTION B.—BIOLOGICAL, GEOLOGICAL, AND
CHEMICAL SCIENCE.

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The Academy *desire it to be understood that they are not answerable for any opinion, representation of facts, or train of reasoning that may appear in any of the following Papers. The Authors of the several Essays are alone responsible for their contents.*

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CONTENTS

SECTION B.—BIOLOGICAL, GEOLOGICAL, AND CHEMICAL SCIENCE.

ERRATA.

SECTION B.

Page 130, 2nd column, line 14 from bottom, *for* Enerthenema *read* Enerthenema

Page 133, column 1, line 26, *delete* Sclerotinia parasitica *Cav.* L 2

Page 134, column 1, line 4 from bottom, *for* HYPODERMATACEA *read* HYPODERMATACEAE

Page 157, line 24, *for* Erysibe *read* Erysiphe

Page 164, column 1, *for* Cystopus, . . . 141 *read* Cystopus, . . . 131

PROCEEDINGS

OF

THE ROYAL IRISH ACADEMY

PAPERS READ BEFORE THE ACADEMY

I.

ON THE EVIDENCES OF A FORMER LAND-BRIDGE BETWEEN NORTHERN EUROPE AND NORTH AMERICA.

BY R. F. SCHARFF, PH.D., M.R.I.A.

Read NOVEMBER 8. Ordered for Publication NOVEMBER 10. Published NOVEMBER 13, 1909.

WHEN I enunciated the theory some years ago that north-western Europe and north-eastern America had been connected with one another by land within comparatively recent geological times, my views were adversely criticized by a reviewer in *Natural Science*.[1] What particularly gave rise to these criticisms was my statement that the reindeer had probably utilized this land-connexion in gaining access to Europe from its supposed American centre of dispersion. My reviewer urged that he failed to perceive any evidence for a land-connexion between North America and Europe by way of Greenland at the time when the reindeer flourished in the British Islands—that is to say, during or just previous to the human period.

Another reviewer—Dr. L. Stejneger—disapproved of my suggested land-bridge between northern Norway and America by way of Spitsbergen and Greenland, while advocating at least a discontinuous one further south.[2] He thought that Dr. Nansen's oceanographic results in the Polar basin militated against my views. Dr. Nansen's detailed treatise, since published, shows that in this he was mistaken. Further studies, nevertheless, have led me to the conviction that a second and more southerly land-connexion,

[1] Review of Scharff's "European Fauna," Natural Science, vol. xv., p. 358.

[2] Stejneger, L., Scharff's "History of the European Fauna," p. 107.

joining Scotland, Iceland, and Greenland with America, must have existed in later Tertiary times. This does not materially alter the general principle of my original views; and I still adhere to the belief in a North Atlantic land-bridge between Europe and America during the lifetime of the reindeer. (Fig. 1.) In defence of my opinion I propose to enlarge the scope of my arguments by bringing forward some additional pieces of evidence.

The testimony in favour of my theory is of a twofold character. It is based on an investigation of the sea-floor, and on a study of the plants and animals of the countries supposed to have been joined to one another by land.

In 1897, Mr. W. S. Green gave us the results of his expedition to the Rockall Bank. Surrounded by deep water on all sides, this bank is of an average depth of 100 fathoms, and lies far out in the Atlantic to the west of Scotland. Dredging on the bank yielded only such shallow-water species of molluscs and other marine invertebrates as could not have lived there under the present conditions. Moreover, as all the specimens were dead, it was concluded that the bank had only subsided to its present depth within comparatively recent times.[1] In 1900 the Danish 'Ingolf' expedition to Iceland likewise reported having met littoral molluscs near the island at considerable depths where these animals could not possibly have lived. That such cases as these are due to accidental dispersal by floating icebergs containing shells in the ice-foot or by floating seaweeds, had been suggested; but the view that the occurrence of shore forms of animal life in deep water implies a depression of the land seems to meet with more general favour, especially as no icebergs are known to stray to the Rockall Bank at present.

It has been demonstrated by Sir Archibald Geikie that a considerable subsidence has taken place in the area between the west of Scotland and Iceland since the time of the volcanic eruptions that produced the great basalt plateau of north-western Europe.[2]

Many other geologists, notably Professor de Lapparant and Professor M'Kenny Hughes have directed attention to the evidences indicating a sinking of the land in the same region. But the subject was also studied from another point of view. It was Mr. Austen, I believe, who first brought under our notice the continental shelves or platforms of submerged land surrounding the British Isles.[3]

[1] Green, W. S., "Notes on Rockall Island."
[2] Geikie, A., "Tertiary Basalt Plateaux of North-western Europe," p. 399.
[3] Austen, R. A. C., "Valley of English Channel," p. 94.

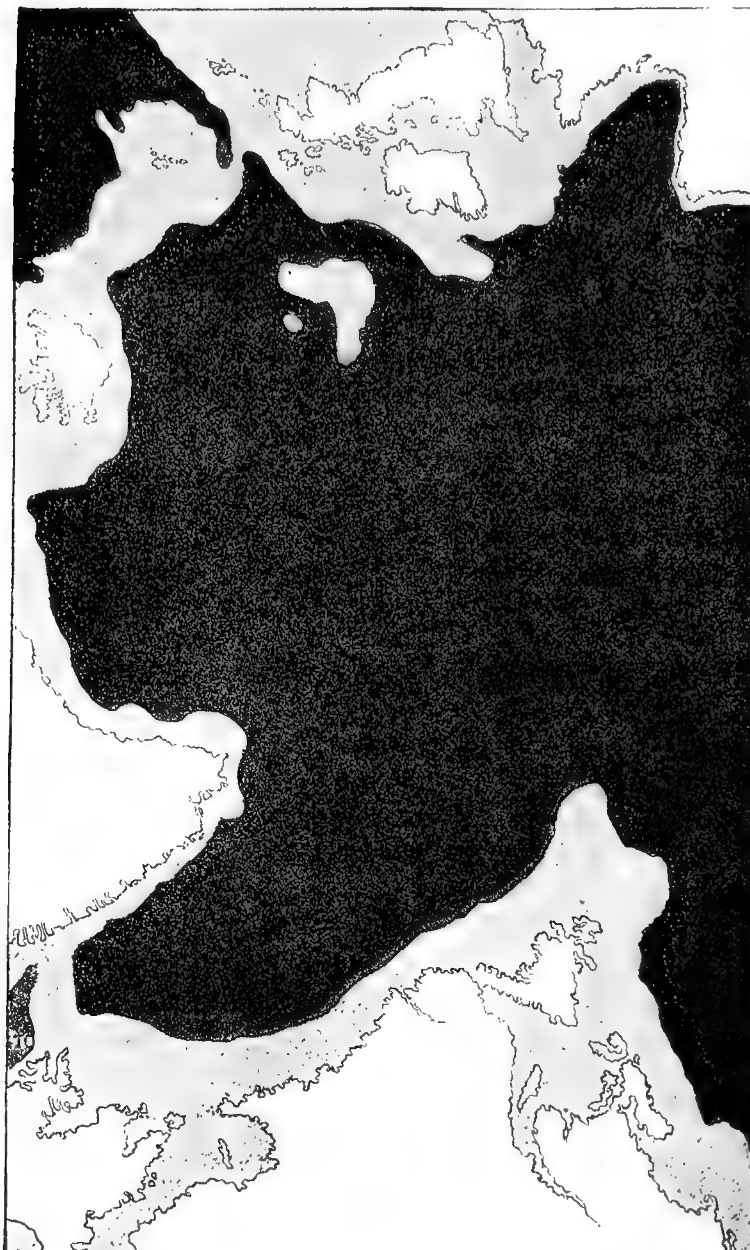

FIG. 1.—Map showing the supposed conditions of land and water in the North Atlantic during later Pliocene times.

More recently, in a series of interesting articles, Professor Hull lays stress on the occurrence of channels in these platforms, and urges that they represent the drowned river-valleys and cañons of an ancient land-surface. By means of the Admiralty charts he succeeded in tracing the course of the River Shannon for a hundred miles beyond its present mouth, right to the edge of the continental platform, while he followed the continuation of the River Erne for a distance of eighty miles from the Irish coast.[1]

In America similar researches have been conducted, chiefly by Dr. Spencer.[2] He maintains that the drowned channel of the Hudson River is clearly traceable across the submarine shelf of the continent for over a hundred miles, but that the exact course of the ancient Laurentian valley cannot be located with certainty. These submarine valleys, he thinks, were sculptured on the great continental slopes by atmospheric agents, and these features are considered by him to be more recent, in point of age, than the remnants of the Miocene accumulations of the coastal plains.

Professor Hull advocates an elevation of the land during the early part of the Glacial period of 7000 to 8000 feet. Dr. Spencer even suggests an uplift of 12,000 to 15,000 feet.

A more cautious attitude on these oceanographic problems is adopted by Mr. Huddleston. He concedes that some sort of a bridge across the Atlantic may have existed during portions of the Tertiary era; but he does not believe in an uplift beyond 2000 or 3000 feet.[3]

The subject of continental shelves has lately received renewed attention from Dr. Nansen, and is discussed by him at great length. At several places, he argues, there is weighty evidence for the supposition that the drowned river-valleys have been sculptured after the formation of the continental shelves. The latter consequently have been dry land after their formation.[4]

When the basaltic plateau so graphically described by Sir Archibald Geikie towered about 1500 feet above sea-level, the Faröes and Iceland, according to Dr. Nansen, were probably connected with one another by land (p. 173). He believes the continental shelf of Iceland to have been formed chiefly in Pre-Glacial times during the Pliocene and Pleistocene periods (p. 172).

Dr. Thoroddsen's ideas are similar, in so far as he strongly repudiates the suggestion of a Post-Glacial land-connexion.[5]

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[1] Hull, E., "Submerged Terraces and River Valleys."
[2] Spencer, J. W., "Submarine Valleys," p. 224.
[3] Huddleston, W. H., "Eastern Margin of North Atlantic Basin," p. 148.
[4] Nansen, F., "North Polar Expedition," p. 192.
[5] Dr. Stejneger very kindly directed my attention to this paper.

The remarkable circumstance that the submarine fjord-valleys on the European and on the American side, and likewise the submarine ridges connecting the two continents, are situated at about the same depth makes it probable that the whole area had once been raised simultaneously, and had thus become connected by land. This was not Dr. Nansen's opinion only (p. 173). Professor Dana long ago urged that the refrigeration of the climate at the close of the Tertiary era was connected with a period of high-latitude elevation.[1] Dr. Wright and Mr. Upham, two well-known American authorities on glacial phenomena, expressed the view that the northern lands must have been gradually elevated in Pliocene times, becoming continuous before the Ice Age.[2] They assume that North America thus became joined to northern Asia across the area of the shallow Bering Sea, while land extended from Norway to the Faröes, Iceland, and Greenland.

Incidentally Dr. Wright warns us that a cautious attitude of agnosticism with respect to the cause of the Glacial period is most scientific and becoming. Nevertheless I venture to think, and cannot refrain from expressing my opinion, that the Glacial period was primarily due to the diversion of oceanic currents produced by changes in the distribution of land and water. This again is no new suggestion. It was put forward, among others, by Dr. Wallace,[3] and has, I believe, been adopted by many naturalists. With every respect for the views of those who hold different opinions, it seems to me that the peculiar phenomena connected with the Ice Age in western Europe, and especially the apparent survival of southern species of plants and animals in Ireland through the Glacial period, are best explained by such a theory as that just stated. No doubt astronomical causes, as Sir Robert Ball has so clearly demonstrated, have affected the temperature of the northern hemisphere conjointly.[4] However, as it is not my intention to engage in the speculative discussion of the causes of the Ice Age, I may as well turn to the biogeographical evidences for the former existence of a North Atlantic land-bridge.

It is especially the teachings of Edward Forbes and A. R. Wallace that led to the recognition of the significance of the present geographical distribution of animals and plants as an indicator of the changes which have taken place in the arrangement of land and water. They believed that many terrestrial animals and plants require a continuous land-surface for their dispersal.

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[1] Dana, J. D., "Manual of Geology," 3rd edition, p. 540.
[2] Wright, F., and W. Upham, "Greenland Icefields," p. 331.
[3] Wallace, A. R., "Island Life," pp. 150–151.
[4] Ball, R., "The Cause of an Ice Age."

Yet the diversity and comparative richness of the fauna and flora of some of the oceanic islands, and the depth of water intervening between them and the mainland, had to be accounted for in some other manner. Neither Wallace nor Darwin was inclined to admit extensive geographical changes within the period of existing species. The distribution of plants and animals by "accidental," or what Darwin called "occasional," means of dispersal seemed to furnish them with a clue to the world-wide dissemination of certain species. With his wonted indomitable industry and perseverance, Darwin collected every possible fact that might be of service to him in demonstrating the dispersal of species by accidental means. He endeavoured to show by the most ingenious experiments how certain plants and animals might be floated by marine currents across many miles of open sea from one country to another. He demonstrated that many kinds of seeds may retain their vitality for several days in the crop of a freshly-killed bird, which might drift away to a distant island during that period. A pellet of earth adhering to the leg of a Red-legged Partridge contained seeds from which eighty-two plants germinated after having been kept in a dried condition for three years. He proved experimentally that young freshwater molluscs are apt to attach themselves firmly to the feet of ducks, and that they might thus easily be transported from one pond to another.[1]

Darwin's experiments have found many imitators; and valuable observations tending to show that at any rate some of the more minute animals and plants are liable to be conveyed by occasional means of dispersal, have been made. Thus the winter-eggs of Cladocera (water-fleas) have been found adhering to the feathers of wild ducks and other water-fowl. It has been demonstrated that algæ are sometimes carried by water-beetles from pool to pool, and that water-bugs, during their flights, occasionally transfer larval water-mites from one ditch to another.[2]

The most practical experiments of all are those unintentional transmissions of seeds, insects, and other terrestrial invertebrates, and even of vertebrates such as the mouse and rat, which we witness every day from one country to another, from island to island, across vast expanses of territory, and from one climatic extreme to another.

Beyond these we know very little of what actually happens in nature without man's intervention. Many people have speculated on the possible means of accidental transport. Yet their theories do not afford us any real guidance as to the manner in which animals and plants are actually

[1] Darwin, C., "Origin of Species," pp. 316–362.

[2] Zacharias, O., "Tier- und Pflanzenwelt d. Susswassers," pp. 306–308.

disseminated. We do not even know that the experiments conducted in the workroom are repeated under natural conditions. Mr. Kew, in his well-known work on the "Dispersal of Shells," has to acknowledge:—"Unfortunately I do not know that any observation clearly indicating the transportal of Molluscs or their eggs with drift-timber, &c., has ever been made. The creatures have never been found, as far as I have ascertained, in the crevices, or under the bark either of trees encountered upon the sea, or of those stranded on foreign coasts."[1] We possess, moreover, very numerous records of intentional introductions of species by man having either entirely failed to establish themselves, or having become extinct after several years of apparent success. I have already had occasion to quote an example which has come under my notice, and which is of particular interest, as it relates to a species which seemed to Darwin to possess special facilities for dispersal, viz., *Cyclostoma elegans*.[2] This snail is provided with a lid or operculum. When, as Mr. Darwin tells us, a dozen of them were immersed for a fortnight in sea-water, eleven specimens survived the treatment.[3] Being endowed with an exceptional device for resisting the action of sea-water on its delicate organism, and being abundant all over the western parts of Continental Europe, we should expect *Cyclostoma elegans* to have been conveyed by marine currents to the Canary Islands, Madeira, or even to Ireland. None of these islands is at too great a distance from the mainland to be beyond easy reach of a floating object; and yet it does not inhabit any of them. This is of particular interest as regards Ireland; because dead shells of this species have been picked up on the Irish coast, indicating that marine currents do carry specimens, and have probably transported living ones to that island for centuries. That *Cyclostoma elegans* has nevertheless failed to establish itself in Ireland seems to justify the belief that other animals or even plants arriving in a similar manner may find it equally difficult to do so.

A more striking fact against the theory of "accidental or occasional" introduction is furnished by the land molluscs inhabiting the Pacific islands. These are tenanted entirely by the most primitive groups of snails; while the more highly organized genera and even families which occur on the neighbouring continents of Asia and America are unrepresented. "It is very easy," remarks Dr. Pilsbry, "to show that snails may have been carried from place to place by a hurricane, a floating tree, or floating island, or their eggs may find room in the pellet of earth clinging to a bird's feather; but it

[1] Kew, H. W., "Dispersal of Shells," p. 138.
[2] Scharff, R. F., "European Animals," p. 2.
[3] Darwin, C., "Origin of Species," p. 353.

is incumbent upon the theorist who peoples the Mid-Pacific islands by such means to show why such dominant groups as the Helicidae, Buliminidae, Rhytididae, Streptaxidae—in fact, the whole Holopoda and Agnathomorpha with the higher members of Aulacopod families, as well as the higher operculates—should have utterly failed to take advantage of these means of transport."[1]

In connexion with the well-known fact that many invertebrate species have acquired an immensely wide distribution, it is well to recall what Darwin already told us, that within each great class the lower organisms change at a slower rate than the higher. Consequently they will have had more opportunity for dispersal, while still retaining the same specific character.[2]

But even Darwin had no conception of the remoteness of the date of origin of most of our common genera, and even of species of land and freshwater shells. Palaeontological discoveries have revealed even in Mesozoic deposits certain species which are still living at the present day. Genera like Clausilia have now been traced to the Cretaceous period. Their dispersal to remote regions may have taken place in the dawn of the Tertiary era, when, as we know from independent researches the allocation of land and water was vastly different from what it is now.

And yet the influence of accidental or occasional means of dispersal upon the fauna and flora of a country is considered by many zoologists and botanists to be of profound importance. Until recently the evidence that could be adduced in favour of their theory was almost unsupported by any actual demonstration in the field, as we might say. At last the longed-for evidence has been discovered in the shape of an island whose fauna and flora are alleged to have been completely destroyed by a volcanic eruption, and subsequently entirely reintroduced by accidental means. Dr. Ernst's account of it made quite a sensation. The terrible outburst of fire and ashes from what was looked upon as an extinct volcano on the island of Krakatau (Krakatoa) occurred not very many years ago—in 1883. Half the island sank beneath the ocean; the remainder was covered with a layer of glowing stones and hot ashes, reaching an average depth of 100 feet. In some parts of the island, however, as the author tells us, not more than two months after the eruption, subaerial denudation had already carved out of the loose strata deep valleys and gorges. "In the vicinity of the peak," as he puts it, "where the newly-formed deposit must have been thinnest, patches of the original rock-surface

[1] Pilsbry, H. A., "Genesis of Mid-Pacific Faunas," p. 572.
[2] Darwin, C., "Origin of Species," p. 359.

protruded here and there, exposing the blasted and carbonized remains of tree-stems."[1]

Within sixty days after the eruption the ashes had been washed away to such an extent as to expose the original surface in certain parts. I wonder how many stems of the tropical forest alluded to were crowded with insect life, and to what temperature the interior of these tree-trunks rose when the external parts were charred, or to what depth of soil the heat of the hot ashes penetrated? I should have imagined that multitudes of insects or their larvae, and countless seeds, would have survived the ordeal that Dr. Ernst so vividly describes. At any rate, I can fancy a naturalist, imbued with Darwin's methods of research, eager to root up these dead tree-stumps in order to examine what seeds and what insects were still living in the soil beneath or in the adjoining rock-crevices. Nothing of the kind was attempted! We are simply informed that all organic life had been destroyed. It is well known that such seeds as can stand desiccation are extremely resistant to heat when dry, and may not be injured by the temperature of boiling water. Would the heat of the hot ashes penetrating into the soil destroy all vitality among the seeds contained therein? I think not. And yet we are led to believe that three years after the volcanic outburst in 1886 the pioneers of the new vegetation which reached the island by accidental dispersal from elsewhere were seen stretching from the shore to the peak of the mountain. Seven years later the whole island was covered with a dense, almost impenetrable thicket, and numerous insects and even lizards were noticed. If dispersal really proceeded on those lines, the study of geographical distribution may be abandoned—at any rate so far as the main principle of Wallace is concerned, that the study of zoogeography enables us to map out the islands and continents of former epochs. That Wallace's maxim has been adopted by Messrs. P. and F. Sarasin during their exploration of Celebes, and carefully applied in their treatise on the geological history of that island, implies that they do not attach much importance to accidental distribution, though their labours were conducted not far from and in about the same latitude as the volcanic island of Krakatau.[2]

It would be idle to deny that the seeds of certain plants are carried to great distances by wind; that many others are undoubtedly transported by ocean currents; that some seeds are even scattered here and there by birds. My contention is—and I concur in this opinion with many eminent botanists—that only a small percentage of plants are disseminated and actually established

[1] Ernst, "New Flora of Krakatau," p. 4.
[2] Sarasin, P. and F., "Geol. Geschichte d. Insel Celebes."

in that manner. Most of them require for their dispersal a solid and continuous expanse of soil. They will proceed on it slowly, and step by step as it were.

To return to the subject under discussion, Sir Joseph Hooker evidently believed that the flora of Greenland had travelled across from Europe by a land-bridge in Pre-Glacial times. He considered the existing plants of the country as certainly older than the Glacial period; for he argued that the severity of the climate destroyed many species, while the remainder took refuge and survived in the southern parts of Greenland.[1]

Professor James Geikie maintains that a land-connexion between Greenland, Iceland, the Faroes, and Scotland must have existed, because the plants could only have migrated from Europe over a land surface.[2]

To Professor Geikie the idea of a survival of plants during the Ice Age in Greenland is inconceivable. He therefore argues that the land-bridge could only have existed in Post-Glacial times. Hence the Glacial period and its supposed adverse influence upon the flora of northern Europe has now become the mainspring of most speculations as to the former presence or absence of a northern land-bridge.

Professor Nathorst concurs with Professor Geikie in so far as he believes in the extinction of the Greenland flora during the Ice Age. He had formerly advocated a Post-Glacial land-bridge, and now regards it as somewhat doubtful.[3] Another Scandinavian botanist, Professor Warming,[4] admits that the mass of the Greenland flora survived the Glacial period in the country. The remainder arrived more recently by various modes of occasional transport, and with this view Sir Henry Howorth agrees.[5] In his "Botany of the Faroes," Professor Warming argues that the entire flora of the islands is due to accidental dispersal. Yet, in the same volume, Dr. Ostenfeld expresses himself very strongly against Professor Warming's theory. Only 35 per cent. of the flora, he maintains, are adapted for dissemination by the agency of wind. The ocean currents seem to be as unfavourable as possible for the Faroes. A strong extension of the Gulf Stream flows south-east of the islands; and as it comes from the open Atlantic directly south-west of the Faroes, and has not touched land since the West Indies, the only seeds it could possibly convey are tropical. The current thus forms a regular barrier between Scotland and the Faroes. Any seeds coming from

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[1] Hooker, J. D., "Distribution of Arctic Plants," pp. 252–55.
[2] Geikie, James, "Prehistoric Europe," p. 520.
[3] Nathorst, A. G., "Geschichte d. Vegetation Grönlands," p. 214.
[4] Warming, E., "Ueber Grönlands Vegetation," p. 403.
[5] Howorth, H., "Geological History of Arctic Lands," p. 500.

Scotland are caught up and carried towards the north-east right away from the Faröes.

Since Darwin's classical experiments, birds have always been quoted as very important factors in the transmission of seeds from the mainland to an island. Nevertheless, actual examination of birds during their migratory flights had never been made. Now we know, at any rate, that the migration of birds from Europe in the direction of Iceland is inconsiderable. Secondly, for at least four or five years the alimentary canals, the beaks, feet, and feathers of all the migratory birds caught at Danish lighthouse stations have been thoroughly investigated, with the result that the birds were found to migrate on an empty stomach, and were almost always clean externally. Dr. Knud Andersen, who conducted these inquiries, is of opinion that migratory birds are hardly of any importance as disseminators of plants.

A summary of the above arguments leads Dr. Ostenfeld to the conclusion that the principal portion of the flora of the Faröes must have travelled from the mainland of Europe on a bridge of continuous land. But assuming that the Ice Age destroyed the flora of the islands, he takes for granted, with Professor James Geikie and Mr. Simmons, that this belt of land was Post-Glacial in age, notwithstanding that the disappearance of Glacial conditions in Europe is often synchronized with the submergence of the land-bridge.[1]

Much the same view is advocated by Professor Drude, except that he places the age of the land-connexion further back—to the Glacial period itself.[2] The theory of the existence of an ancient land-bridge between northern Europe and North America has likewise been adopted by Dr. Schulz,[3] who argues that an immigration of plants from arctic America to Europe took place by means of two land-connexions. One of these joined Greenland with Iceland, the Faröes, and Scotland; the other with Spitsbergen, Franz Joseph Land, Novaya Zemlya, and northern Russia. He contends that these land-bridges existed during the greater part of late Tertiary times until the beginning of the Pliocene period.

The question of the supposed survival of plants through the Ice Age in Greenland largely depends on the problem whether or no the glaciers of that country had a vastly greater extension formerly than they have at present, and covered the whole of the land now free from ice. That the latter has never been entirely invaded by ice has been clearly demonstrated by the leader of the German Greenland Expedition, Dr. E. von Drygalski. The

[1] Ostenfeld, C. H., "Phyto-geographical Studies," pp. 115–118.

[2] Drude, O., "Pflanzengeographische Anhaltspunkte," p. 329.

[3] Schulz, A., "Pflanzenwelt Mitteleuropas," p. 1.

greater extension of ice in former times no doubt can be proved, he remarks; yet glaciers certainly never reached the cliffs and rock-pinnacles which abound on all parts of the coast-lands of Greenland.[1] No reason, therefore, can be adduced why the flora of Greenland should not have survived the Ice Age in that country, particularly as we have some grounds for the supposition that the land in the Arctic Regions then stood higher than it does now. Indeed, Professor Vanhöffen, who describes the plants and animals observed during the expedition, adopts this attitude. He not only believes in the survival of the flora of Greenland through the Ice Age, but he argues that the great mass of the fauna is indigenous to the country. Though he does not deny the possibility of organisms being accidentally carried by birds, he protests against the assumption that the fauna of Greenland owes its origin to such a mode of transport.[2] This quite harmonizes with the views of Mr. Hart, who was attached, as naturalist, to the British Polar Expedition of H.M.S. "Discovery." It is quite possible, he thinks, that migratory birds, currents of air or water, or other agents may, in some rare cases, introduce mature seeds to a soil prepared to receive them; but it should always be kept in mind that much importance ought not to be attached to the dispersal of plants by such means.

It would be wrong to suppose that plant migration to the Faröes and Iceland has proceeded altogether from Europe. A stream has likewise advanced from the opposite direction. Thus in the Faröes we find at least seven plants unrepresented in the British Islands. These came from Greenland and arctic America. Many others no doubt succeeded in invading the British Islands and the Continent, after utilizing the same land-bridge. Professor Asa Gray long ago pointed out that no less than twenty-four species were common to America and Europe, while unknown in Asia.[4] These were reduced subsequently by Professor Engler to ten species, because he argued that the remainder either had since been found in Asia, or might originally have been introduced by man from the one continent to the other. Ten species may seem very few; but, supposing a plant originated in Europe and subsequently passed to America by the direct land-bridge, it would probably be an ancient species. Hence it must have had many opportunities for invading the neighbouring Asiatic continent as well, and would not therefore come under the category alluded to. Plants of East American origin would have had a much more arduous journey to reach Asia; and it is on that account that most

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[1] Drygalski, E. von, "Gronland Expedition," vol. i., p. 335.
[2] Vanhoffen, E., "Gronland Expedition," vol. ii., p. 174.
[3] Hart, H. C., "Botany of Polar Expedition," p. 10.
[4] Gray, Asa, "Plants of United States and Europe, p. 173.

of the ten species alluded to are apparently of American origin. One, however, the common European Ling (*Calluna vulgaris*), certainly has its home in Europe. It is restricted in North America to a few localities on the coast of Newfoundland and southward. . I shall allude later on to some animals with a similar range. A few of the other plants have rather a confined distribution in Europe. Some, like the Water Lobelia (*Lobelia Dortmanna*), are widely disseminated over the western parts of our continent.[1]

FIG. 2.—*Eriocaulon septangulare*, growing in its native habitat in the West of Ireland.
R. Welch, Photo.

A small group of plants is of particular interest to Irish botanists, as being almost exclusively confined to the West of Ireland and North America. According to Messrs. Colgan and Scully, five species of plants occurring in Ireland belong to this group, viz., *Spiranthes Romanzoviana, Sisyrinchium angustifolium, Eriocaulon septangulare, Naias flexilis,* and *Juncus tenuis.* Two of these, the *Sisyrinchium* and *Juncus*, may possibly have been introduced. But Messrs. Colgan and Scully express the opinion that no doubt has ever been raised as to the indigenous standing of the remaining three.[2] All of these plants are discontinuously distributed. An interval of more than 200 miles separates the northern and southern stations in Ireland of the rare orchid *Spiranthes Romanzoviana*. The water plants *Eriocaulon septangulare* (fig. 2)

[1] Engler, A., "Entwicklungsgeschichte d. Florengebiete," i., p. 15.
[2] Colgan, N., and R. W. Scully, "Cybele Hibernica," 2nd ed., p. 71.

and *Naias flexilis* inhabit not only some of the western Irish lakes, they occur also in Scotland.

If we regard these plants as having been accidentally introduced from America through the agency of wind, waves, or birds, they must have been transported repeatedly to different parts of Ireland. Sir William Thiselton Dyer only alludes to *Eriocaulon*, and seems convinced that it was brought across the ocean by birds.[1] Messrs. Colgan and Scully do not explain the presence in Ireland of these plants as being due to any such accidental transport. They believe them to have reached Europe by means of an ancient northern land-connexion. Mr. Praeger likewise comes to a similar conclusion with regard to the origin of the American plant group in Ireland. He does not favour the theory of accidental dispersal. A land surface, long since destroyed, of Pre-Glacial age, appeals to him as a more likely explanation of the presence of the American plants.[2]

The number of plants common to Europe and North America is really far greater than we imagine, though very few, as we have seen, are quite confined to these continents. Of those which also occur in Asia there are many, like the Orchid *Listera cordata*, which grows only in a few localities in the extreme east, that are apparently absent from the greater part of the continent. It is probable that all these have found their way from America to Europe by a direct passage. Including the horsetails and ferns with the flowering plants about 575 species are identical in Canada and Europe, and only [illegible] in Canada and Japan or the Amur district of eastern Asia. Many of these are possibly modern introductions. On the other hand, we know from Professor Drummond's researches that of seventy species of fossil plants observed by him in the Pleistocene clays of Toronto in Canada, twenty occur at the present day both in that country and in Europe.[3]

This seems to indicate that during the Pleistocene period, the great mass of the flora common to America and Europe had already found its way from the one continent to the other. Altogether our available botanical evidence in favour of a former land-connexion between Scotland and Labrador, by way of Greenland and Iceland, can scarcely be considered as very weighty; yet, in conjunction with the preceding factors, it acquires greater significance.

The zoological testimony in support of this view is of a much more pronounced character. The interest aroused in Ireland by the discovery of the American plants has led to research in other directions. Thus, in 1895, three

[1] Dyer, W. Thiselton, "Geographical Distribution," p. 289.
[2] Praeger, R. Ll., "Irish Topographical Botany," p. 22.
[3] Drummond, A. T., "Plants common to Europe and America," p. 55.

species of freshwater sponges were detected in various lakes at some distance from the sea on the west coast. Only one of these sponges, viz., *Tubella pennsylvanica*, has since been observed in another European locality, in Loch Baa in Scotland, but all of them are identical with American species.[1] Dr. Hanitsch identified them as *Ephydatia crateriformis, Heteromeyenia Ryderi* and *Tubella pennsylvanica.* Being unaware of the theory advanced by botanists as to the existence of a former direct land-bridge to America, he speculated on the origin of these freshwater sponges by appealing to accidental means of transport, such as winds, ocean-currents, and birds, and argued that any of these modes of conveyance might have carried the gemmules across the Atlantic.

Of all the occasional means of transmission, only that by birds deserves, to my mind, serious consideration. The two others are clearly out of the question as far as the gemmules of freshwater sponges are concerned. As I shall endeavour to show later on (p. 21), birds probably never fly directly across the Atlantic; nor is there any reason to believe that they set foot on the west coast of Ireland first on reaching Europe. That they imported the gemmules of the freshwater sponges on their feet or feathers, from the mainland of America, is therefore extremely improbable. It is of interest to note that Dr. Stejneger argues in favour of a former discontinuous land-connexion between Scotland and Greenland from the route of migration followed by a bird. Because the large-winged race of the Common Wheatear (*Saxicola œnanthe leucorhoa*) is known to breed in Greenland and eastern arctic America, migrating in winter to the British Islands and France by way of Iceland, the Faröes, and Shetland Islands, he contends that greater land-masses than at present must have existed formerly along this migration route. He does not suggest a complete land-connexion such as I now advocate, but merely a series of large islands separated by ocean straits. He believes this incomplete or discontinuous land-bridge to have existed during part of the Glacial period.[2]

In my more recent work on European Animals, I have incidentally dwelt on the past range of the Great Auk (*Alca impennis*) as indicating the presence of a former more continuous coast-line between the British Islands, Iceland, Greenland, and Newfoundland, in all of which countries this bird was known to have been abundant.[3]

Yet, after all, the best evidence in favour of a North Atlantic land-bridge

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[1] Hanitsch, R., "Freshwater Sponges of Ireland," p. 126. Annandale, "Freshwater Sponges in Scotland."

[2] Stejneger, L., "Scharff's History of the European Fauna," pp. 107–108.

[3] Scharff, R. F., "European Animals," pp. 37–39.

is furnished by the invertebrates. Our special attention is drawn by Mr. Born to the importance of the "Running Beetles" of the genus Carabus. From the fact of their being wingless and usually found under stones or clods of earth, they are not liable to be transported accidentally by any of the means usually supposed to aid animals in their dispersal. Mr. Born claims that at least two European species of Carabus, viz. *C. catenulatus* and *C. nemoralis*, have crossed the Atlantic by means of an ancient land-bridge. A third form—*Carabus grœnlandicus Chamissonis*—seems to have originated in America, and to have travelled from there to Greenland and Lapland.[1]

Of another group of insects—the Collembola—Prof. Carpenter remarks: "It is of interest to find that the presence of not a few species of these wingless insects in America, in Greenland, in the islands to the north of Europe and Asia, and on the Euro-Asiatic continent, lends support to our belief in a Pliocene or Pleistocene land-connexion to the north of the Atlantic Ocean—a belief already upheld by so much evidence, both geological and zoological."[2]

The butterflies and moths do not yield much evidence in favour of the view of a North Atlantic land-connexion. Yet Mr. Petersen cited no less than twelve species as occurring in arctic Europe and arctic America, while absent from Asia. He thought that this fact pointed to the possibility of a direct land-bridge between the two continents.[3] At least three kinds of butterflies are known to breed in Greenland, and to go through their complex life-history within the confines of that inhospitable country.

Quite a number of naturalists believe that any resemblance between the European and the American fauna must have arisen, not from any direct intercourse between Europe and America, but by a migration across Asia and a Bering Strait land-connexion. The supposition of an ancient northern Pacific land-bridge presents fewer difficulties to them than the Atlantic one, and is preferred for that reason. Dr. Horváth, for example, who states that no less than 128 species of Hemiptera are common to the two continents, argues that they all must have crossed Asia in reaching the one from the other.[4]

But Dr. Horváth and those who agree with him were apparently unaware that certain freshwater species common to Europe and America are almost totally absent from Asia or western America.

Let us take, for example, our common Perch (*Perca fluviatilis*), a variety

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[1] Born, Paul, "Carabologische Studien," pp. 8, 9.
[2] Carpenter, G. H., "Collembola from Franz Joseph Land," p. 276.
[3] Petersen, W., "Lepidopterenfauna der arktischen Gebiete," p. 38.
[4] Horváth, G., "Faunes hémiptérologiques," pp. 4–7.

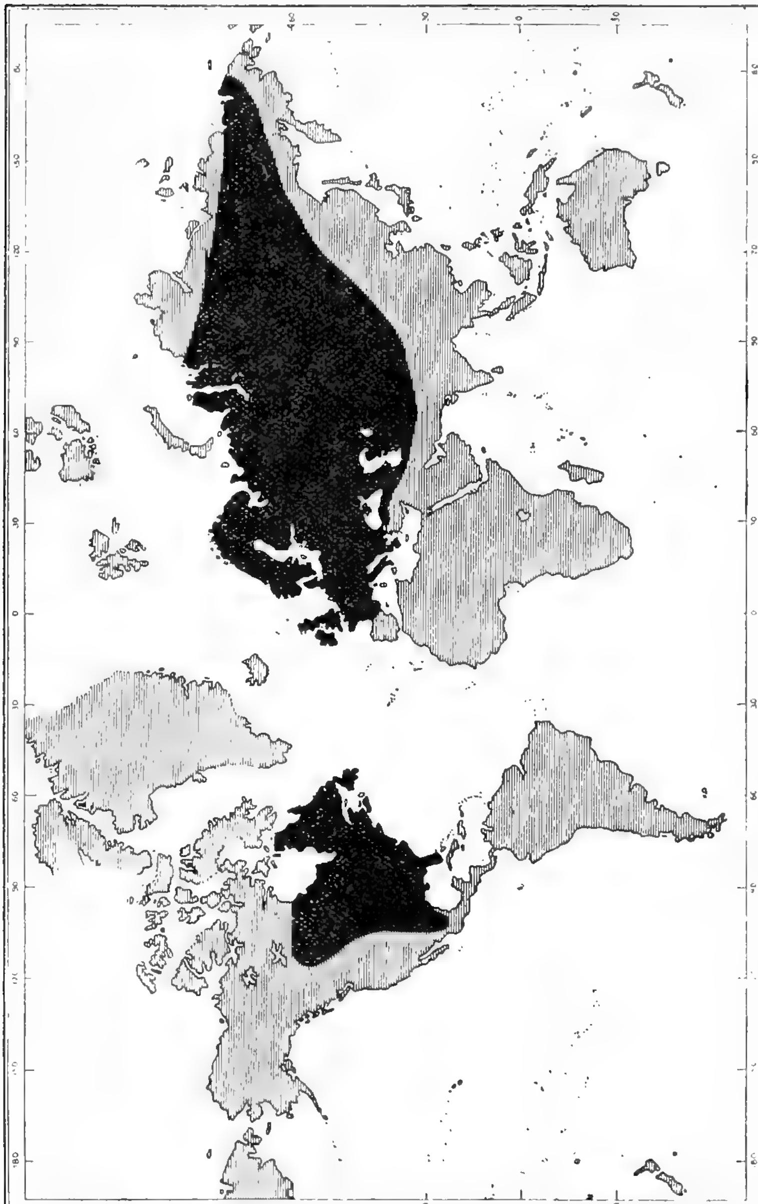

FIG. 3.—Map of the World, showing the geographical distribution of the Perch family (Percidæ), after C. Tate Regan.

of which also inhabits North America (fig. 3). It is absent not only from a large part of Asia, but also from western North America. Certainly this looks like a case of direct migration from America to Europe. Nevertheless, those who favour accidental methods of dispersal may claim that the feet and feathers of birds had some share in this distribution; for it is assumed that fish-spawn may occasionally cling to birds alighting on water. It will scarcely be conceded, however, that birds have the power to select the spawn of Perch, and carry it across the Atlantic to the exclusion of that of all other species. For according to Mr. Tate Regan, to whom I am indebted for the map of distribution which I herewith reproduce, the Perch and the whole Perch family (*Percidæ*) are absent from western North America and largely from eastern Asia. An accidental transport of freshwater fish-eggs from land to land across the Atlantic, either by wind or waves, seems to me quite beyond the range of possibility. Human introduction is altogether out of the question, because, apart from the Common Perch, we have to deal with genera and species of Percidæ found in the one continent and not in the other. These must have evolved from some remote ancestor, common to America and Europe, long anterior to the appearance of Man.

Another example that I have had occasion to quote in my work on "European Animals" (p. 35) is the freshwater Pearl-Mussel (*Margaritana margaritifera*). On our continent it inhabits the British Islands except eastern England, the mountain streams of Scandinavia, and the hill region of Central Europe except the Alps. Far to the east it reappears in a different form in the River Amur in eastern Siberia, in the island of Sakhalin, and in Kamtchatka. Another variety is met with across the Bering Strait in Alaska and in western North America generally. The type form occurs in the Quebec province of Canada, in the Lower Saskatchewan River, and in New England. The typical freshwater Pearl Mussel is only met with in eastern North America and in central and north-western Europe. America is undoubtedly its original home. From it the mussel spread to Europe in an eastward direction, and not by way of Asia. As the young of these mussels attach themselves to the gills of fishes, they are liable to wide dispersal within at least one river-system; but fishes in this case could scarcely have aided them in reaching Europe. A land-connexion between the two continents explains their distribution certainly better than any other theory.

The most striking piece of evidence we possess in favour of a Pre-Glacial land-connexion between north-western Europe and north-eastern North America is the presence in the latter country of the snail *Helix hortensis*.

A western species in Europe, *Helix hortensis,* is remarkable for its extensive northern range. It occurs in Scandinavia, all over the British islands, in the Shetlands and Faröes, and even in Iceland (fig. 4). It is altogether absent from Asia. Its occurrence in southern Greenland had generally been attributed to a recent human introduction; but it has been taken in several different localities; and we must, I think, look upon it as an indigenous species. Its presence in the state of Maine in North America has frequently been cited as a familiar example of the facility with which European species are introduced by human agency to foreign countries.

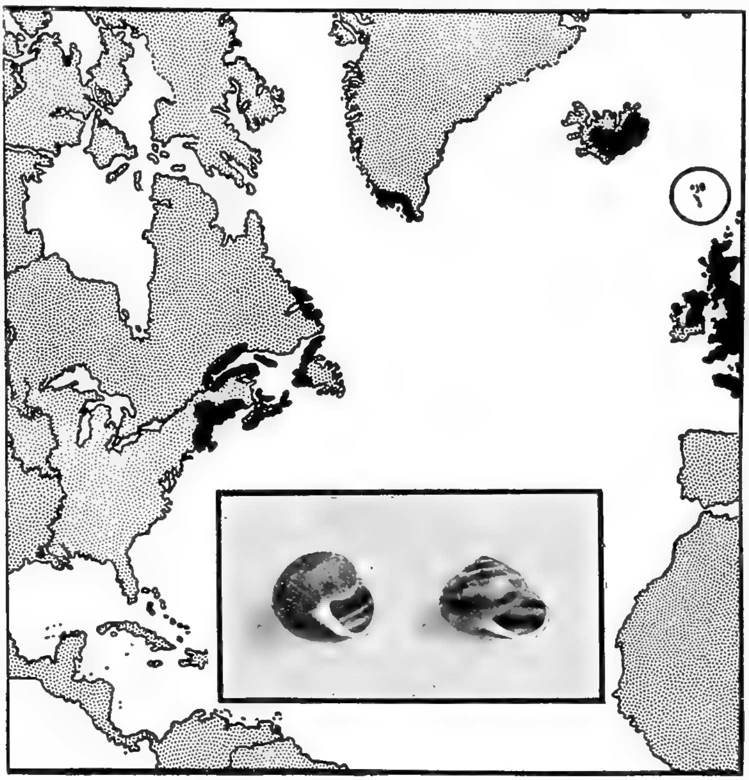

FIG. 4.—Map indicating the geographical distribution of the snail *Helix hortensis.*

Until the year 1864 no other theory was ever thought of. During that year, however, Professor E. S. Morse first discovered the shell of this snail among ancient "kitchen-middens" on some of the islands off the coast of Maine. This fact led him to reconsider the generally accepted view of its being a recent introduction. It seemed to him much more likely that the snail had wandered along some ancient coast-line from the Old World across the North Atlantic. Dr. Binney, and more recently Professor Cockerell, concurred with Professor Morse's opinion, while the Rev. Mr. Winkley even suggested that *Helix hortensis* arrived in North America before the advent of the Glacial period. With the latter theory, Mr. Johnson, another conchologist, expressed his agreement; and it is to his paper that I am indebted for the above-mentioned information.[1]

The only one who adhered to the introduction theory was Dr. Pilsbry. He even argued in favour of artificial importation by the ancient Vikings during their supposed visit to the American coast in the eleventh century.

All doubts as to the claim of *Helix hortensis* being an indigenous American species are now set at rest through the discovery by Dr. Dall of the shell of this snail in undoubtedly Pleistocene deposits in the state of Maine.[2] Moreover, the species is now known to inhabit a much greater area than was formerly supposed; for it has been collected in Labrador, Newfoundland, Prince Edward Island, and many other small islands where it could not possibly have been brought by man. It may therefore be considered as definitely established that *Helix hortensis* reached America in Pleistocene or Pliocene times without human intervention. That greater facilities may have existed for the occasional transport across the Atlantic in those remote times than obtain at present might still be urged in accounting for its presence in America. Such an hypothesis, however, is unsupported by any testimony, while the view advocated that it travelled across a land-bridge to America is corroborated by other distributional facts, and meets with the approval of many zoologists.

The discovery of *Helix hortensis* in Greenland is an important factor in favour of the land-connexion theory. That this species should have survived the Glacial period in that country need not surprise us: for several other species of land and freshwater molluscs certainly must have done so. *Planorbis arctica*, *Limnaea Vahli*, *L. Wormskioldi*, *Succinea groenlandica*, *Vitrina angelicae*, *Pupa Hoppii*, and *Conulus Fabricii* are almost all confined to Greenland, and no doubt originated there in Pre-Glacial times.

I feel sure many other European terrestrial Invertebrates with a range similar to that of *Helix hortensis* are found in America. I know of such among the earthworms and woodlice, but there is no need to add to the above examples.

Before summarizing the results of these investigations into the evidences of a former land-bridge between northern Europe and North America, I wish to mention the opinions of a few naturalists besides those referred to who

[1] Johnson, C. W., "Distribution of *Helix hortensis*," p. 73.
[2] Dall, W. H., "Land and Freshwater Mollusks," p. 20.

have expressed their agreement with this theory. Mr. Madison Grant believes that the distribution of the living fauna points to the existence of continuous land between Greenland, Spitsbergen, and Scandinavia in Pleistocene times.[1] Prof. Lobley[2] assumes a land-bridge in Pre-Glacial times, extending from Europe to Iceland, Greenland, and Labrador; whereas Prof. Jacobi advances a similar theory in less definite terms, for he speaks only of a long-continued land-connexion between the New and the Old World by way of Greenland.[3] Dr. Arldt considers the land-bridge to have existed since the Oligocene period, and to have been finally destroyed in Pliocene times.[4]

Of all the theories which have been advanced in explanation of the occurrence of identical species on both sides of the Atlantic Ocean, only the following three have met with wide approval:—

1. Migration from Europe across Asia and a Bering Strait land-bridge to America or *vice versa*.
2. Occasional transport by birds across the Atlantic Ocean.
3. Migration across a direct Atlantic land-connexion.

If we consider the zoological evidence alone, namely, the absence of *Helix hortensis* from Asia and Western America, the distribution of the Perches and the freshwater Pearl Mussel, and that of the freshwater Sponges, the first of the three hypotheses is scarcely applicable to these instances of distribution, and does not therefore explain the presence of identical species on both sides of the Atlantic in a satisfactory manner.

As regards the supposed conveyance by birds of seeds and invertebrates across the same ocean, the second theory must be applicable to a transport in two directions, both from America to Europe as well as *vice versa*.

Mr. Eagle Clarke, of the Edinburgh Museum, who has made a special study of bird migration, informs me that in his opinion all the American species of birds that have made their appearance in Europe have travelled by way of Greenland and Iceland. All of them, he says, are birds of high northern summer range in America; and they are mostly birds of the year which, instead of returning southward or westward in their autumnal flights, have taken an eastward course. All the other accidental visitors from America, he thinks, must have had an assisted passage across the ocean as cage-birds. There is only one point which I venture to think Mr. Clarke may have overlooked, namely, the possibility of some American birds having

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[1] Grant, Madison, "Origin of Mammals of North America," p. 12.
[2] Lobley, J. L., "American Fauna and its Origin," p. 27.
[3] Jacobi, A., "Lage und Form biogeographischer Gebiete," p. 207.
[4] Arldt, Th., "Entwicklung d. Kontinente," p. 406.

come to Europe without crossing the Atlantic Ocean at all. The circumstance that a few, such as the American Robin, seem to have occurred more frequently in eastern Europe than in the west, may imply that they have flown across Bering Strait to Siberia, thus entering Europe from Asia.

Altogether no less than sixty-eight species of American birds have been recorded from Europe by Mr. Dalgleish, while only twenty American species are known from Ireland.[1] The claim of ten of the latter as genuine stragglers from America is considered doubtful, in so far as they may possibly be escaped cage-birds.[2] A large percentage of the sixty-eight species have been observed in England; but even on the small island of Helgoland, near the mouth of the Elbe, twelve species of American birds have been noticed.[2]

From these observations it is evident that the west coast of Ireland is by no means the region where the American bird-visitors first set foot in Europe. Many apparently alight on the Continent of Europe, after completing their perilous voyage across the North Atlantic from Greenland. Others have only been recorded from Scotland or England. Ireland has not yielded any exceptional number of such records; and they are not all from the west coast.

From Mr. Freke's Catalogue we can gather some idea as to the frequency of European bird-visitors to America; that is to say, of such species as are supposed to have crossed the Atlantic in the opposite direction. Only about one-fourth of the number of American visitors to Europe have made the voyage in the reverse direction, and most of the latter are such species as have been recorded from Greenland or arctic America.[3] Very few have passed southward into the United States. Mr. Praeger pointed out to me, and I quite concur with him, that the comparatively small number of bird-visitors from Europe to America might, to some extent, be due to the fact that the prevailing winds in the North Atlantic from west to east would retard the flight of birds in the opposite direction.

The fact that both in America and Europe the indigenous species of plants and animals identical to the two continents are largely confined to the coast region may appear at first sight in favour of the theory of introduction by birds. Almost all the American plants, and all the American freshwater sponges at any rate, occur in the vicinity of the coast. It has been argued, therefore that, after their long flight across the ocean, birds would naturally alight on the earliest opportunity; and that it was for this reason that the

[1] Dalgleish, J. J., "North American Birds in Europe."
[2] Ussher, R. J., "List of Irish Birds."
[3] Freke, Percy, "Birds found in Europe and North America."

plants and animals common to the two continents were so largely confined to the coastal districts. But from what has been mentioned we have no reason to infer that American birds do habitually alight on the west coast of Ireland on first reaching Europe. It seems highly probable that they cross by way of Greenland. We should therefore expect all the species of the invertebrates and plants common to the two continents to be found in Greenland as well. This is not so. Only comparatively few of them are met with in Greenland. The theory that the resemblance in the fauna and flora of eastern North America and western Europe is due to the action of birds is, I think, not supported by sufficient evidence.

The third theory, that the identical species on either side of the Atlantic Ocean are the result of a direct land-connexion between Scotland, Iceland, Greenland, and Labrador, such as I have suggested in the illustration (fig. 1), appears to me to be well founded on geological, bathymetrical, and biological evidence. No decisive testimony, however, has as yet been brought forward to show during what geological period this land-bridge was formed and how long it lasted. The assumption that such geographical conditions prevailed during early Tertiary times is very widespread. That this state continued during the Miocene period is likewise maintained by many; though Professor Dawkins and a few others do not admit the existence of the northern land-bridge in Pliocene or more recent times.[1] Sir Archibald Geikie's researches point to the production of the great basalt plateaux of north-western Europe in early Tertiary times. These plateaux formed a continuous tract of land, as far as the Faröes at any rate. He proves that in many places, such as Iceland, the Faröes, and the West of Scotland, enormous subsidence subsequently took place. Yet he gives us no idea of the approximate geological date of that event.[2]

Once we admit that animals and plants were able to survive the Glacial period in northern latitudes, a land-connexion such as suggested in Pliocene times would readily account for the presence of all the animals and plants common to Europe and America. By many of those best able to judge, an admission to that effect has been made. Pliocene deposits are scanty in the British Islands; yet they yield valuable suggestions as to the geographical conditions of the North Atlantic. An examination of the fossil invertebrates contained in the St. Erth beds in Cornwall, which are of Pliocene age, showed that the fauna possessed a remarkably southern facies, and that there was a total absence of boreal or arctic species. This fact led Professor Kendall and

[1] Dawkins, W. Boyd, "Early Man in Britain," p. 43.
[2] Geikie, A., "Basalt Plateaux of North-Western Europe," p. 405.

Mr. Bell to the conclusion that at the period during which these deposits were laid down—that is to say, during the latter part of the Pliocene period—no channel or direct communication existed between the North Sea and the Atlantic Ocean, the Straits of Dover being closed in the south, while in the north the Tertiary volcanic chain formed a barrier across from the north of Scotland to Greenland by way of the Shetland Islands, Faröes, and Iceland.[1]

Mr. Reid's contention that the St. Erth beds are older than Messrs. Kendall and Bell estimated—that they are, in fact, of early Pliocene age—is founded chiefly on the circumstance that the percentage of extinct species is about the same as that of the Coralline Crag. The consideration of the supposed climatic conditions does not seem to me of any particular value; and, as he remarks, the exact age of the clays is still doubtful.[2] Even if the St. Erth beds belong to the lower Pliocene, there are no grounds for the supposition that the northern barrier, alluded to by Messrs. Kendall and Bell, had ceased to exist in later Pliocene times.

The change in the Pliocene fauna of the east coast of England, as we pass from the older to the newer beds, no doubt implies, as Mr. Harmer pointed out, an opening up of the area to the influence of the northern seas.[3] But we do not possess the slightest evidence for the assumption that the Atlantic Ocean was similarly affected. Many of the facts, indeed, lead to the conclusion that the land on the Atlantic coasts of the British Islands stood highest in late Pliocene and early Pleistocene times, and that it was then that *Helix hortensis* and many other European species must have made their way to America.

Glacial conditions prevailed at this time on all the high mountain ranges surrounding the warm Atlantic Ocean, and yet the coast region must have supported an abundance of animal and plant life. The presence of a land-bridge between Scotland and North America by way of Greenland, and another between England and France, would have excluded the Gulf Stream from the Arctic Regions. Professor Blytt's argument that under such conditions all the coast region, including Iceland and southern Greenland, would have had a higher temperature than at present, while the lands beyond were probably colder, seems irrefutable.[4] Yet Professor James Geikie believes that even the latter countries would then have had a more genial climate.[5]

In my opinion it was during this epoch, in Pre-Glacial times, that the

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[1] Kendall, P. F., and A. Bell. "The Pliocene Beds of St. Erth," pp. 206, 207.

[2] Reid, C., "Pliocene Deposits of Britain," p. 61.

[3] Harmer, J. W., "Pliocene Deposits of Holland," p. 754.

[4] Blytt, Abel, "Theorie d. wechselnden Klimate," p. 49.

[5] Geikie, James, "Prehistoric Europe," p. 520.

interchange between the fauna and flora of north-western Europe and north-eastern America was effected across the northern land-bridges.

Only one other point needs to be commented upon. I have shown that most of the American species occupy the Atlantic coast region in the British Islands. Almost all the southern or Lusitanian species are found in precisely the same area in England, Ireland, and Scotland. This seems to me partly due to the fact that the temperature was considerably higher there during the Glacial period than in the more inland localities. Even now the plants are under more favourable climatic conditions on the west coast than further inland, and less exposed there to competition with the stronger eastern rivals. Moreover, almost the whole of Ireland and a large portion of England are thickly swathed in a mantle of Glacial clay. We can only suppose that the forces which controlled the deposition of this clay were less effective on the west coast, which may have extended far to the west of its present boundary, and have thus given rise to the preservation of many species of animals and plants which were destroyed elsewhere.

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II.

A LIST OF THE NEUROPTERA OF IRELAND.

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(BEING THE EIGHTH REPORT FROM THE FAUNA AND FLORA COMMITTEE.)
(COMMUNICATED BY PROF. G. H. CARPENTER, B.SC.)

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Introduction.

It is now more than twenty years since one of us issued the first general list of Irish Neuroptera.[1]

This catalogue contained records of some 211 species, comprising Dragon-flies, May-flies, Stone-flies, Psocids, Planipennia, and Caddis-flies. It was largely the result of original work, as comparatively little had been previously known concerning the occurrence of these interesting insects in Ireland.

Since then several additional species (see page 31) have been observed which did not find a place in the old list. Many changes of nomenclature and arrangement are necessary in order to bring the Irish records into line with recent work on the Neuroptera. At the same time, our knowledge of the distribution of the great majority of the species has been considerably extended. It is hoped that the present list, including all the previous records, will form a useful standard of reference for future observers of Irish neuropterous insects.

It is to be regretted that the study of the Neuroptera has been greatly neglected in this country. Indeed we have had no resident collectors either in the south or west of Ireland, so that our knowledge of the fauna of those parts which we should expect to be the most interesting is almost entirely due to the excursions carried out from time to time by a few enthusiastic entomologists.

It is therefore not surprising that records of Neuroptera are distributed in a very unequal manner in Ireland. In order to show what has been done, we have prepared a list (page 37), giving the various localities, under the thirty-two Irish counties, where collecting has been carried on. In not more

[1] A full bibliography of papers and notes referring to Irish neuropterous insects will be found on pages 39–42.

than six or seven of the counties is the neuropterous fauna tolerably well known; for it should be pointed out that in many places only a few species were collected. It will be seen that extensive tracts of country in all of the four provinces are practically unexplored; while from the counties of Longford, Meath, Leitrim, and especially Cavan, with its extensive chain of lakes, no records are forthcoming.

The late A. H. Haliday formed a collection of local Neuroptera; and a manuscript "Catalogue of Irish Insects," which he compiled, gives a fair idea of what was known of the Irish species in his time. This distinguished entomologist, however, did not devote as much attention to the Neuroptera as he did to other orders of insects; otherwise there would certainly have been a more satisfactory basis to work on when the preparation of an Irish list was undertaken more than twenty years ago. Many of the species in the Haliday catalogue are recorded with reserve, and very few exact localities are mentioned; yet it was the means of supplying useful information relating to the capture of such uncommon insects as *Gomphus vulgatissimus*, *Erythromma najas*, and *Chrysops abbreviata*, which have not been observed in this country since Haliday's time. This manuscript catalogue is now preserved in the library of the Irish National Museum.

It seems desirable to refer briefly to some of the changes and additions which it has been found necessary to carry out in the present list.

Although our knowledge of the native Dragon-flies is far from complete, there can be no doubt that the Irish fauna is much poorer in these insects than is that of Great Britain. Twenty-five species were included in the Irish list of 1889; it would appear, however, that one of these, *Orthetrum cancellatum*, was certainly included in error. A second species, *Cordulia aenea*, said to have been taken many years ago at Killarney, is, in our opinion, more likely to have been *Somatochlora arctica*, which is known to occur in that locality; while a third species, *Lestes barbara*, remained for many years on the British list on the strength of a *supposed* Irish specimen seen by De Selys, as long ago as 1845, in the Dublin University Museum. No trace of this specimen is now to be found; and the record must be regarded as extremely doubtful. Allowing for these changes, there are reliable records of twenty-three species of Dragon-flies in this country, including *Libellula fulva*, an Irish example of which has recently been brought to light in the collection of the late C. W. Dale.

The Ephemeridae (May-flies) have been much neglected, so that there are few changes to record. The recent finding of the northern form *Leptophlebia vespertina* in the west of Ireland may be referred to as the only unrecorded species observed since 1889.

It has been found necessary to thoroughly revise the species of Perlidae (Stone-flies) in the light of the recent researches of Morton, Kempny, and others. We hope the present short list, containing several additional species, will serve as an accurate basis for future work in this country.

In the group Planipennia (Alder-flies, &c.), eight species have been added to the Irish list. Undoubtedly the most notable discovery is that of *Psectra diptera* in County Wexford, an insect of great rarity in the Britannic area, where it is now known to have been found in three localities; and it seems almost equally rare both in Europe and America. The apparent absence from Ireland of certain conspicuous British insects belonging to this group is noteworthy; we may refer to the genera Rhaphidia (Snake-flies) and Nothochrysa as examples. Of interest, also, is the recent capture in County Cork of one of the Scorpion-flies, *Panorpa germanica*, the first recorded occurrence of these insects in Ireland.

Eleven species of Trichoptera (Caddis-flies), some of considerable rarity, have been added. There is little doubt that fresh discoveries await the assiduous collector of these interesting insects, especially amongst such small forms as are contained in the family Hydroptilidae.

For convenience of reference, we give here the names of the various species which have been added to, or deleted from, the 1889 list. They are as follows:—

Libellula fulva *Müll.*
[Orthetrum cancellatum (*L.*). Deleted.]
[Cordulia aenea (*L.*). Doubtfully native.]
[Lestes barbara *Fab.* Doubtfully native.]
Leptophlebia vespertina *L.*
Perla maxima *Scop.*
Perla cephalotes *Curt.*
Dictyopteryx Mortoni *Klap.*
[Dictyopteryx microcephala *Pict.* Deleted.]
Dictyopteryx recta *Kempny.*
Isopteryx tripunctata *Scop.*
Isopteryx torrentium *Pict.*
[Isopteryx Burmeisteri *Pict.* Deleted.]
Capnia atra *Morton.*
Taeniopteryx Risii *Morton.*
Nemoura praecox *Morton.*
Nemoura Meyeri *Pict.*
[Nemoura lateralis *Pict.* Deleted.]
[Nemoura humeralis *Pict.* Deleted.]

Leuctra Klapaleki *Kempny.*
[Leuctra fusciventris *Steph.* Deleted.]
Leuctra hippopus *Kempny.*
Leuctra inermis *Kempny.*
[Leuctra nigra *Klap.* Deleted.]
Amphigerontia fasciata *Fab.*
Psocus major *Kolbe.*
Ectopsocus Briggsi *McLach.*
Hyperetes guestfalicus *Kolbe.*
Osmylus chrysops *L.*
Psectra diptera *Burm.*
Chrysopa tenella *Sch.*
Chrysopa vulgaris *Sch.*
Chrysopa prasina *Ramb.*
Chrysopa ventralis *Curt.*
Chrysopa abbreviata *Curt.*
Panorpa germanica *L.*
Grammotaulius atomarius *Fab.*
Limnophilus decipiens *Kol.*
Limnophilus fuscinervis *Zett.*
Limnophilus nigriceps *Zett.*
Anabolia nervosa (*Leach*) *Curt.*
Chaetopteryx villosa *Fab.*
Apatania Wallengreni *McLach.*
Triaenodes conspersa *Ramb.*
Adicella reducta *McLach.*
Tinodes unicolor *Pict.*
Ithytrichia lamellaris *Eaton.*

The Irish Trichoptera are of special interest on account of the occurrence of at least four species which have not been so far observed in other parts of the Britannic area. These are *Limnophilus fuscinervis*, *Apatania fimbriata*, *Tinodes maculicornis*, and *Agapetus delicatulus.* It is not unlikely that the first-mentioned species will eventually be found inhabiting parts of northern Britain. The three remaining species have now been known from Ireland for more than twenty years, yet it would seem that no evidence of their occurrence in Great Britain is forthcoming. These species are interesting from a faunistic point of view. Notes on their distribution will be found in other parts of this paper.

We have endeavoured to give an outline of the geographical distribution of each of the Irish species. The scarcity of records, however, more especially of the families Ephemeridae and Psocidae, not only in the British Isles, but throughout Europe, has rendered the ascertaining of this information difficult, so that in many cases the distributional notes are very imperfect. The statement that a species ranges from Devonshire to the Shetlands is not meant to imply that it occurs in all parts of Britain; indeed, in few cases are the records sufficient to justify such a conclusion. All that is meant to be conveyed is that the insect in question has been definitely recorded from these localities, and is at least widely distributed in the Britannic area.

In spite of the fact that much work remains to be accomplished, the poverty of the Irish fauna, as compared with that of Great Britain, is as manifest amongst the Neuroptera as it is in other groups of insects. It is evident that many conspicuous species and even genera of British Neuroptera are either absent from or of great rarity in this country. In order to show clearly the relative proportions of the two faunas, we have prepared a table giving the number of genera and species found in the two countries, as far as they are known at the present time. It will be seen that we have records of 239 species of Neuroptera in Ireland, or rather less than two-thirds of those recorded from Great Britain.

—	Ireland.		Great Britain.	
	Genera.	Species.	Genera.	Species.
Odonata,	15	23	20	42
Ephemeridae,	11	24	14	39
Perlidae,	8	18	9	29
Psocidae,	14	30	21	43
Planipennia,	9	31	14	56
Trichoptera,	48	114	61	175
	105	240	139	384

The deficiency in number of species is especially noticeable in the case of the Dragon-flies. It has already been pointed out that we possess only twenty-three of the forty-two species recorded from the Britannic area. It is of interest to note that the great majority of the nineteen British species which do not appear to have reached Ireland inhabit the south and south-eastern parts of England: examples are *Anax imperator* and *Aeschna isoscelis*. Abroad many of these missing species are widely distributed; yet it is evident that the majority of them are found chiefly in the south of Europe, becoming decidedly rarer towards the north. At the same time it should be pointed out that there are in Ireland a few species which do not appear to have penetrated far into North Britain: we may refer to *Libellula depressa*, *Gomphus* [illegible], *Brachytron pratense* and *Lestes dryas*; naturally these range south in Ireland; and they appear to rank amongst the more local members of our fauna. Perhaps our most interesting native Dragon-fly is *Somatochlora arctica*, a northern and alpine insect which occurs as far south as the Killarney district, while in Great Britain it is known to inhabit only certain heaths and swamps in the highlands of Perth and Inverness.

A rough analysis of the Irish Trichoptera (Caddis-flies), an order represented by all the characteristic [illegible] groups in the Irish fauna, may be of interest in this connexion, more especially as they are feeble fliers, aquatic during their early stages, and not subject to artificial introduction through the interference of man.* It should be remembered, however, that the analysis is only approximately accurate, as much remains to be found out concerning their distribution in Europe.

DISTRIBUTION IN EUROPE OF THE IRISH SPECIES OF TRICHOPTERA (CADDIS-FLIES).

Common and widely distributed forms,	60
Northern and parts of central Europe,	38
Central and southern Europe,	10
South-western Europe,	4
Alpine,	2
	114

As might be expected, the great majority of the Irish Trichoptera are widespread in the Palaearctic region. The large proportion also of northern and central forms is not surprising, seeing that the Trichoptera reach their greatest development in cold and temperate countries. Yet the proportion of these forms amongst the more local species holds good in most groups, and seems a characteristic feature of the Irish fauna.

* [illegible] some other sections of the Neuroptera. In the Psocidae and [illegible], for example, many of the species pass their lives on forest trees, especially conifers, and may occasionally be liable to introduction into fresh localities on this account.

Examples are *Phryganea obsoleta*, *Limnophilus fuscinervis*, and *Molanna palpata*. The central and southern species constitute a much smaller group; we may perhaps refer to *Adicella reducta*, and *Wormaldia mediana*. In so far as we can judge by their known range, it seems likely that at least four of our Irish Caddis-flies are south-western in Europe: namely, *Setodes argentipunctella*, *Tinodes maculicornis*, *Lype fragilis*, and *Agapetus delicatulus*; while *Polycentropus Kingi* should probably also be referred here. The scarcity of purely alpine, as opposed to northern and alpine, forms in Ireland is notable, a scarcity which appears to hold good for these insects throughout the entire Britannic area. The two species which would appear to possess such a range are *Drusus annulatus*, and *Apatania fimbriata*.

The following is a short list of some Irish species that are interesting on account either of their geographical distribution or of their general rarity. More detailed notes on their range will be found in the systematic part of this paper:—

ODONATA (Dragon-flies).

Somatochlora arctica Zett. Northern and alpine Europe; Caucasus; Siberia; Kamtschatka.

Ischnura pumilio (Charp.). Widespread in southern and central Europe; Asia.

EPHEMERIDAE (May-flies).

Leptophlebia vespertina (L.). Northern and central Europe.

PERLIDAE (Stone-flies).

Capnia atra Morton. Northern and alpine Europe.

PLANIPENNIA (Lacewing flies, &c.).

Psectra diptera Burm. Rare.

Chrysops abbreviata Curt.
Sisyra Dalii McLach.
Sisyra terminalis Curt. } These are apparently local insects, though little is known of their continental range.

TRICHOPTERA (Caddis-flies).

Phryganea obsoleta Hagen. Northern and arctic Europe.

Limnophilus fuscinervis Zett. Northern and central Europe. Not known to occur in Great Britain.

Limnophilus nigriceps Zett. Northern and central Europe.

Drusus annulatus Steph. Mountains of central Europe.

Apatania Wallengreni McLach. Northern Europe.

Apatania fimbriata (Pict.). Mountains of central Europe; Ireland. Not known to occur in Great Britain.

Silo nigricornis (Pict.). Central Europe.

Crunoecia irrorata (Curt.). Central Europe.

Molanna palpata McLach. Lapland; Finland; Russia; Siberia; N. Scotland; Ireland.

Adicella reducta (Steph.). Central and southern Europe.

Setodes argentipunctella McLach. Belgium; Germany; Switzerland; Spain; Britain.

Philopotamus montanus (Donov.) var. **scoticus** McLach. Perthshire N. Wales; Kerry.

Wormaldia mediana McLach. Central and southern Europe.

Polycentropus Kingi McLach. Britain; Portugal; Sardinia; and probably other places.

Setodes maculicornis Pict. Ireland; Switzerland; France; Portugal. Not known to occur in Great Britain.

Lype fragilis (Pict.). Ireland; Switzerland; France; Spain. Not known to occur in Great Britain.

Agapetus delicatulus McLach. Ireland; Arran (Scotland); Pyrenees. Probably overlooked in other localities.

Our acknowledgments are due to the Fauna and Flora Committee appointed by the Royal Irish Academy, and also through the same Committee to the Royal Society, for enabling us to organize expeditions to visit remote parts of the country, thus considerably extending our knowledge of the range of many species.

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With regard to nomenclature and systematic arrangement, we have made use of C. W. Dale's "Catalogue of British Neuroptera and Trichoptera" (Harwood, 1907), as revised and corrected by Messrs. W. J. Lucas, K. J. Morton, and others.

An asterisk is prefixed to such species as do not figure in the "Neuropterous Fauna of Ireland" (1889), and in this case, also, the captor's names are indicated.

Irish specimens of the great majority of the species recorded in the following list are preserved in the natural history collections of the National Museum of Ireland.

LIST OF LOCALITIES IN WHICH COLLECTING HAS BEEN DONE.

MUNSTER.

CLARE.—Lahinch.

CORK.—Adrigole, Ballygriffin woods, Blackwater River, Blarney, Carrigrohane, Castletown Berehaven, Gearagh, Glandore, Glengariff, Hungry Hill, Kinsale, Lismore, Macroom, Mallow, Skibbereen, St. Anne's, Youghal.

KERRY.—Ardagh Lough, Ardtully, Boreen-a-Morave, Caragh Lake, Carrantuohill, Cloghereen, Cloonee, Coppagh Glen, Crincaum Lough, Derrynane, Deenagh River, Deer Park, Dingle, Dinish, Gap of Dunloe, Flesk River, Garagarry Lough, Glena, Glencar, Horses Glen, Kilbrean Lough, Loo Bridge, Mangerton, Muckross, Parknasilla, Ross Castle, Spa Well, Staigue Fort, Torc Cascade, Valentia, Waterville, Windy Gap, Woodlawn.

LIMERICK.—Near Limerick.

TIPPERARY.—Cahir, Tipperary.

WATERFORD.—Cappagh Lough, Cappoquin, Dromana wood, Glendine, Glenshelane, Lismore, Mount Melleray, Salterbridge, Villierstown, Waterford.

CONNAUGHT.

GALWAY.—Ashford, Ballinasloe, Castlekirk, Clonbrock, Cong, Lough Corrib, Lough Derg, Maam, Maumwee Lough, Oughterard, Recess, Ross Lake, Roundstone, Salthill, Shindillagh Lough, Tuam, Woodford.

MAYO.—Achill, Aille Lough, Ballinlough, Bleachyard, Broad Lough, Carrowbeg River, Castlebar, Clare Island, Cogaula, Croaghpatrick, Croft, Dooghan Lough, Doo Lough, Inishbofin, Kip Lough, Knappa Lough, Knappabeg Lough, Mount Brown Lough, Newport River, Prospect Lough, Westport.

ROSCOMMON.—Athlone, Mote Park, Summerhill, Yew Point.

SLIGO.—Ballymote, Keshcorran, Lough Gill, Markree Castle, Rosses Point, Sligo.

LEINSTER.

CARLOW.—Fenagh.

DUBLIN.—Dundrum, Balbriggan, Finglas, Glasnevin, Glencullen, Glendhu, Howth, Harold's Cross, Kingstown, Lucan, Portmarnock, Rathgar, Rathmines, River Tolka, Royal Canal, Sandymount, Santry, Sutton, Tallaght, Templeogue, Terenure, Tibradden.

KILDARE.—Maynooth, Straffan.

KILKENNY.—Inistioge, Johnstown, Thomastown (River Nore).

KING'S COUNTY.—Edenderry.

LOUTH.—Carlingford, Castlebellingham, Drogheda (Boyne), Killincoole, Omeath.

QUEEN'S COUNTY.—Portarlington (River Barrow).

WESTMEATH.—Athlone, Ballykerran, Bog of Allen, Coosan Point, Lough Derravaragh, Glassan, Hare Island (Lough Ree), Killinure Bay, Killeean (Lough Ree), Moate, Mullingar, Shannon side, Twy River, Twy Lough, Waterston demesne, Wine Port.

WEXFORD.—Ardcandrisk, Ballyhyland, Courtown, Edenvale, Enniscorthy, Ferns, Johnstown Castle woods, Killurin, New Ross, Rosslare, Slaney, Wexford.

WICKLOW.—Altidore, Bray, Calary Bog, Enniskerry, Glendalough, Glendasan, Glenmalur, Greystones, Laragh, Lough Bray, Lough Dan, Powerscourt, Roundwood.

ULSTER.

ANTRIM.—Ballinderry, Belfast, Cave Hill, Colin Glen, Derrymore, Fair-head, Island Magee, Lough Neagh, Portmore Lough, Randalstown, Shane's Castle, Toome.

ARMAGH.—Acton Glebe, Armagh, Cam Lough, Churchhill, Coney Island (Lough Neagh), Derrymore, Fathom, Lough Gall, Kellystewart Lough, Lowry's Lough, Maghery, Mullinure, Poyntzpass, Scarva, Tanderagee.

DONEGAL.—Akibbon Lough, Ardara, Askerry Lough, Belleek, Bundoran, [illegible], [illegible], Coolmore, [illegible], Coxtown, Dunleary Lough, Fern Lough, Lough Foyle, Glenbeagh, Gartan Lough, Gweedore, Keel Lough, Kilmacrenan, Lennan Bridge, Lurgy River, Reelan Lough, Madourchin Lough, [illegible] Lough, [illegible] Lough, Lough Salt, Lough Swilly, Sproules Lough.

DOWN.—Annalong valley, Belfast, Cove Lake, Holywood, Lagan Canal.

FERMANAGH.—Enniskillen, Portora.

LONDONDERRY.—Near Derry.

MONAGHAN.—Emyvale, Glaslough.

TYRONE.—Altadiawan, Castlederg, Favour Royal.

It may be noticed that the counties of Leitrim, Longford, Meath, and Cavan are altogether absent from this list.

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SYSTEMATIC PART.

ODONATA.

LIBELLULIDAE.

Sympetrum striolatum (Charp.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney and Muckross districts; Waterville; Parknasilla; Kenmare; Caragh Lake; &c.). Cork (west, mid., and east Cork; Glengariff; Skibbereen; Youghal; &c.). Waterford (Glenshelane; Cappagh Lough). **C.**—Roscommon (Yew Point). Mayo (Inishbofin; Westport and Newport districts). Sligo (Markree). **L.**—Wexford (Ballyhyland; Killurin; Johnstown Castle; &c.). Wicklow. Dublin (common, Botanic Gardens; Royal Canal; Howth; &c.). Westmeath (Killucan; Waterstown). **U.**—Armagh (Poyntzpass; Churchhill; &c.). Monaghan (Glaslough and Emyvale). Down (Rostrevor). Donegal (Bundoran; Ardara; Coolmore). Derry. Antrim (Randalstown bog).

Common and widely distributed in Ireland, as it is in the Britannic area generally. Mr. Moffat informs us that it is abundant everywhere in County Wexford, from the fourth week of June to the end of October, and it is occasionally seen in November.

Distribution.—Over the greater part of Europe, except the extreme north. Occurs also in N. Africa; the Canaries; Madeira; northern India (*Morton*), &c.

Sympetrum scoticum (Don.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Waterford (*W. H. Bath*). **C.**—Galway (Maumwee Lough). Roscommon (Yew Point). Mayo (Mount Brown Lough). **L.**—Kilkenny (Johnstown, *Haliday* MS.). Westmeath (Bog of Allen). **U.**—Monaghan (Glaslough, swarmed on a bog, *Morton*). Tyrone (Castlederg). Armagh (Poyntzpass). Down (Belfast, *Haliday* MS.).

Distribution.—In Great Britain this species frequents moors and marshes from Devonshire to Inverness, and appears to be more common towards the north. Widely spread in the Palaearctic region, ranging from Lapland to northern Italy, Russia, northern and central Asia, Japan. It also inhabits North America (Colorado, New Hampshire, *Ris.* Canada).

Libellula depressa L.

MUNSTER.

M.—Waterford (Glendine, July, 1834, *Miss Ball*). Ireland (*Haliday* MS. *De Selys*).

Apparently very rare. It is remarkable that this conspicuous Dragon-fly has not been observed in Ireland during recent years. Both Haliday and De Selys were aware that it had been taken by Miss Ball; but they did not record the locality. Fortunately the place and date of capture are mentioned by Miss Ball in her annotated copy of Stephens' "Catalogue of British Insects" (1829), now in the possession of the Irish National Museum. An Irish specimen, possibly the one recorded by Miss Ball, is preserved in the Trinity College Museum. Mr. Lucas remarks that this species passes a great deal of its time at a distance from water, and, in consequence, probably often escapes observation.

Distribution.—Great Britain (north midlands, southwards). Temperate Europe, ranging to the Caspian Sea; Greece; the Iberian Peninsula; Syria.

Libellula quadrimaculata L.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Derrynane; Loo Bridge; Ross Castle). Cork (west; Skibbereen; Castletown; Adrigole; &c.). Clare (Lahinch). **C.**—Galway (Recess, and near Ballinasloe). Mayo (Carrowbeg River). Sligo (Markree Castle). **L.**—Wexford "Ballyhyland, rare, probably not breeding on our streams, but occurs at intervals in the imago state. May be a straggler from the lower ground of the Slaney valley. I have never seen it fly over water in this neighbourhood," *Moffat, in litt.*). Carlow (Fenagh). Wicklow (*A. W. Foot*). Dublin (Glencullen, &c.). Westmeath (Twy Lough). **U.**—Monaghan (Glaslough, sparingly, *Morton*). Armagh (near Armagh; Churchhill).

This is the only species of *Libellula* found commonly in Ireland. We have no records of the occurrence of migratory swarms of this insect in Ireland, such as have been observed on the Continent and even in Great Britain. The variety *praenubila*, Newman, with a brownish suffusion of the wings surrounding the stigma spot, and saffron-coloured costa, occurs in Ireland.

Distribution.—Great Britain (Devonshire to Inverness, and the Hebrides). Extremely widely distributed throughout the Palaearctic region, from Lapland (rare) to Spain; Kashmir (*Calvert*); Kamtschatka, and Alaska. Found also in North America (Massachusetts and Colorado).

*Libellula fulva Müll.

MUNSTER.

M.—Kerry (Dingle, a male in the collection of the late C. W. Dale, *fide* W. J. Lucas, *Entom. Monthly Magazine*, (2) xix., p. 199. 1908).

In the above reference Mr. Lucas draws attention to an apparently unrecorded Irish example of *Libellula fulva* contained in the Dale Collection of insects, now preserved in the Hope Department of the Oxford University Museum. The specimen is labelled "Ireland, R. W., 1849," in the handwriting of the late J. C. Dale, while a label at the side of the specimen indicates "Dingle" as the locality in which it was found. The initials R. W." are probably those of Richard Weaver, formerly a well-known collector of British insects. The species is one which may well occur in this country. Mr. Lucas points out that it may easily be overlooked on account of its resemblance to other species, such as *L. depressa*, and perhaps *Orthetrum caerulescens*, a not uncommon species in the south-west of Ireland.

Distribution.—This Dragon-fly occurs very locally in the south of England and as far north as Yorkshire or Durham at least. It is widely distributed in Europe, frequenting lakes and slowly flowing waters.

Orthetrum caerulescens (Fab.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Derrynane; Dinish; Gap of Dunloe; Windy Gap; Loo Bridge; Caragh Lake; Killarney; Ardtully). Cork (Castletown Berehaven; Glengariff). **C.**—Galway (Recess). **L.**—Wicklow (taken by *A. W. Foot*). Wexford ("not at all uncommon in peaty bogs in the north-western part of Co. Wexford, towards the Blackstairs range. In the valley of the small River Urrin, a tributary of the Slaney, it is, in suitable spots, often quite abundant." *Moffat, Irish Nat.* xviii., 1909, p. 24).

In Ireland, this species seems characteristic of the south; and we have no records further north than Galway and Wicklow. For the latter county we must rely on an old record made by Dr. A. W. Foot (Proc. Dubl. Nat. Hist. Soc., 1870). In Co. Wexford Mr. C. B. Moffat finds this species locally plentiful, from the end of June to the middle of August.

Distribution.—In Great Britain, this insect has a southern range, occurring from Cornwall at least to Cumberland. It is said to have occurred in the south-west of Scotland; but the species does not figure in Mr. Evans' list of the Dragon-flies of the Forth area. Isle of Man. Abroad it is found in the temperate parts of Europe, ranging from southern Scandinavia to Spain; Algeria; Madeira.

[*Orthetrum cancellatum* (L.).

There is no reason to believe that this Dragon-fly has ever been found in Ireland. The only evidence of its occurrence is in a list of the British Dragon-flies published by De Selys, "Revue des Odonates" (page 257), where the species is indicated as having occurred in Ireland. No doubt this is an error, as in the same work (page 12) the author remarks, concerning *L. cancellata*, "n'a pas encore été observée en Ecosse ni en Irlande." Haliday makes no mention of the insect in his MS. Catalogue. The record in the "Neuropterous Fauna of Ireland" must therefore be deleted.

Distribution.—According to Mr. McLachlan, the British range of this species is confined to the southern half of England. On the Continent it ranges from Scandinavia to Russia and Spain, occurring also in northern Africa.]

Somatochlora arctica (Zett.).

MUNSTER.

M.—Kerry (Killarney, *McLachlan*; Dinish, *King*).

Very local. The following is the original record of the occurrence of this northern and alpine Dragon-fly in Ireland:—"I have in my cabinet a male of *Cordulia arctica*, Zetterstedt, taken at Killarney in 1862 by Mr. Birchall, and presented to me by that gentleman. This Dragon-fly had hitherto only been found in one British locality, Rannoch, Perthshire (see note on distribution). Being an essentially northern species, one would scarcely have suspected its occurrence in the south-west of Ireland; but Mr. Birchall remarks that he has found *Cœnonympha davus* and *Hadena rectilinea* at the same place, neither of which occurs in the southern parts of England. De Selys-Longchamps mentions that it has been taken on an elevated heath near Arlon in Belgium, a locality still farther south." (McLachlan, *Entom. Monthly Mag.*, i., p. 76, 1864-5). There are two Irish specimens of this species in the Dale Collection at Oxford; one of these is labelled "Killarney" (*Lucas* in *Entom. Monthly Mag.*, (2, xix., p. 201, 1908).

Distribution.—Frequents boggy heaths and swamps in the highlands of Perthshire and Inverness (Rannoch, Strathglass, and Breadalbane). Abroad it is found in the mountain regions of northern and central Europe, ranging from Lapland to France (Ardennes). Also reported from the Caucasus and Siberia (*De Selys*, 1887). Kamtschatka (*Ris*).

[*Cordulia aenea* (L.).

"*Cordulia aenea.*—Killarney" (*Hely* in letter to Haliday in 1838, *fide Haliday* MS.).

"Ireland?—Towards the northern lakes (*Haliday*). I have not seen the specimens. There is no doubt that a Cordulia is found there, but the species has not been determined with certainty" (*De Selys*, Revision of the British Libellulidae, *Ann. Mag. Nat. Hist.*, xviii., p. 222, 1846).

These are the only available records of the occurrence of this Dragon-fly in Ireland. The locality mentioned in De Selys' "Revision" is evidently unsatisfactory, as no specimens appear to have been captured in the north. We are inclined to believe that the Killarney insect taken by Mr. Hely may have been the preceding species.

Distribution.—In Great Britain, this species is found chiefly in the south of England; and it has not been observed in Scotland. Jersey. Widespread in northern and temperate Europe, extending from Scandinavia, Finland, &c., to Spain (*Navás*) and eastwards to the Ural mountains and northern Asia].

Gomphus vulgatissimus (L.).

IRELAND ("Certainly Irish, Miss Ball," *Haliday* MS.; *De Selys.*)

Found in Ireland many years ago by Miss Ball; but unfortunately the place of capture seems unrecorded. It is not unlikely that the insect was taken in the south—perhaps in the Youghal district, where Miss Ball spent some time collecting Dragon-flies. A specimen of this species marked as Irish, in Trinity College Museum, was in all probability captured by Miss Ball. The rarity of this insect in Ireland is remarkable, as it usually occurs in numbers wherever it is found.

Distribution.—In Great Britain, this species is found in the south. Lucas records several localities ranging from Hants to Worcester (British Dragonflies, 1900). Widespread in northern and central Europe. Navás says he has not seen it in Spain (1908). Represented by races in the south of Europe and Asia (*Ris*).

Cordulegaster annulatus (Latr.).

ULSTER.

U.—"Northern Lakes, Haliday," *De Selys, Ann. Mag. Nat. Hist.*, xviii., 1846. Ireland (*Haliday* MS.).

This conspicuous insect was apparently taken in Ireland both by Haliday and Tardy (*fide Haliday* MS.) The locality quoted above was evidently supplied by Haliday to De Selys during the visit of the latter to this country in the summer of 1845. Mr. K. J. Morton records that a Dragonfly seen, but not taken, by him at Glaslough in county Monaghan, was probably *C. annulatus* (*Entom. Monthly Mag.*, 1892, p. 301). One of the Haliday specimens is now in the Irish National Museum.

Distribution.—Widespread in Great Britain (Cornwall to Inverness). Jersey. Found over the greater part of central and southern Europe, ranging north to Sweden, where it is rare; occurs in northern Africa and Asia Minor. Mr. Morton informs us that in the west of Spain the type form is found, but in the eastern parts it is replaced by the variety *immaculifrons*, Selys.

Brachytron pratense (Müll.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Cork (Kinsale). Waterford ("It occurs abundantly near Waterford." *Harcourt Bath*, in "British Dragon-flies," 1890, p. 58; Dromana wood). **C.**—Galway. Mayo (at a pool near the convent at Westport). **L.**—Wexford (Rosslare). Wicklow (*A. W. Foot*). Dublin (a single specimen captured on a bush in a garden near Balbriggan, *Wade*). Westmeath (Twy Lough; near Athlone). Louth (Castlebellingham). **U.**—Fermanagh (Portora; Enniskillen, *Allen*).

Though seldom met with, this species appears to be widespread in Ireland. The Kinsale specimen was captured at the Old Head lighthouse.

Distribution.—Occurs in the southern half of England and Wales. Apparently unrecorded from Scotland. Widely distributed in Europe from central Scandinavia to France, Italy, and the Caucasus. Asia Minor (*De Selys*).

Aeschna juncea (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Derrynane; Kenmare; Valentia; Dinish; Muckross; Caragh Lake; Waterville; Staigue Fort). Cork (Skibbereen). Tipperary (Cahir and Templemore). Limerick. **C.**—Galway (near Ballinasloe; Shindilla Lough; Castlekirk). Mayo (Kip Lough). Sligo (Markree). **L.**—Wexford (Ballyhyland district "moderately common, but less so, I think, than in suitable spots in Dublin and Wicklow. June 4th and September 18th are my earliest and latest dates for seeing it." *Moffat, in litt.*). Carlow (Fenagh). Wicklow (Altidore). Dublin heaths on the Dublin mountains, Tibradden, Glendhu, &c.). Westmeath (Waterstown; near Athlone). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Lurgan; Lowry's Lough; Mullinure; Poyntzpass). Derry. Antrim (*Haliday*). Donegal (Lough Swilly, *Dale* collection).

Rather common in suitable localities, and probably as frequent in its occurrence in the north as in the south of Ireland. This fine species has often been captured in the vicinity of fir-woods, especially in boggy upland districts; and it has even been noticed "hawking" after prey in the streets and squares of Dublin. Dr. D. Freeman informs us that on one occasion, while collecting by a wood near Ballinasloe he secured a number of males that were apparently attracted by a captured female specimen.

Distribution.—Great Britain (south of England to Inverness and the Hebrides, though apparently commonest towards the north). Exceedingly widespread throughout the northern part of the Palaearctic region, ranging from Finland to Kamtschatka. Occurs also in North America. Alaska (*Harriman* Expedition).

Aeschna grandis (L.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Galway (Woodford). **L.**—Carlow (Fenagh). Wicklow (taken by A. W. Foot). Westmeath (Waterstown). **U.**—Monaghan (Emyvale and Glaslough, commoner than *A. juncea* at the latter place, *Morton*). Armagh (Derrynoose). Antrim (Derrymore).

We have few records of the occurrence of this Dragon-fly, and none from the province of Munster; no doubt its Irish range is much wider than is here indicated. Mr. Morton remarks that at Glaslough "this fine insect was commoner than *A. juncea*; and many examples of it were under notice during the hours of bright sunshine, when it might be seen chasing and capturing such large game as *Charaeas graminis* and *Hydroecia nictitans*; it also followed its well-known crepuscular habit; and one dull, warm evening I watched some examples carrying on their feeding operations along the shores of the lake until it was nearly dark" (*Entom. Monthly Mag.*, 1892).

Distribution.—Although the continental range of this species is very similar to that of *A. juncea*, the distribution of the two in Great Britain is very different, as *A. grandis* is found in the south (Devonshire to Yorkshire at least). It has been recorded from the extreme south of Scotland. Northern and central Europe. Asia.

AGRIONIDAE.

Calopteryx virgo (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Derrynane; Glencar; Killarney). Cork (St. Anne's, *Haliday* MS.; Castletown Berehaven; Hungry Hill; Glengariff). Waterford (Lismore; Glenshelane). **C.**—Galway (Lough Corrib at Oughterard; Recess). **L.**—Wexford (Ballyhyland, very common; Rosslare; Johnstown Castle grounds; Edenvale; Ferns). Queen's County (river Barrow near Portarlington). King's County (Frankford). Wicklow (taken by *A. W. Foot*). **U.**—Antrim (Belfast, *De Selys*).

The records of this beautiful species are comparatively few, yet they are sufficient to show that it is as widespread as the following species in Ireland. All the Irish specimens that we have seen belong to the northern form with paler bases and tips to the wings. The variety of the male with uniformly smoke-coloured wings and evidently finer venation (*anceps* Steph.) occurs at

Glenshelane and Lismore in the Blackwater district. This form is, however, considered to be a mere condition of the species.

Distribution.—Ranges further north in Great Britain than *C. splendens.* Cornwall to Sutherland; while the continental distribution is equally wide. Europe, northern Asia to Amur and Japan (*Ris*). In the south of Europe (Iberian Peninsula, &c.) it is represented by the form *meridionalis* De Selys.

Calopteryx splendens (Harr.).

MUNSTER CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River). Cork (Glengariff; Skibbereen; common in the marshy ground at The Gearagh; Macroom; Blackwater at Fermoy; St. Anne's). Waterford (Glenshelane). Tipperary (Cahir). Clare. **C.**—Galway (Clonbrock). Mayo (Carrowbeg River). Sligo (Markree Castle). **L.**—Wexford (Edenvale; Ballyhyland). Kilkenny (Johnstown, *Haliday* MS.; banks of the Nore near Thomastown). Carlow (River Barrow). Queen's County (River Barrow near Portarlington, *Patterson*). King's County (Edenderry). Kildare (Straffan). Wicklow (taken by *A. W. Foot*; Powerscourt, *Dale* collection). Dublin (River Liffey near Lucan). Westmeath (Athlone; Twy River). Louth (Killincoole; Castlebellingham). **U.**—Monaghan (Emyvale). Belfast district (*Dale* collection, *Entom. Monthly Mag.*, 1909).

Locally common, frequenting wooded river-banks, especially in the south of Ireland. At Ballyhyland Mr. Moffat says it is totally unknown in most seasons; but in July, 1889, it appeared in great profusion in the valley of the Urrin, where for the time being it quite outnumbered the common *C. virgo.* It lasted for about a month, and has not been seen in the district since that year.

Distribution.—In Great Britain the species does not seem to have been observed north of Yorkshire (*Lucas*, 1900). Widely distributed in the Palaearctic region from Scandinavia and Finland (Nurmijarvi-See) to Algeria; Asia Minor, Turkestan, and Siberia. Replaced in the extreme south of Europe by the race *xanthostoma* (Charp.).

Lestes dryas Kirby.

MUNSTER. LEINSTER.

M.—Kerry (Caragh Lake, taken by *H. M. Edelsten* early in September, 1906, *Lucas, Entom.*, xl., p. 66, 1907). **L.**—Westmeath (an immature specimen taken in June on the River Shannon near Athlone, *King, Entom. Monthly Mag.*, (2) vi., p. 120, 1895).

Until the recent discovery of this species its occurrence in Ireland was regarded as doubtful. The records of Haliday and De Selys were based on a specimen supposed to have been taken in Ireland by Mr. Tardy. Dr. A. W. Foot includes *Lestes nympha* in his list of Wicklow Dragon-flies; but as no authority name is quoted, this record had better be referred to the following species.

Distribution.—This widely spread European insect is apparently very local in the Britannic area, having been observed chiefly in the fen districts of Cambridge, Essex, and Lincolnshire. Europe and northern Asia to Amurland (*Ris*).

Lestes sponsa (Hansem.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Killarney, *Dale* collection; Kenmare; Waterville; Parknasilla; Kilbrean Lough). Cork (Ballygriffin woods; East and West Cork, *Balfour Browne*). Waterford (Cappagh Lough). **C.**—Galway (Ross Lake near Galway). **L.**—Wexford (banks of Slaney). Wicklow (*Lestes nympha, Foot*). Westmeath (near Athlone). **U.**—Monaghan (Emyvale and Glaslough, exceedingly common on both bogs and lakes, *Morton*). Donegal (Coolmore).

Widespread, though apparently less common in the east than in the south of Ireland.

Distribution.—Great Britain (in suitable places from Kent to Inverness at least). Common in northern (Finland, &c.) and central Europe, ranging to Amurland and Japan (*Ris*).

[*Lestes barbara,* Fab.

"Ireland? A male in the Dublin Museum under the name of *nympha*" (*De Selys, Ann. Mag. Nat. Hist.*, 1846). "Un mâle du Museum de Dublin est indiqué comme ayant été pris en Irlande" (*De Selys,* "Revue des Odonates," 1850).

Extremely doubtful. The only evidence of the occurrence of this Dragon-fly in the Britannic area is furnished by De Selys, who saw a *reputed* Irish specimen in Trinity College Museum more than fifty years ago. No trace of this specimen is now to be found. According to a note in Mr. Haliday's MS. "Catalogue of Irish Insects," the specimen in question was taken by J. Tardy, but its Irish origin was evidently doubted by Haliday. Under the circumstances it seems best to relegate this species to the list of reputed British insects—a course which has already been adopted by Mr. Lucas in his work on British Dragon-flies (1900).

Distribution.—*Lestes barbara* is Mediterranean in its habitat, ranging from Portugal and Algeria to Asia Minor, becoming more local and sporadic in its occurrence towards central Europe. Kashmir, Persia, and Turkestan.

As it occurs in Belgium and in the Channel Islands (Alderney), it may yet be found living in this country.]

Erythromma najas (Hansem.).

ULSTER.

U.—Down ("Covelake, June," *Haliday* MS.; "près de Belfast, Haliday," *De Selys*, Revue des Odonates, 1850).

Apparently a very rare species in this country; and it has not been met with in recent years. The locality "Covelake," noted in Haliday's MS. Catalogue, is rather indistinctly written; but there can scarcely be any doubt that it is meant for Cove Lough, some 1500 feet up on the Mourne Mountains, near Slieve Donard, a district often visited by Haliday. At the same time it should be pointed out that *Erythromma najas* is not an upland species in Great Britain. We are indebted to Mr. R. Ll. Praeger for indicating the position of this little-known lake.

Distribution.—Mr. Lucas reports *E. najas* as a very local insect in England, ranging from Lincolnshire to Dorset. Abroad it is found from Scandinavia and Finland (Nurmijärvi-See) to the extreme south-west of Europe, penetrating eastwards into Siberia.

Pyrrhosoma nymphula (Sulz.)

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Derrynane; Waterville; Deenagh River; Muckross). Cork (Glengariff; Adrigole; Castletown; Macroom; &c.). **C.**—Galway (Ross). Mayo (Carrowbeg River). **L.**—Wexford (banks of Slaney; New Ross; Johnstown Castle grounds; "Ballyhyland, the commonest of our small Dragon-flies, and always the first to appear and the last to linger. May 3rd and October 1st are my extreme dates for it," *Moffat, in litt.*). Wicklow. Kildare (Maynooth). Dublin (Tallaght, &c.). Westmeath (Killucan; Twy Lough). Louth (Castlebellingham). **U.**—Monaghan (Emyvale). Armagh (common). Donegal (Ardara and Foyle district). Down (Slieve Donard and Annalong valley). Antrim (Ballinderry). Derry.

Common in suitable localities.

Distribution.—Occurs throughout Great Britain. Europe; Asia Minor.

Ischnura pumilio (Charp.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Galway (near Roundstone, 1908, *Praeger*). Mayo (Carrowbeg River). **L.**—Wexford (Rosslare). **U.**—Down or Antrim (near Belfast, *De Selys*, "Revision," 1850).

Rare. An Irish specimen, probably taken near Belfast, is in Mr. Haliday's Collection, now preserved in the National Museum in Dublin.

Distribution.—Local in Great Britain. Mr. Lucas vouches for a comparatively few localities in the south and east of England. Occurs in southern and central Europe, inhabiting also Algeria; Madeira; Asia Minor; extending, according to Ris, into northern and eastern Asia.

Ischnura elegans (Van Lind).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Derrynane; Ross Castle; Dinish; Deenagh River; Cloonee; Waterville). Cork (Glengariff; Castletown; Glandore). **C.**—Galway (Maumwee Lough). Mayo (Inishbofin; Carrowbeg River; Knappagh; Kip Lough; Doolough; Westport). Sligo (Rosses Point; Markree). **L.**—Wexford (Ballyhyland; New Ross; Rosslare; Killurin; Johnstown Castle; &c.) Wicklow. Dublin (Royal Canal, where the variety *rufescens* was common in 1887, *Moffat*; Glasnevin; Sutton; &c.). Westmeath (Shannon side; Coosan Point). **U.**—Monaghan (Emyvale and Glaslough, in great abundance, *Morton*). Armagh (Lowry's Lough; Mullinure; Lough Gall; &c.). Donegal (Coolmore; Ardara; Foyle district). Down (Holywood, and Lagan Canal). Antrim (Island Magee and Randalstown).

Common and widely distributed. The variety *rufescens*, Leach, occurs in many localities.

Distribution.—This species is found in most parts of the Britannic area, from the Scilly Isles to the Hebrides. It is widely distributed in northern and central Europe. Asia.

Agrion pulchellum Van Lind.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Parknasilla; Muckross). **C.**—Mayo (Westport). **L.**—Louth (Castlebellingham). Wicklow (Newcastle). **U.**—Armagh (*Johnson*). Monaghan (Emyvale, *Morton*). Donegal (Belleek; Foyle district). Antrim (Belfast and Ballinderry).

The few available records of this Dragon-fly show that it is widely spread in Ireland, though it may prove to be less common than the following species.

Distribution.—Ranges from the northern counties of England southwards. Recorded from Argyleshire, but not recently observed in Scotland. Abroad it is found from Scandinavia to Italy and Spain (*Navás*); Algeria; Asia.

Agrion puella (L.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Muckross; Ross Castle; Parknasilla). Cork (Glandore; Macroom). Waterford (Cappoquin). **C.**—Mayo (Westport; Carrowbeg

River; Knappagh Lough). **L.**—Wexford (Ballyhyland, very common, *Moffat*; New Ross; Edenvale; Johnstown Castle woods). Wicklow (taken by *A. W. Foot*). Dublin (Royal Canal). Westmeath (Killucan; Moate).

Common where it occurs.

Distribution.—*Agrion puella* is a common species in England, becoming rarer towards the north, and there are extremely few records from Scotland (Midlothian, *Evans*). Widespread in the western ports of the Palaearctic region from Lapland (very rare) and Finland to Algiers and Russia.

Enallagma cyathigerum Charp.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Derrynane; Ross Castle; Deenagh River; Ardagh Lough; Waterville; Cloonee; Parknasilla). Cork (St. Anne's; Ballygriffin wood; Glengariff). Waterford (Cappagh Lake; Cappoquin). **C.**—Galway (Maumwee Lough). Mayo (Inishbofin; Carrowbeg River; Kip and Knappagh Loughs). **L.**—Wexford (banks of Slaney). Wicklow (Glendalough). Dublin (Royal Canal). Westmeath (Twy Lough; Coosan Point; Mullingar; Deravaragh). Louth (Castlebellingham). **U.**—Monaghan (Emyvale and Glaslough, common, *Moffat*). Armagh (Lowry's Lough; Lough Gall; &c.). Donegal (Ardara; Coolmore; Bundoran). Derry. Antrim (Belfast).

Common and widely distributed.

Distribution.—Found throughout the British Isles. Abroad it ranges from Scandinavia and Spain eastwards to Turkestan.

PLECTOPTERA.

EPHEMERIDAE.

Ephemera vulgata L.

Connaught. Leinster. Ulster.

C.—Mayo (Castlebar Lake). Sligo (near Sligo). **L.**—Westmeath (Athlone). **U.**—Armagh (Churchhill). Donegal (Coolmore). Antrim (Lough Neagh, *Haliday* MS.).

Distribution.—Great Britain (Midlands, east, and south of England, occurring in warmer waters than the next species); widely distributed in Europe ranging from Lapland to Spain. Mr. Eaton informs us (*in litt.*) that the normal race is found in Scandinavia; Denmark; France, near Blois; and Switzerland near Geneva; a darker-winged race in Posen, near Messeritz (*Zeller*); and a dwarf form in central Spain, near Madrid and Cuença (*Rambur* and *Chapman*).

Ephemera danica Müll.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle). **C.**—Roscommon. Sligo (near Sligo). Mayo (Mount Brown Lough). **L.**—Westmeath (Athlone). Louth (Castlebellingham).

Probably overlooked in many localities. The male and female subimago stages are known to anglers as the "Green Drake" and the "Bastard Drake"; and the fully matured insect is the well-known May-fly. It is the Ephemera of the English Lakes and the High Peak district, and of Interlaken, and the Doubs near Pontarler abroad (*Eaton in litt.*).

Distribution.—Great Britain (in the south of England this species ranges westwards to Somerset and Devon, and as far north at least as Perthshire in North Britain). In western Europe it is as widely distributed as the preceding species.

Leptophlebia marginata (L.).

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River; Woodlawn; Torc Cascade). **L.**—Westmeath (Twy Lough).

Distribution.—Great Britain (London district to Inverness). Temperate and arctic Europe. Occurring also in Asia, Turkestan, and in North America.

Leptophlebia cincta (Retz).

CONNAUGHT. LEINSTER.

C.—Mayo (Westport; Mount Brown Lough; Carrowbeg River). Roscommon (Summerhill). **L.**—Dublin (Lucan). Westmeath (Twy River; Shannon; Bog of Allen; Killinure; Glasson).

Distribution.— Great Britain (not ascertained; Rannoch, &c.). Northern (Finmark, Schoyen: *fide Petersen,* 1908) and temperate Europe. Not recorded from Spain.[1]

Ephemerella ignita Poda.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Woodlawn; Cloghereen; Horse's Glen; Cappagh Glen; Spa Well; Gap of Dunloe). **C.**—Roscommon (Summerhill; Yew Point). **L.**—Dublin (Lucan). Westmeath (Hare Island; Shannon; Coosan Point; Twy River; Glasson).

NOTE ADDED IN PRESS.

[1] **Leptophlebia vespertina** (L.) (*L. Meyeri* Eaton, 1884).

CONNAUGHT.

C.—Mayo (Castlebar Lough, coll. *Halbert*). Specimens of a May-fly taken in this locality on the 18th June, 1909, were identified as the present species by the Rev. A. E. Eaton.

Distribution.—Hitherto known from Scandinavia (arctic and southern); Switzerland; Denmark (Horsens and Svejbock, *Petersen*); and the Scotch highlands (Strathglass, *Briggs*).

Distribution.—Great Britain (common, south of England to Inverness-shire). Central and southern Europe. Denmark (Horsens; Svejbaek, *Petersen*).

Caenis dimidiata Steph.

Leinster.

L.—Westmeath (Shannon; Coosan Point; Killinure).

Distribution.—Great Britain. Widespread throughout Europe (Finland, *fide Aro*; Denmark, *fide Petersen*).

Caenis halterata (Fab.) (*C. macrura* Steph.)

Connaught. Leinster.

C.—Mayo (Westport Mall). **L.**—Dublin (Glasnevin, common, *Haliday* MS.). Westmeath (Coosan Point; Killinure).

Recorded in Haliday's MS. list under the name of *Caenis macrura* Steph.

Distribution.—Great Britain (not ascertained). On the Continent this species ranges from Lapland to Algeria (Biskra and neighbourhood, *fide Eaton, in litt.*).

Baëtis binoculatus (L.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Deenagh River; Woodlawn; Torc Cascade; Gap of Dunloe). **C.**—Mayo (Clare Island). **L.**—Wicklow (Enniskerry). **U.**—Armagh (Mullinure).

Distribution.—Great Britain (not ascertained). Widespread in Europe (Finland, *Aro*; Norway, Schoyen; Denmark, *Petersen*, &c.) North America (Hudson's Bay Territory, *Eaton*).

Baëtis scambus Eton.

Leinster.

L.—Dublin (Lucan).

Distribution.—Great Britain (occurs as far north as Inverness). Range abroad not known; has been recorded from Denmark (Horsens; Skellerup, *fide Petersen*). Germany (*Ris*).

Baëtis vernus Curt.

Munster. Leinster. Ulster.

M.—Kerry (Deenagh River; Torc Cascade; Horse's Glen; Coppagh Glen; Gap of Dunloe). **L.**—Dublin (Rathfarnham). **U.**—Antrim (Cave Hill, *Haliday* collection).

Distribution.—Great Britain (uncertain). Finland (*Aro*). Arctic Norway (Hatfjelddalen, *fide Strand*). Germany (*Ris*).

Baëtis rhodani (Pict.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Gap of Dunloe). **C.**—Roscommon (Summer Hill). **L.**—Wicklow (Enniskerry, in October). Westmeath (Shannon at Athlone). **U.**—Armagh (Armagh).

Distribution.—Great Britain (Devonshire to Inverness). Widely spread in western Europe, ranging from Norway (Lardalsoren and Aal, *fide Strand*) to Algeria; Madeira, and the Canaries.

Baëtis pumilus (Burm.).

Munster. Connaught. Leinster.

M.—Kerry (Deenagh River; Woodlawn; Spa Well; Gap of Dunloe; Farranfore). **C.**—Mayo (Clare Island). Roscommon (Summerhill). **L.**—Dublin (Lucan). Westmeath (Killinure and Glasson).

Distribution.—Great Britain (uncertain, occurs as far north as Perthshire). Widely distributed, ranging from Scandinavia to Corsica, &c.

Centroptilum luteolum Müll.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Woodlawn; Deenagh River; Glena; Torc Cascade). **C.**—Roscommon (Summerhill and Yew Point). **L.**—Dublin (Tolka at Glasnevin; Lucan). Westmeath (Shannon; Coosan Point; Twy River; Glasson; Bog of Allen). **U.**—Donegal (Lough Fern; Gorteen Lough).

Distribution.—Great Britain (common, ranging to North Shetlands). Ranges from Finmark to Portugal, northern Italy, and Algeria (at the foot of Mount Edough, Bône, *fide Eaton*). Found also in North America (Hudson's Bay Territory, *Eaton*).

Cloëon dipterum (L.).

Munster.

M.—Kerry (Ross Castle and Deenagh River).

Distribution.—Great Britain (range unknown). Abroad this species is found from Scandinavia to Algeria (Ain Sefra, Province of Oran, *fide Eaton*); Egypt; Japan; and the Atlantic islands (Madeira, Teneriffe, &c., *Eaton*).

Cloëon simile Eaton.

Munster. Connaught. Leinster.

M.—Kerry (Ross Castle; Deenagh River; Glena; Horse's Glen; Gap of Dunloe). **C.**—Mayo (Knappabeg; Prospect; Aille and Doogan Loughs; Newport River; Castlekirk; Achill). **L.**—Westmeath (Shannon; Coosan Point; Killinure; Waterstown).

Distribution.—Great Britain (ranges from the south of England to North Shetlands). Central and southern Europe. Jersey. Also in Denmark (Silkeborg and Randers, *fide Petersen*).

Cloëon rufulum (Müll.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Deenagh River; Gap of Dunloe). **C.**—Mayo (Knappagh and Mount Brown Loughs). **L.**—Westmeath (Coosan Point).

Distribution.—Great Britain (south of England to Inverness). Widely distributed, Scandinavia to Algeria.

Siphlurus armatus Eaton.

MUNSTER.

M.—Kerry (Killarney).

Distribution.—Not ascertained. England (*Eaton*).

Siphlurus lacustris Eaton.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Gap of Dunloe). **C.**—Galway (Castlekirk; Maumwee Lough). Roscommon (Yew Point). Mayo (Kip Lough). **L.**—Westmeath (Shannon at Athlone; Coosan Point).

Distribution.—Great Britain (Snowdon, Rannoch, &c.). Norway (Tysfjorden, *fide Strand*). Savoy; Italy; Denmark; and Steiermark (*Ris*, Die Süsswasserfauna Deutschlands, 1909).

Rithrogena semicolorata (Curt.).

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River and Coppagh Glen). **L.**—Dublin, (Dodder at Tallaght).

Distribution.—Great Britain (Devon; Dorset; Cumberland; Lake District; Perth; Inverness). Western Europe, ranging from Scandinavia to the Alps and Pyrenees.

Heptagenia sulphurea (Müll.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Woodlawn; Dinish; Horse's Glen; Gap of Dunloe). Waterford (Lismore). **C.**—Galway (Lough Corrib near Galway). Roscommon (Yew Point). Sligo (near Sligo; Markree Castle). **L.**—Dublin (Lucan). Westmeath (Bog of Allen; Shannon; Coosan Point; Ballykeeran; Killinure; Waterstown). Louth (Castlebellingham). **U.**—Donegal (Gorteen; Fern and Keel Loughs; Glen Beagh; Clonkillybeg). Armagh (Coney Island in Lough Neagh).

Distribution.—Great Britain (London district to Inverness). Europe. Eastern Amur (*McLachlan*).

Ecdyurus venosus (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River; Torc Cascade, *McLachlan*). **C.**—Roscommon (Yew Point). **L.**—Dublin (Lucan). Westmeath (Hare Island and Coosan Point). **U.**—Donegal (Keel and Irvine's Loughs).

Distribution.—Great Britain (South of England to Inverness). Generally distributed from Scandinavia to the Mediterranean region. In Switzerland, near the Traubach (4,000 feet alt.) in the neighbourhood of Habkern, Interlaken, water 60° F. (*Eaton*). Lower down in Habkern Thal the Ecdyurus is *E. helveticus* (*Eaton in litt.*).

Ecdyurus insignis Eaton.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Woodlawn; Deenagh River). **C.**—Mayo (Mount Brown Lough). **L.**—Westmeath (Glasson). **U.**—Donegal (Gorteen and Keel Loughs (Lennan Bridge).

Distribution.—Not ascertained.

Ecdyurus lateralis (Curt.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Gap of Dunloe). **C.**—Mayo (Clare Island). **L.**—Wicklow (Enniskerry).

Distribution.—Great Britain (common in the north and west. Extending from Inverness-shire to Dorset, *Eaton*). Widespread in Europe.

PLECOPTERA.

PERLIDAE.

***Perla maxima** Scop.

MUNSTER. LEINSTER.

M.—Waterford (Blackwater near Lismore, *Halbert*; Youghal, *Miss Ball*). **L.**—Dublin (River Dodder at Terenure and Tallaght, *Halbert*). Wicklow (Bray, *Haliday* MS.).

Owing to its lurking habits, this fine insect has probably been overlooked in many Irish counties. Haliday includes "*Perla marginata*" in his MS. Catalogue; in all probability this record should refer to the present species.

Distribution.—Great Britain (widespread from Devonshire to Perthshire and Aran, *Morton*). Abroad it inhabits Scandinavia and central Europe; Lower Alps; Carinthia; Croatia to Bosnia; Herzegovina; &c. Not recorded in Navás's Spanish list (1908).

*Perla cephalotes Curt.

MUNSTER.

M.—Kerry (nymph taken in a stream flowing out of Lough Eighter at an elevation of about 1500 feet on Carrantuohill, June, *Halbert*).

A Perla-nymph found under stones in the above-mentioned locality is apparently referable to the present species, as it agrees exactly with *cephalotes* nymphs taken by Mr. K. J. Morton in the south of Scotland. An adult male taken in Ireland by Prof. G. H. Carpenter is in the Dublin Museum. Unfortunately the place of capture of this specimen is uncertain, though it is possibly from the shore of Lough Gill in County Sligo.

Distribution.—Found in Great Britain, from Devonshire to the Clyde and Forth districts of Scotland (*Morton*); northern and central Europe, and as far east as the Carpathians; Spain (*Navás*).

Dictyopteryx Mortoni Klap.

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River, *King*). **L.**—Louth (Castlebellingham! *Thornhill*).

Probably widespread in Ireland. Mr. Morton points out that the insect figuring in British collections as *Dictyopteryx microcephala* must in future be recorded as the present species (*Entom. Monthly Mag.*, 1907).

Distribution.—In Great Britain this insect has been reported from many highland lakes and lowland rivers, ranging south to the rivers Severn, Kennet, and Test (*Morton*). Continental range uncertain.

Dictyopteryx (Dictyopterygella) recta Kempny.

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Mote Park, *Halbert*). Sligo (near Sligo! *Johnson*). **L.**—Wicklow (Streams from Glendalough Lake and Glenmalur valley, *Halbert*). **U.**—Armagh (Coney Island in Lough Neagh! *Johnson*).

Occurs under stones on the margins of streams and lakes, appearing at about the middle of April. This species has been named in British collections for many years as *Isogenus nubecula*.

Distribution.—Great Britain (recorded by Mr. Morton as an abundant insect at many highland lakes, from the Forth district northwards). Northern Europe to Finland. Klapálek records this species from alpine lakes in the Riesengebirge; Carpathians; Siberia.

Chloroperla grammatica Poda.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River; Kenmare; Glencar). **C.**—Mayo (Carrowbeg River). **L.**—Wicklow (Enniskerry). **U.**—Armagh (Tanderagee).

Distribution.—Great Britain (common, Devonshire to Inverness). Widely spread in Europe, ranging from Scandinavia to Spain.

***Isopteryx tripunctata** Scop.

ULSTER.

U.—Donegal (Ardara, *Johnson*).

Found in moss from this locality (*McLachlan, Entom. Monthly Mag.*, xxix., 1893).

Distribution.—Great Britain (widespread, Devonshire to Inverness). Scandinavia (*Kempny*); central Europe (*Tümpel*). Not recorded from Spain.

Isopteryx torrentium Pict.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Deenagh River; Torc; Woodlawn; Ross Castle; Ardagh Lough; Devil's Punch-bowl; Gap of Dunloe; &c.). **C.**—Galway (Castlekirk). Mayo (Carrowbeg River). **L.**—Westmeath (Coosan Point).

Distribution.—Great Britain (common, ranges as far north as the Hebrides and Inverness). Mountain districts of northern and central Europe, extending to Spain.

Capnia nigra Pict.

LEINSTER. ULSTER.

L.—Dublin (River Dodder at Tallaght). **U.**—Down (Holywood, *Haliday* MS.).

Common in the bed of the river Dodder, appearing towards the end of March.

Distribution.—Great Britain (uncertain, ranges north at least to Perthshire). On the Continent it is found in most parts of northern and central Europe, and Navás reports it from Spain.

***Capnia atra** Morton.

MUNSTER.

M.—Kerry (Devil's Punch-bowl on Mangerton, June, *Halbert*; July, *King*).

Occurs in great abundance under stones on the margins of the subalpine lake in this locality (*Irish Nat.*, 1908). Mr. Morton has verified the identification of the Irish specimens, and remarks that they belong to an interesting form of this insect. "The genitalia of the ♂ are identical with a preparation of mine (typical) from Loch Ard, Perthshire. The form is slightly brachypterous, and therein lies the interesting point. I saw in the McLachlan collection, some ♀♀ from Braemar which were also somewhat short-winged. Klapálek has described from ♀♀ a species which he calls *C. vidua*, and he suggests that the Braemar specimens may be his *vidua*. In the absence of the ♂, however, it is somewhat difficult to decide on the value of the species at all" (*Morton, in litt.*).

Distribution.—In Great Britain this insect has been found on the shores of highland lakes in Inverness, Perth, and Aberdeenshire. On the Continent it has been recorded from Scandinavia, ranging north to Finnish Lapland (*Sahlberg*); Switzerland (*Ris*); Spain (Sierra Nevada, *Klapálek*).

*Taeniopteryx Risii Morton.

LEINSTER.

L.—Wicklow (Glendalough and Laragh, *Halbert*).

Common where it occurs on the banks of rapid streams, appearing about the middle of April.

Distribution.—Great Britain (frequents streams in various localities from Devon to Perthshire). Widely distributed in Europe, having been recorded from Norway; Switzerland; Albania; France; Pyrenees, and Spain.

[*Taeniopteryx nebulosa* is given with reserve in Mr. Haliday's MS. Catalogue, so that further evidence of its occurrence in Ireland is required.]

*Nemoura praecox Morton (*N. marginata* Kempny).

LEINSTER.

L.—Wicklow (Glencree, *Carpenter*).

A female specimen taken at this locality in April is in the Dublin Museum (*fide Morton*).

Distribution.—Great Britain (not rare; Perthshire; Clyde; Forth; and Manchester districts, *Morton*). Continental range unknown; has been recorded from Germany (*Ris*), Switzerland, and Lower Austria.

*Nemoura Meyeri Pict.

LEINSTER. ULSTER.

L.—Dublin (River Dodder at Tallaght, *Halbert*). Wicklow (streams at Glendalough, Glendasan, Laragh, Lough Bray, and Powerscourt, *Halbert*).
U.—Antrim (Cave Hill, *Haliday* collection).

Apparently common in suitable localities. Appears on the Wicklow streams at about the middle of April.

Distribution.—The range of this insect in Great Britain is not known.

Morton says it is rather common at streams in North Britain (as far north as Perthshire). Briggs reports it from Devonshire. Abroad it has been recorded from Germany (*Ris*); Switzerland (*Ris*); Carinthia; Lower Austria; and Portugal (*Navás*).

Nemoura cinerea Oliv.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Glencar; Muckross; Kenmare demesne; Deenagh River). Mayo (Westport). **L.**—Wicklow (stream from Lough Bray). Dublin (Lucan demesne). **U.**—Donegal (Gorteen Lough near Kilmacrennan). Antrim (Lough Neagh, *Haliday* collection).

Distribution.—Great Britain (uncertain, occurs as far north as Inverness-shire). Abroad this species has been recorded from various countries, ranging from Scandinavia to Spain and Portugal.

Nemoura variegata Oliv.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Glencar; Muckross). **C.**—Mayo (Westport; Carrowbeg River). Roscommon (Yew Point). **L.**—Westmeath (Athlone; Killinure Lough; Coosan Point; Twy Lough; Bog of Allen). **U.**—Armagh (Mullinure). Antrim (Portmore Lough). Donegal (Ardara).

Distribution.—Great Britain (common, ranging north to Inverness and the Outer Hebrides). On the Continent it is found from Finmark to Spain and eastwards to Turkestan. Frequents standing and slowly flowing water on the Alps, ascending to 2000 métres (*Ris*).

Nemoura inconspicua (Pict.). Morton.

Munster. Leinster. Ulster.

M.—Kerry (Glencar and Kenmare). **L.**—Wexford (Edenvale). Westmeath (Athlone). **U.**—Armagh (Lowry's Lough and Mullinure). Monaghan (Emyvale).

Distribution.—Great Britain (uncertain; Morton finds it sparingly at small streams and springs in Scotland). Norway; Switzerland; Bohemia; &c.

[*Nemoura lateralis* Pict., and *N. humeralis* Pict., have been recorded in the "Neuropterous Fauna of Ireland" (1889); but on account of the recent revision of the nomenclature of the Perlidae, these names must be removed from the Irish list.]

***Leuctra Klapáleki** Kempny.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Glencar, *Halbert*). **C.**—Mayo (Westport, *King*). **L.**—Wicklow (Glendalough, *Halbert*). Dublin (Lucan, *King*; Glendhu, *Halbert*). **U.**—Monaghan (Emyvale, *Morton*). Donegal (Ardara! *Johnson*).

Distribution.—Great Britain (common in Scotland and ranges southwards to Devonshire). Continental range uncertain. Norway; Germany; Switzerland; &c.

***Leuctra hippopus** Kempny.

MUNSTER. LEINSTER.

M.—Kerry (Devil's Punch-bowl and Muckross, *Halbert*). **L.**—Wicklow (streams at Lough Bray and Enniskerry, *Halbert*). Dublin (River Dodder at Tallaght, and mountain streams, *Halbert*).

Abundant where it occurs, frequenting streams in hilly districts.

Distribution.—Great Britain (common in Scotland, *Morton*). Norway; Germany; Austria; &c.

***Leuctra inermis** Kempny.

MUNSTER. LEINSTER.

M.—Kerry (Upper Lake of Killarney, *Halbert*). Wicklow (streams at Glendalough, Glendasan, and Laragh, *Halbert*).

Distribution.—Great Britain (common in Scotland; Wales, *Morton*). Continental range unknown.

[*Leuctra nigra* Oliv., was inserted in the 1889 list by error.]

COPEOGNATHA.

PSOCIDAE.

Amphigerontia variegata (Latr.).

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River and Cloghereen). **L.**—Dublin (Lucan and Howth). Ireland (*Haliday* coll.).

Distribution.—Great Britain (no doubt common, *Guermonprez, in litt.*). Northern and central Europe. Spain (*Navás*).

***Amphigerontia fasciata** (Fab.).

LEINSTER.

L.—Wexford (Edenvale, *King*).

Distribution.—Great Britain (common, extending to Inverness-shire at least). Widely spread in northern and central Europe, ranging from Finland to the Pyrenees.

Amphigerontia bifasciata (Latr.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Cloghereen; Torc Cascade). Waterford (Mount Melleray; Cappoquin). **C.**—Galway (Salthill and Castlekirk). Mayo (Carrowbeg River; Cogaula and Kip Loughs). **L.**—Dublin (Lucan and Howth). Wexford (Arcandrisk). **U.**—Donegal (Foyle district).

Distribution.—Great Britain (common, ranging north to the Shetlands). Northern and central Europe (*Reuter*). Spain (*Navás*).

Psocus sexpunctatus L.

LEINSTER.

L.—Dublin (Lucan).

Distribution.—Common in Great Britain, ranging north as far as Inverness-shire. Northern and central Europe (*Reuter*). Spain (*Navás*).

***Psocus major** Kolbe.

LEINSTER.

L.—Wexford (Enniscorthy).

Taken by Mr. Beaumont at Enniscorthy in September (*McLachlan, Entom. Monthly Mag.*, (2) i., p. 234).

Distribution.—Great Britain (recorded from the southern half of England). Abroad it is reported from Finland and Germany.

Psocus nebulosus Steph.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River; Torc; Dinish; Deer Park; Ross Castle). Waterford (Dromana wood). **C.**—Roscommon (Yew Point). Mayo (Carrowbeg River and Mount Brown). **L.**—Dublin (Lucan). Westmeath (Wineport; Waterstown). **U.**—Monaghan (Glaslough).

Distribution.—Great Britain (common, *McLachlan*). Northern and central Europe (*Reuter*). Spain (*Navás*).

Psocus longicornis (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River; Torc Cascade; Cloghereen; Dinish). Cork (Ballygriffin woods). Waterford (Dromana and Villierstown). **C.**—Roscommon (Yew Point). **L.**—Dublin (Lucan and Santry). Westmeath (Twy River and Hare Island). **U.**—Monaghan (Glaslough). Antrim (Portmore).

Distribution.—Great Britain (widely and generally distributed, *Guermonprez, in litt.*). Northern and central Europe (*Reuter*). Eastern Pyrenees (*McLachlan*).

Stenopsocus immaculatus (Steph.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Ardagh Lough; Tore Cascade; Dinish; Boreen-a-morave). Cork (Ballygriffin woods). Waterford (Dromana). **C.**—Roscommon (Yew Point). Mayo (Carrowbeg River). **L.**—Wexford (Johnstown Castle grounds; Edenvale). Wicklow (Enniskerry). Dublin (Royal Canal bank). **U.**—Donegal (Largy River).

Distribution.—Great Britain (widespread, occurring as far north as Sutherland). Northern and central Europe (*Reuter*). Spain (*Navás*).

Graphopsocus cruciatus (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Tore Cascade; Kenmare). Waterford (Lismore). **C.**—Mayo (Carrowbeg River). **L.**—Wexford (Johnstown Castle woods). Dublin (Howth and Phœnix Park). Westmeath (Coosan; Athlone; Waterstown). **U.**—Donegal (Sproule's Lough; Lennan Bridge; Largy River; Cottian; Foyle district). Down (Newcastle).

Distribution.—Great Britain (common and generally distributed, Devon to Inverness). Northern and central Europe, Sardinia, Madeira (*Reuter*). Spain (*Navás*). Portugal (*McLachlan*).

MESOPSOCIDAE.

Mesopsocus unipunctatus (Mull.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Boreen-a-Morave; Cloghereen; Ardagh Lough; Cahirciveen). **C.**—Galway (Salthill). Roscommon (Yew Point). Mayo (Carrowbeg River and Mount Brown Lough; Westport). **L.**—Wexford (Rosslare). Dublin (Tolka at Glasnevin; Howth and Portmarnock). Westmeath (Coosan; Killinure; Twy Lough).

Distribution.—Great Britain (equally widespread as the last). Northern and central Europe, ranging to North Cape. Spain (*Navás*).

Philotarsus flaviceps (Steph.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Muckross; Tore; Gap of Dunloe; Lee Bridge, &c.). Waterford (Dromana and Glenshelane). **C.**—Galway (Salthill). Mayo (Carrowbeg River; Mount Brown; Kip and Cogaula Loughs). **L.**—Wicklow (Lough Dan). Dublin (Lucan and Howth). Westmeath (Waterstown, and Shannon at Athlone).

Common where it occurs amongst coniferous trees.

Distribution.—Great Britain (occurs as far north as Inverness). Widespread in Europe, ranging from Finland to Spain.

Elipsocus hyalinus (Steph.).

Munster. Leinster.

M.—Kerry (Ross Castle and Cloghereen). **L.**—Dublin (Lucan and Howth). Westmeath (Hare Island).

Distribution.—Great Britain (recorded from numerous localities from Sussex to Inverness). Widely spread in western Europe, ranging from Scandinavia to Spain.

Elipsocus Westwoodi McLach.

Munster. Connaught. Leinster.

M.—Kerry (Ross Castle; Deenagh River; Boreen-a-Morave; Cloghereen; Ardagh Lough). Cork (Ballygriffin woods). Waterford (Lismore; Dromana and Mount Melleray). **C.**—Galway (Salthill). Roscommon (Yew Point). Mayo (Westport; Carrowbeg River; Mount Brown; &c.). **L.**—Wexford (near Wexford; Killurin; Rosslare). Dublin (Lucan and Howth). Westmeath (Coosan; Athlone; Moate).

Distribution.—Widely distributed in Great Britain, ranging into the Shetlands. Abroad it has been found in Scandinavia (Finland southwards); Germany; Holland.

Elipsocus abietis Kolbe.

Connaught. Leinster.

C.—Galway (Salthill). Mayo (Carrowbeg River; Mount Brown Lough). **L.**—Wicklow (Roundwood). Dublin (Lucan and Howth). Westmeath (Twy River; Waterstown; Moate).

Distribution.—Great Britain (probably general). Europe, frequent in pine forests (*Enderlein*).

Elipsocus cyanops Rostock.

Munster.

M.—Kerry (Ross Castle; Deenagh River; Cloghereen; Dinish; Boreen-a-Morave; Spa Well).

Distribution.—Great Britain (recorded from various localities ranging from Sussex to Inverness). Abroad it is reported from Finland, Germany, and the Pyrenees.

Pterodela pedicularia (L.).

Munster. Leinster.

M.—Kerry (Ross Castle; Boreen-a-Morave). **L.**—Wexford (Edenvale and Rosslare). Wicklow (Roundwood). Dublin (Lucan and Howth). Westmeath (Athlone).

Distribution.—Great Britain (common in houses, from the Isle of Wight, London district, &c., to the north of Scotland). Widely spread on the Continent, ranging from Finland and Spain to Turkestan.

CAECILIIDAE.

Peripsocus alboguttatus Dalm.

LEINSTER.

L.—Dublin (Lucan).

Distribution.—Northern and central Europe (*Reuter*). Madeira.

Peripsocus subpupillatus McLach.

MUNSTER. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Muckross; Booreen-a-Morave). Waterford (Dromana and Glenshelane). **L.**—Wexford (Edenvale; Killurin; Rosslare). Dublin (Lucan).

Distribution.—Referring to *Peripsocus alboguttatus* and *P. subpupillatus*, Mr. Guermonprez remarks (*in litt.*) that they are very likely generally distributed in Great Britain. West of England, &c.

Peripsocus phæopterus (Steph.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Boreen-a-Morave; Muckross; Ardagh Lough; Kenmare). Waterford (Lismore; Glenshelane and Mount Melleray). **C.**—Mayo (Carrowbeg River and Cogaula). **L.**—Wexford (Killurin; Edenvale and Rosslare). Dublin (Lucan; Howth, off Larch). Westmeath (Waterstown; Glassan; Athlone; Moate).

Distribution.—Great Britain (probably general). Widely spread in western Europe, ranging from Finland (*Reuter*) to Spain (*Navás*).

***Ectopsocus Briggsi** McLach.

MUNSTER. LEINSTER.

M.—Cork (Ballygriffin woods, beaten out of trees, *King*). Waterford (Lismore, *King*). **L.**—Wicklow (Roundwood, *Halbert*). Dublin (Howth and Phoenix Park, *Halbert*).

At Roundwood, and in the Phoenix Park, this interesting species occurred commonly in plantations of Conifers during the month of October.

Distribution.—The distribution of this species seems little known. In Great Britain it has been found in various localities in the south of England, ranging from Devonshire to Kent. Abroad it has been reported from Sydney, N.S.W., and from Salisbury, Mashonaland. In the latter place it occurred on a plateau at about 5000 feet elevation. Enderlein suggests that the insect may have been brought from Australia to Britain. According to McLachlan, however, both Australia and Africa may have received it from England, where to all appearances it is native, occurring chiefly amongst fallen leaves during the autumn and winter months. (*Entom. Monthly Mag.*, 1903, p. 296).

Caecilius fuscopterus (Latr.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Deenagh River; Boreen-a-Morave; Torc; Ross Castle). Waterford (Glenshelane). **C.**—Roscommon (Yew Point). Mayo (Carrowbeg River). **L.**—Wexford (Edenvale; Killurin). Westmeath (Bellevue; Waterstown).

Distribution.—Great Britain (common, ranging as far north as Inverness). Northern and central Europe (*Reuter*). Spain (*Navás*).

Caecilius flavidus (Steph.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Cloghereen; Muckross Abbey; Glena; Horse's Glen; Deenagh River; Kenmare; &c.). Cork (Ballygriffin woods). Waterford (Dromana). **C.**—Galway (near Maam). Mayo (Carrowbeg River). **L.**—Wexford (Killurin and Johnstown Castle). Wicklow (Lough Dan) Dublin (Lucan). Westmeath (Waterstown). **U.**—Donegal (Cottian; Largy River; Lough Madourchin; Sproule's Lough).

Distribution.—Great Britain (occurs as far north as Inverness). Europe, Lapland to Spain.

Caecilius obsoletus (Steph.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Deenagh River; Boreen-a-Morave; Ross Castle: Dinish). Waterford (Lismore; Glenshelane). **C.**—Galway (Salthill; Maam). **L.**—Wexford (Edenvale; Arcandrisk; Johnstown Castle woods). Dublin (Lucan; Howth; Tolka at Glasnevin). Westmeath (Waterstown).

Distribution.—Great Britain (South of England to Inverness). Northern and central Europe from Finland to France.

Caecilius Burmeisteri Brauer.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Dinish; Ross Castle; Boreen-a-Morave). **C.**—Galway (Maam). Mayo (Carrowbeg River). **L.**—Wicklow (Roundwood). Dublin (Howth; Lucan; Phoenix Park). Westmeath (Waterstown).

Distribution.—Great Britain (probably generally distributed—Surrey, Sussex. Inverness; common amongst Junipers). Northern and central Europe.

Caecilius perlatus Kolbe.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Dinish; Ross Castle; Deenagh; Boreen-a-Morave). **C.**—Galway near Maam; Salthill). Mayo (Carrowbeg River). **L.**—Wexford (Arcandrisk and Edenvale). Dublin (Tolka at Glasnevin; Lucan). Westmeath (Killinure; Waterstown).

Distribution.—Great Britain (probably general). Northern and central Europe, ranging into Finland.

Trichopsocus Dalei (McLach.).

MUNSTER.

M.—Kerry (Cloghereen).

Distribution.—Probably generally distributed—Devon; Dorset; Sussex [illegible]; Glasgow (common in greenhouses [illegible]; and other localities. Continental range unknown. McLachlan records it from Madeira and the Canaries.

ATROPIDAE.

Atropos pulsatoria L.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Killarney and Kenmare). **C.**—Mayo (Westport). **L.**—Dublin. Westmeath (Athlone).

Found in old books, and in collections of insects and plants.

Distribution.—Great Britain (widely spread). Europe. North America.

***Hyperetes guestfalicus** Kolbe.

LEINSTER.

L.—Wicklow (Roundwood and Lough Dan, on Conifers, *Halbert*). Dublin (Howth; Phoenix Park; Grand Canal bank, on elms, *Halbert*).

Not uncommon in the Dublin district, hiding in the crevices of rough-barked trees. At Howth it also occurs amongst shingle and refuse on the seashore, just above high-water mark.

Distribution.—This insect is no doubt generally distributed in the Britannic area (*McLachlan, Entom. Monthly Mag.*, 1898), and is probably often overlooked on account of its retired habits. Mr. Guermonprez, who has examined some of the Irish specimens, remarks (*in litt.*) that he has found it commonly in Sussex and elsewhere in England. Continental range not ascertained. Germany.

Lepinotus inquilinus Heyd. (*P. picea* Mots.).

CONNAUGHT. LEINSTER.

C.—Mayo (in a house at Westport). **L.**—Dublin. (Howth, &c., in houses). Westmeath (in a house at Athlone). Ireland (*Haliday* MS.).

Found occasionally in natural history collections. Haliday records it in his MS. catalogue as occurring among corks, hay, &c.

Distribution.—This insect used to be considered rare in Britain. It has recently been found in great abundance in London granaries (*Entom. Record*, 1905); also at Hastings in a neglected collection of plants; Sussex; Surrey, &c. Mr. McLachlan says it is "found living in boxes of exotic (in one case Egyptian) insects. If it be not indigenous in England, it is at any rate naturalized here" (*Entom. Monthly Mag.*, iii., 1867). Abroad it has been reported from Finland; Russia; central Europe; Spain; Egypt; and North America.

TROCTIDAE.

Troctes divinatorius (Müll.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Killarney). **C.**—Mayo (Westport). Sligo. **L.**—Dublin. **U.**—Donegal (Kilmacrennan).

In houses, and collections of insects and plants.

Distribution.—Found throughout Great Britain. Probably cosmopolitan, occurring in Europe; North America; Greenland; &c.

PLANIPENNIA.

SIALIDAE.

Sialis lutaria (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Waterford (Glenshelane valley). **C.**—Mayo (Carrowbeg River). Sligo (Markree Castle). **L.**—Dublin (*Haliday* MS.; River Tolka near Finglas). Westmeath (Athlone). **U.**—Armagh (Lowry's Lough and Churchhill). Antrim (Lough Neagh near Toome).

This insect, the "Alder Fly" of anglers, probably occurs in suitable localities throughout the country.

Distribution.—It is common in Great Britain, having been observed as far north as Inverness and the Outer Hebrides. Widely spread in the Palaearctic region, ranging from Lapland and Finland to Spain, and eastwards to Siberia (Lake Baikal). Occurs in the Alps at an elevation of over 7000 feet (*Zschokke*).

OSMYLIDAE.

*Osmylus chrysops (L.) (*O. maculatus* Fab.).

Munster. Connaught. Leinster.

M.—Kerry (Ardtully near Kenmare, July, 1893, *Kane*; Killarney, *Haliday* MS.). Cork (banks of the Shournagh River, *Haliday* MS.). **C.**—Galway (Leenane, *Haliday* MS.). **L.**—Wexford (Edenvale, *King*). Kilkenny (Inistioge, *Haliday* MS.). Dublin (Lucan, *Freeman*).

Apparently this beautiful insect is to be found, locally, on river-banks in the southern half of Ireland. The records noted in Mr. Haliday's MS. catalogue have not been previously published.

Distribution.—In Great Britain it is recorded as not uncommon about streams (*McLachlan*), ranging from Devonshire to Yorkshire at least. It has not been observed in Scotland.

Widely spread in Europe, extending from southern Sweden to Spain and the Caucasus.

HEMEROBIIDAE.

Sisyra fuscata (Fab.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Gap of Dunloe). **C.**—Mayo (Carrowbeg River, Prospect Lough, Kip Lough). **L.**—Wexford (Killurin). Dublin (Lucan). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Keel and Sproule's Lough; [illegible]; Glenveagh). Armagh (Loughgall). "Ireland" (*Haliday* MS.).

Probably common. Haliday was of opinion that the curious larva described by Westwood under the name of *Branchiotoma spongillae*, found living in fresh-water sponges, is in reality the larva of *Sisyra fuscata* (Trans. Entom. Soc. London, v., pp. 31, 32, 1847). The larvæ of *Sisyra* are now known to live in fresh-water sponges, and they may be found in the canal system of species of *Euspongilla* and *Ephydatia*.

Distribution.—Great Britain (common, ranging into Inverness). Northern and central Europe.

Sisyra Dalii McLach.

Munster. Leinster.

M.—Kerry (Ross Castle, Dinish). **L.**—Wexford (Edenvale). Dublin (Tolka at Glasnevin).

Distribution.—Great Britain (local, has been found in Yorkshire, at Ambleside, in North Wales, Surrey, Dorset, and the Scilly Isles). The continental range has not been ascertained: but it is known to occur in Germany (Westphalia and Saxony); Denmark (Bornholm); and Portugal.

Sisyra terminalis Curt.

Munster. Leinster.

M.—Kerry (Lakes of Killarney, *Haliday* MS.; *Hagen* in *Entom. Annual*, 1858; Ross Castle; Deenagh; Cloghereen). **L.**—Dublin (Lucan).

The first British specimens of this rare species were discovered at Killarney by A. H. Haliday.

Distribution.—Great Britain (the range of this species is little known; it has been recorded from Worcestershire and Surrey). Sweden; Germany (Saxony); and the Carpathians (*Wallengren*).

Hemerobius micans Oliv.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Cloghereen; Torc Cascade; Deenagh River; Deer Park; Boreen-a-Morave). **C.**—Galway (Cong; Salthill). Mayo (Carrowbeg River; Mount Brown; Westport). **L.**—Wicklow (Dargle; Greystones). Dublin (Lucan). Westmeath (Coosan Point; Waterstown; Bog of Allen). **U.**—Armagh (Mullinure; Loughgilly). Donegal (Coxtown; Kilmacrennan; Glenbeagh).

Distribution.—Ranges from Devon to Perthshire in Great Britain. Isle of Man. Probably spread all over Europe (*McLachlan*). Swedish Lapland (*Wallengren*).

Hemerobius nitidulus Fab.

Munster.

M.—Kerry (Ross Castle; Torc Cascade).

Apparently rare. Occurs on *Pinus sylvestris*.

Distribution.—Great Britain (south of England to Inverness). Widespread in Europe, occurring in arctic Norway; Turkestan.

Hemerobius humuli L.

Connaught. Leinster. Ulster.

C.—Mayo (Carrowbeg River). **L.**—Wicklow (Enniskerry). **U.**—Donegal (Coolmore). "Ireland" (*Haliday* MS.).

Distribution.—Great Britain (Devon to Perthshire). Isle of Man. Widespread in Europe, arctic Norway, &c. Siberia. North America.

Hemerobius lutescens Fab.

Munster. Connaught. Leinster.

M.—Kerry (Cloghereen; Torc Cascade; Boreen-a-Morave). Cork (Ballygriffin woods). **C.**—Galway (Salthill). Mayo (Carrowbeg River; Mount Brown). Sligo (near Sligo). **L.**—Wexford (Rosslare). Dublin

Lucan). Westmeath (Coosan Point; Shannon side; Wineport; Waterstown; Athlone). **U.**—Armagh (Mullinure). Donegal (Cottian; Largy River).

Distribution.—Great Britain (Devon to Inverness). Recorded by McLachlan as probably abundant over Europe, occurring amongst deciduous trees, and more rarely amongst Conifers.

Hemerobius marginatus Steph.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Tore Road). **C.**—Mayo (Carrowbeg River). **L.** — Wicklow (woods at Lough Dan). **U.**— Donegal (Glenbeagh; Kilmacrennan; Cottian Lough).

Distribution.—Great Britain (south of England to Inverness). Apparently widely spread in Europe (*McLachlan*).

Hemerobius orotypus Wall.

Munster. Leinster. Ulster.

M. — Kerry (Tore Cascade; Boreen-a-Morave). **L.** — Westmeath (Waterstown). **M.**—Armagh (Mullinure; Ballybrennan). Armagh (Fathom). Donegal (Coxtown). "Ireland" ("*variegatus Z.*" of *Haliday* MS. probably).

The *Hemerobius* "*sp. nov.*" of the "Neuropterous Fauna of Ireland" (1889) is to be referred to the present species.

Distribution.—Great Britain (Devon northwards to Sutherland). The continental range of this species has not been ascertained, though it is known to occur in Scandinavia (to Lapland, *Wallengren*) and in the Pyrenees, extending as far east as the Carpathians; Styria (*Morton*).

Hemerobius nervosus Fab.

Leinster. Ulster.

L.—Dublin (Lucan; Tolka). Westmeath (Waterstown).

M.—Antrim (Lough Neagh at Toome and Portmore). Armagh. "Ireland" (*Haliday* MS.).

Distribution.—Great Britain (locally common: Mr. Morton records it as occurring in Scotland wherever there is natural birch). Abroad it is widely spread, extending into the Arctic Circle, and probably less common south of the Alps (*McLachlan*).

Hemerobius subnebulosus Steph.

Connaught. Leinster. Ulster.

C.—Sligo (near Sligo). **L.**—Kildare (Maynooth). Dublin (Dundrum). Westmeath (Coosan Point). **U.**—Armagh (Mullinure; Armagh in garden). Down (Holywood).

Local in woods. In England this species is especially common in gardens; and, as McLachlan points out, it is consequently liable to artificial dispersal with plants and shrubs.

Distribution.—Great Britain (Devonshire to Shetlands). Isle of Man. Widespread in Europe, ranging from Lapland to Spain; Atlantic Islands; Siberia; Turkestan.

Hemerobius stigma Steph.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle; Deenagh River; Torc Road). **C.**—Galway (Castlekirk). **L.**—Wexford (Killurin). Dublin (Howth). Westmeath (Wineport; Waterstown; Bog of Allen; Bellevue).

Distribution.—Great Britain (occurs in coniferous woods from Devonshire to the extreme north of Scotland). Widely distributed in Europe, ranging from Lapland to Corsica; Portugal, &c.; it also inhabits the Canaries.

Hemerobius atrifrons McLach.

CONNAUGHT. LEINSTER.

C.—Galway (Castlekirk). **L.**—Westmeath (Waterstown).

Apparently rare. Occurs on Conifers.

Distribution.—Great Britain (Devonshire to Inverness). Northern and central Europe; eastern Siberia.

Micromus paganus (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle). **C.**—Sligo (Lough Gill, and near Sligo). **L.**—Wicklow (Enniskerry). Kildare (Maynooth). **U.**—Tyrone (Altadiawan). Armagh (Mullinure, &c.).

Distribution.—Great Britain (Devonshire to the Clyde area). Northern and central Europe; Lapland.

Micromus variegatus (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Torc Cascade). Waterford (Lismore and Cappagh Lake). **C.**—Galway (Maam River). Mayo (Westport demesne; Carrowbeg River). **L.**—Wexford (Slaney bank near Wexford). Dublin (Howth). **U.**—Armagh (Mullinure, &c.).

Distribution.—Generally distributed in England (Worcester; Hereford; Devon; &c.).

Northern and central Europe, extending to Italy; Austria; and Corsica.

Micromus angulatus (Steph.) (*M. aphidivorus* Schr. ?).

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River). Wexford (Courtown, Enniscorthy, *Beaumont, Entom. Monthly Mag.*, xxix., p. 263).

Distribution.—Great Britain (rare, though widely distributed, extending into the south of Scotland, Kircudbright).

Europe ranging to arctic Norway: Siberia; Madeira; North America (Colorado; Canada).

***Psectra diptera** Burm.

LEINSTER.

L.—Wexford (banks of the River Slaney near Wexford, July, 1900, *Halbert*).

In the summer of 1900 one of us had the good fortune to find two examples of this little-known insect during a collecting tour in county Wexford. Unfortunately the great rarity of the insect was unsuspected at the time of capture else more specimens might have been obtained, and more exact details of its occurrence noted. It is certain, however, that the insects were swept from amongst bushes including some hazel and alder, bordering the south bank of the River Slaney, a few miles to the north of the town of Wexford, during the month of July. *Psectra diptera* is remarkable for its small size, the rudimentary condition of the second pair of wings in the male, and also for its extreme rarity. Nothing appears to be known concerning its life-history.

The first recorded British specimen was found on a hazel bush in Breagh Wood, Somersetshire, by J. C. Dale, as long ago as 1843, and apparently there have been no subsequent captures of the species in England. The insect has, however, been recently discovered by Mr. B. McGowan, on the banks of the Nith in Dumfriesshire (*Entom. Monthly Mag.*, (2) xiv., (39), p. 14, 1903).

Distribution.—*Psectra diptera* seems to be generally rare, yet it is widely spread in the Palaearctic region, occurring in Finland; Sweden; Russia, Germany; Holland; Italy; and in Siberia (Irkutzk). It has also been found in North America (New York; Michigan; New Hampshire; N. Illinois), where, according to Banks (1905), it is apparently of more common occurrence than in Europe.

CHRYSOPIDAE.

Chrysopa vittata Wesm.

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Yew Point). **L.**—Wicklow (Altidore). Westmeath

(Killucan). Louth (Castlebellingham). **U.**—Tyrone (Altadiawan). Donegal (near Kilmacrennan). "Ireland, common" (*Haliday* MS.).

Distribution.—Widely spread in Great Britain. Northern and central Europe; Styria; Siberia.

Chrysopa flava (Scop.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Deenagh River; Torc road; Boreen-a-Morave). Cork (Glandore). Waterford (Cappoquin). **C.**—Mayo (Carrowbeg River). Sligo (near Sligo). **L.**—Wexford (Rosslare). Wicklow (Altidore; Enniskerry). Dublin (Kingstown). Westmeath (Coosan; Waterstown). Louth (Castlebellingham). **U.**—Monaghan (Emyvale). Armagh.

Distribution.—Common in Great Britain from Devonshire to Inverness, and in western Europe generally.

Chrysopa alba (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Torc road; Boreen-a-Morave). **C.**—Galway (Cong). Mayo (Carrowbeg River). Roscommon (Yew Point). Sligo (near Sligo). **L.**—Wexford (Edenvale; Killurin; Johnstown Castle grounds). Wicklow (Enniskerry and Powerscourt demesne). **U.**—Tyrone (Favour Royal). Donegal (Cottian; Largy River; near Kilmacrennan).

Distribution.—Great Britain (Devonshire to Inverness at least). Northern and central Europe.

Chrysopa flavifrons Brauer.

CONNAUGHT.

C.—Mayo (Carrowbeg River).

Distribution.—Great Britain (south of England; Wales; not recorded from Scotland). Sweden to Dalmatia (*Brauer*).

Chrysopa tenella Sch.

LEINSTER. ULSTER.

L.—Dublin (Rathgar, coll. *Carpenter*). **U.**—Armagh (near Armagh, coll. *Johnson*).

A Chrysopa from the first-mentioned locality in the Irish National Museum is apparently referable to the present species. It is somewhat larger than the average size of British specimens; but it has two characters which are of *C. tenella*, a broad paler line on the thorax, and a black spot on the cheeks (*fide Morton*).

***Chrysopa vulgaris** Schneider.

Leinster.

L.—Wexford (near Wexford, *King*). Dublin (Howth, *King*). Westmeath (Athlone, *King*). "Ireland" (*Haliday* collection).

This common British species has not been previously recorded from Ireland.

Distribution.—Europe and the Atlantic Islands; Asia Minor; Turkestan; &c. Referring to the occurrence of *Chrysopa vulgaris* in Madeira, the Canaries, and St. Helena, Mr. McLachlan points out that it is rather liable to introduction into new localities during the larval stage. In Great Britain it is found from the south of England to the Shetlands, though possibly introduced in the latter place.

***Chrysopa prasina** Ramb. (*C. aspersa* Wesmael).

Munster. Leinster.

M.—Cork (Glandore, *Halbert*). **L.**—Wexford (Rosslare, *King*). Westmeath (Athlone, *King*).

Distribution.—Great Britain (generally common in the south; Yorkshire; North Wales. Not recorded from Scotland). Widespread in Europe.

***Chrysopa ventralis** Curtis.

Leinster. Ulster.

L.—Wexford (Killurin, *King*). **U.**—Monaghan (Emyvale, *Morton*).

Distribution.—Great Britain (south of England to Yorkshire at least). Northern and central Europe. Siberia.

***Chrysopa abbreviata** Curtis (*C. immaculata* Steph.).

Leinster.

L.—Dublin ("*Chrysopa abbreviata = immaculatus, St.* Portmarnock," *Haliday* ms.)

This species appears to have been well known to Haliday, and it is recorded as above in his ms. catalogue of Irish insects. In a paper which he published in 1857 we find the following note:—"On the sand-hills (Portmarnock) themselves *Chrysopa abbreviata* was more common than I had ever before found it; and along with it, the freckled, sandy-coloured, stout larva, which doubtless feeds chiefly on the Aphides that abound on the sea-reeds" (*Nat. Hist. Review*, iv., p. 35). The identification of one of Haliday's specimens, preserved in the Irish National Museum, has been verified as correct by Mr. K. J. Morton.

Distribution.—Great Britain (little is known of the range of this species; it occurs on sand-hills in the Liverpool district. Curtis records that it was taken on the sand-hills at Appledore and Ravenglass, and on the Marrams near Yarmouth. British Entomology, ii., pl. 520, 1834). According to Reuter it is widely spread in Europe (Finland to Caucasus), but has not occurred in France, Spain, or Italy. Asia Minor.

[*Chrysopa perla* (L.).

Doubtfully Irish. The only indication of its occurrence is in *Haliday's* MS. catalogue. The entry is as follows:—"*Chrysopa perla* (Ste ?) = *reticulata* ?, *cancellata*, certainly Irish, *Hely* !"

The synonyms mentioned by Haliday admittedly refer to *Chrysopa perla* (L.), *fide* McLachlan, "Monograph of the British Neuroptera-Planipennia." However, as some doubt is implied in this record, we think it best to include the species with reserve, until more satisfactory evidence of its occurrence is forthcoming.]

CONIOPTERYGIDAE.

Coniopteryx psociformis (Halid.) Curtis.

Munster. Leinster. Ulster.

M.—Kerry (Ross Castle; Deenagh River; Muckross Abbey; Torc Cascade; Boreen-a-Morave). Waterford (Lismore; Glenshelane). **L.**—Dublin (Lucan; Dundrum). **U.**—Down (Tollymore, *Haliday* collection).

Distribution.—Great Britain (Devonshire to Perthshire). Northern and central Europe (*Enderlein*).

Coniopteryx lactea Wesm. (*C. tineiformis* Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Deenagh River; Boreen-a-Morave; Kenmare; Muckross). **C.**—Galway (Salthill). Mayo (Carrowbeg River; Mount Brown Lough. Westport demesne). Roscommon (Yew Point). **L.**—Westmeath (Coosan Point; Shannon; Waterstown). **U.**—Donegal (Cottian; Largy River; Glenbeagh).

Widely spread and probably common in suitable localities.

Mr. Haliday remarks that this species "occurs in groves (especially on Coniferae) in summer:—When captured they feign death, with their antennae bent in under the thorax, as in Hemerobius and Chrysopa." He also records a Coniopteryx larva which he believed to be referable to the present species. "This larva is found wandering in groves from the end of August to October; it is probably Aphidivorous, though this I have not proved, nor have I bred it, but I can entertain no doubt that it is in the larva of *C. tineiformis.* The general character is closely allied to the larva of

Hemerobius, to which genus it is related." Curtis figures this larva, and remarks that it is rosy, with a large black patch on the back, and large white spots down each side. (See *Curtis*, British Entomology, xi., plate 528. 1834).

Distribution.—Occurs in Great Britain from Devonshire to Inverness at least. According to Enderlein it is widely distributed in Europe, ranging north into Finland.

PANORPIDAE.

*Panorpa germanica L.

MUNSTER.

M.—Cork (Youghal and Blarney, *Halbert, Irish Naturalist*, xvi., pp. 289–299. 1907).

Very local, and probably confined to the south.

The first Irish specimens of this common European "Scorpion Fly" were discovered by Mr. R. Standen at these localities in July, 1907. A male example taken at Youghal approaches the immaculate variety, except for a small spot on the front margin of each of the wings, and an extremely narrow black margin at the tip of the anterior pair (var. *apicalis* Steph.). On the contrary, in a female specimen found at Blarney, the spots are well developed and tend to form continuous bands across the wings, much as in *Panorpa communis*.

Distribution.—Occurs in most parts of Great Britain, ranging from Devonshire to Sutherland. Northern and central Europe.

TRICHOPTERA.

PHRYGANEIDAE.

Neuronia ruficrus (Scop.).

CONNAUGHT. LEINSTER.

C.—Roscommon (Mote Park). **L.**—Westmeath (Bog of Allen).

Distribution.—Great Britain (south of England to Perthshire at least). Northern and central Europe.

Phryganea grandis L.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle). **C.**—Galway (Ashford and Cong). Sligo (Markree Castle). **L.**—King's County (Edenderry). Dublin (River Dodder near Templeogue). Westmeath (Shannon near Athlone). **U.**—Donegal (Lough Fern near Kilmacrennan). Antrim (Lough Neagh).

Distribution.—In Great Britain this species is found from Devonshire to the south of Scotland. Widely spread in Europe.

Phryganea striata L.

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Yew Point). Mayo (Knappagh and Kip Loughs). **L.**—Louth (Castlebellingham). **U.**—Monaghan (Glaslough). Armagh (Loughgall, Keady, &c.). Donegal (Fern, Sproule's and Reelan Loughs).

Distribution.—Somewhat similar to that of the last species. Extends further north, into Finland and Lapland; Spain; Siberia.

Phryganea obsoleta (Hagen) McLach.

MUNSTER. LEINSTER. ULSTER.

M.—Kerry (Killarney, *Cooke, Entom. Monthly Mag.*, xv., 1878). Limerick (August 16th, *Eaton, Entom. Monthly Mag.*, 1877). **L.**—Westmeath (Shannon, *King*). **U.**—Monaghan (Glaslough, *Morton*). Armagh (Kellystewart Lough! *Johnson*). Donegal (Ardara sandhills, *Johnson*).

Distribution.—Inhabits the northern parts of Great Britain (north of England and Wales, extending to Inverness-shire at least). Abroad it is found in Lapland; Finland; Norway; Sweden; North Russia; Germany (East Prussia, Bavaria, Lorraine, &c.); Switzerland, &c. Apparently not recorded from the southern parts of Europe. North-western Siberia (*McLachlan*).

Phryganea varia (Hagen). Fab.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle). **C.**—Galway (Castlekirk and Maumwee Loughs). Roscommon (Yew Point). Mayo (Cushinsheen and Prospect Loughs; Carrowbeg River). **L.**—King's County (Edenderry). Westmeath (Waterstown and Coosan). **U.**—Monaghan (Glaslough). Donegal (Gorteen; Sproule's; Keel; Akiboon; Muethin; and Askerry Loughs; Clonkillybeg; Glenbeagh).

Distribution.—Great Britain (Devonshire to North Shetlands). Almost all over Europe.

Agrypnia pagetana Curt.

ULSTER.

U.—Monaghan (Glaslough). Donegal (Ardara).

Distribution.—Great Britain (not uncommon in the fen districts of the eastern counties of England, *McLachlan*; near Glasgow, *King*). Northern and central Europe; Spain (*Navás*); North-western Siberia; Turkestan.

LIMNOPHILIDAE.

Colpotaulius incisus (Curt.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Galway (Castlekirk). Mayo (Clare Island; Castlebar; Broad Lough; Newport River; Inishbofin). **L.**—Westmeath (Shannon). **U.**—Monaghan (Emyvale). Armagh (Armagh, in garden, *Johnson*). Donegal (Fern and Keel Loughs; Largy River). Antrim (Portmore near Lough Neagh).

Distribution.—Common in Britain, ranging to the Shetlands. According to Ulmer, there is probably only one Palaearctic species of this genus. It is widely distributed in northern and central Europe, and apparently ranges to eastern Siberia (*McLachlan*).

***Grammotaulius atomarius** (Fab.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Mote Park, *Halbert*). Sligo (*Johnson*). **L.**—Wicklow (Roundwood, October, *Halbert*). Louth (Castlebellingham! *Thornhill*). **U.**—Monaghan (Emyvale, *Morton*). Armagh (Mullinure, *Johnson*).

Distribution.—Great Britain (ranges from Devonshire to Perthshire at least). Abroad it is found from Lapland to Italy (Naples, *McLachlan*); Iceland.

Glyphotaelius pellucidus (Retz.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Waterford (near Cappoquin). Limerick. **C.**—Mayo (Croft Lough; in plantation near Convent, Westport). **L.**—Wexford (Johnstown Castle grounds). Dublin (Lucan). Westmeath (Waterstown). **U.**—Monaghan (Glaslough). Armagh (Loughgall).

Distribution.—Devonshire to Inverness, and nearly all over Europe except Lapland and Spain (*McLachlan*).

Limnophilus rhombicus (L.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Mote Park). Mayo (Carrowbeg River). Sligo (Markree Castle). **L.**—Wexford (Edenvale). Dublin (Dundrum). Louth (Castlebellingham). **U.**—Armagh. Donegal (near Kilmacrennan; River Lennan).

Distribution.—Great Britain (common, ranging to the Shetlands). Nearly the whole of Europe (Lapland to central Spain), except extreme south, extending into Eastern Siberia, and Turkestan (*McLachlan*).

Limnophilus flavicornis (Fab.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Dinish; Flesk and Deenagh Rivers). **C.**—Mayo (Carrowbeg River, Westport). Sligo (near Sligo). **L.**—Wexford (Johnstown Castle grounds). Wicklow (Altidore). Dublin (Lucan; Santry; &c.). Westmeath (Moate; Bog of Allen). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Acton Glebe; Lough Gilly; &c.).

Distribution.—Great Britain (common and widely spread). Northern and central Europe.

***Limnophilus decipiens** (Kol.).

Ulster.

U.—Monaghan (Glaslough, *Entom. Monthly Mag.*, 1892).

This species was found fairly commonly by Mr. K. J. Morton, at Kelvey Lough, a small, deep lake near the above-mentioned locality.

Distribution.—England (rare, London district, Haslemere, Norwich). Not recorded from Scotland. Widely distributed in Europe, ranging from Finland to the Balkans. Siberia (*McLachlan*).

Limnophilus marmoratus Curt.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Loo Bridge; Ross Castle; Cloghereen; Coppagh Glen; Gap of Dunloe; Kilbrean Lough; Dinish). Waterford (between Cappoquin and Lismore; Cappagh Lough). **C.**—Galway (Salthill; Castlekirk; Cong). Roscommon (Yew Point). Mayo (common in the Westport and Newport districts). Sligo (Rosses Point). **L.**—Wexford (Edenvale; Killurin: Johnstown Castle grounds). King's County (Edenderry). Dublin (Tolka at Glasnevin). Westmeath (Shannon; Killinure; Waterstown). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Churchhill; Mullinure, &c.). Antrim (gas lamps at Belfast). Donegal (Coxtown; Coolmore; common on lakes in the Kilmacrennan district).

Common.

Distribution.—Great Britain (common, Devonshire to Shetlands). Lapland to France; Spain; and central Italy.

Limnophilus stigma Curt.

Munster. Leinster. Ulster.

M.—Kerry (Killarney, *McLachlan*, 1862). **L.**—Westmeath (Waterstown and River Shannon). **U.**—Armagh (Birches).

Distribution.—Widely spread in Great Britain, ranging from Kent to

Inverness-shire. Northern and central Europe, excepting the boreal parts (*McLachlan*).

Limnophilus xanthodes McLach. (*L. borealis* Kol. *nec* Zett.).

MUNSTER. ULSTER.

M.—Kerry (*L. borealis*, taken by Birchall, *McLachlan* in *Entom. Annual*, 1864). Monaghan (Glaslough, not common, *Morton*). Fermanagh (*L. borealis*, near Enniskillen, *McLachlan*, *Entom. Annual*, 1862). Armagh (Lowry's Lough and Camlough, *Johnson*).

Distribution.—Great Britain (local and not uncommon in the fens of the east, *McLachlan*; extending northwards to Dumfries, *Morton*). Northern and central Europe. Finland; Sweden; Russia; Germany; Austria; Hungary; &c.

Limnophilus lunatus Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Cloghereen; Glena; Horse's Glen; Deenagh River). Waterford (Dromana and Cappoquin). **C.**—Roscommon (Yew Point). Mayo (Doogan, Small and Ballin Loughs; Newport and Carrowbeg Rivers). Galway (Castlekirk; near Maam; Clonbrock). **L.**—Wicklow (Roundwood). Dublin (Tolka at Glasnevin; Lucan). Westmeath (Shannon; Coosan; Twy River; Lough Ree). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Churchhill, Lough Gilly, &c.). Antrim (gas lamps at Belfast). Donegal (Coolmore; Ardara). Common.

Distribution.—In Great Britain this species is found from Devonshire to North Shetland. Spread over most of Europe (except the Spanish peninsula); Finland; North Persia; Asia Minor.

Limnophilus politus McLach.

MUNSTER.

M.—Kerry (Killarney, *McLachlan*, *Trans. Entom. Soc.*, p. 38, *London*, 1865). Apparently rare, and has not been recently met with in Ireland.

Distribution.—Great Britain (very local, extending as far north as the Clyde district). Occurs over a great part of Europe (except Spain), and northern Asia.

***Limnophilus fuscinervis** Zett.

CONNAUGHT.

C.—Mayo (Castlebar Lough, June 17th, 1909, coll. *Halbert*, see *Morton* in *Entom. Monthly Mag.* (2) xx., p. 233, 1909).

The first British specimen of this interesting species was captured at Castlebar Lough on a recent expedition, organized by Mr. R. Ll. Praeger, to investigate the fauna and flora of Clare Island and the surrounding district. It was found on the south shore of the lake, which is also called Lough Lannough, at its eastern extremity, not far from the town of Castlebar.

Distribution.—Great Britain (range unknown).

As pointed out by Mr. K. J. Morton, the distribution of *L. fuscinervis* is northern and south-eastern. It has been recorded by Mr. McLachlan from Lapland, Finland, Sweden, Lithuania (Minsk), Germany (where it is evidently widely spread), Sarepta. A variety *solutus*, McLach., is recorded from Sarepta and Persia ("Trichoptera of the European Fauna"). Denmark (*Petersen*).

Limnophilus ignavus (Hagen) McLach.

Munster. Connaught. Leinster.

M.—Waterford (Cappoquin). **C.**—Mayo (Ballin and Mount Brown Loughs; Carrowbeg River). **L.**—Wexford (Edenvale and Rosslare). Westmeath (Waterstown and Shannon near Athlone).

Distribution.—Great Britain ("very rare in the north," *McLachlan*; ranges from north Shetland as far south as Hereford at least). Northern and central Europe, from Finland to Switzerland.

***Limnophilus nigriceps** (Zett.).

Ulster.

U.—Armagh (Lowry's Lough, *Johnson*).

Several specimens of this rare species were collected during the month of September at Lowry's Lough (*McLachlan, Entom. Monthly Mag.*, xxix., 1893, p. 287).

Distribution.—Great Britain (local; north of England, Edinburgh, and Glasgow districts to Perthshire). Northern and central Europe. Lapland; Vienna; &c; Turkestan. According to Morton, this is a local species both in Great Britain and on the Continent.

Limnophilus centralis Curt.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Killarney; Ross Castle; Gap of Dunloe; Glencar). Cork (Glandore). Waterford (Glenshelane). **C.**—Galway (near Maam). Mayo (Mount Brown Lough and Carrowbeg River). **L.**—Kilkenny. Wexford (Edenvale; banks of Slaney near Wexford). Dublin (Howth). **U.**—Armagh (Mullinure). Donegal (Clonkillybeg; Loughs Akiboon, Fern, and Keel).

Distribution.—Great Britain (common, Devonshire to Inverness). Isle of Man. Probably generally distributed in Europe (*McLachlan*). Not included by Navás in the Spanish fauna (1908).

Limnophilus vittatus (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Ardagh Lough; Deenagh River). Waterford (Cappoquin and Glenshelane). **C.**—Galway (Castlekirk; Ballinasloe; Tuam; Cong). Roscommon (Yew Point). Mayo (Mount Brown and Kip Loughs). **L.**—Wexford (Johnstown Castle grounds). Wicklow (Roundwood and Enniskerry). Dublin (Rush; Tolka at Glasnevin). Westmeath (Shannon; Bog of Allen; Moate). **U.**—Monaghan (Emyvale). Armagh (Mullinure). Donegal (Lough Fern).

Distribution.—Great Britain (Devonshire to North Shetland). Common throughout Europe, extending from Sicily and Spain to Lapland. Asia Minor.

Limnophilus affinis Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Boreen-a-Morave; Deenagh River). Waterford (Dromana). **C.**—Galway (Ballinasloe). Roscommon (Yew Point). Mayo (Ballin Lough). **L.**—Wexford (Edenvale; Rosslare; Johnstown Castle grounds; Slaney near Killurin). Westmeath (Shannon; Coosan; Hare Island in Lough Ree). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Lowry's Lough, &c.). Donegal (River Lennan; Lough Keel; Largy River; Coolmore).

Distribution.—Common in Britain from Devonshire to North Shetland. Abroad it is widely spread, occurring in Iceland, Finland, and other parts of Europe; Amur Land; north Persia; Madeira; &c.

According to McLachlan, this is probably the most widely distributed of the Palaearctic Caddis-flies.

Limnophilus auricula Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney district). Waterford (Dromana and near Cappoquin). **C.**—Galway (Salthill; Maam; Cong; Ballinasloe; Castlekirk). Mayo (Mount Brown, Kip, and Cogaula Loughs; Carrowbeg River). Sligo (Markree Castle). **L.**—Wexford (Rosslare; Johnstown Castle grounds). Wicklow (Lough Dan and Enniskerry). Dublin (Donabate). Westmeath (common in the Athlone district). Louth (Dundalk). **U.**—Monaghan (Emyvale and Glaslough). Armagh (Churchhill; Lough Gilly; Lough Gall; &c.). Donegal (Coxtown).

Distribution.—Ranges in Great Britain from Devonshire to the Shetlands. Occurs also in the Isle of Man. Common in northern and central Europe. Spain (*Navás*).

Limnophilus griseus (L.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Galway (near Maam; Ballinasloe). Mayo (Kip Lough and Carrowbeg River). Sligo (Markree Castle). **L.**—Westmeath (Coosan; Bog of Allen). **U.**—Donegal (Cloghan; Cottian; Gorteen, Muethin, and Keel Loughs).

Distribution.—Great Britain (Devon to north Shetlands). Isle of Man. Jersey. Probably occurs in most parts of Europe from Lapland to the Caucasus (not recorded from Spain); Iceland; Färöes; &c. Also in Siberia (*McLachlan*).

Limnophilus extricatus McLach.

CONNAUGHT. LEINSTER. ULSTER.

C.—Roscommon (Summerhill). L.—Westmeath (Bog of Allen). **U.**—Donegal (Lough Akiboon).

Distribution.—Great Britain (ranges from the south of England to Inverness). Northern and central Europe.

Limnophilus hirsutus (Pict.).

CONNAUGHT. LEINSTER. ULSTER.

C.—Mayo (Knappagh Lough and Carrowbeg River). L.—Dublin. Westmeath (Shannon and Coosan Point). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Coxtown; Lough Keel; near Kilmacrennan).

Distribution.—Great Britain (south of England to Inverness). Guernsey; Holland; Switzerland; Germany; France; Spain.

Limnophilus luridus Curt.

CONNAUGHT. LEINSTER. ULSTER.

C.—Sligo (Markree Castle). **L.**—Westmeath (Shannon; Coosan). **U.**—Donegal (Lough Keel; River Lennan; Cottian; Clonkillybeg).

Distribution.—Great Britain (local; Hampshire to Perthshire at least). Finland; Holland; Belgium; Germany (Hamburg, *Ulmer*).

Limnophilus sparsus Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney district; Kenmare). Cork (Ballygriffin woods; Glandore). Waterford (Dromana; Cappagh Lough). **C.**—Galway (Salthill; Cong; Ballinasloe). Mayo (common in the Westport and Newport districts). Sligo (Markree). **L.**—Wexford (Johnstown Castle grounds). Wicklow (Roundwood and Enniskerry). Dublin (Donabate; River Dodder near Tallaght; Harold's Cross; brackish pond at Sutton).

Westmeath (Shannon; Killinure; Twy River; Waterstown). **U.**—Monaghan (Emyvale). Armagh (Lough Gilly; Acton). Donegal (Coolmore; Bruckless).

Distribution.—Abundant in Great Britain, ranging from Devonshire to the Shetlands and Hebrides. Isle of Man. Northern and central Europe; Spain; Färöes.

***Anabolia nervosa** (Leach) Curt.

LEINSTER. ULSTER.

L.—Wicklow (Roundwood, *Halbert*). Dublin (River Tolka near Dublin, *Halbert*; Harold's Cross, *Carpenter*). Louth (Castlebellingham, *Thornhill*). **U.**—Armagh (near Armagh; Lowry's Lough; Tynan; and Maghery, *Johnson*).

Distribution.—Widely spread in Great Britain (New Forest, Strathglass, &c.). Recorded as generally abundant in western Europe.

Stenophyllax stellatus (Curt.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Cloghereen; The Glen in Deer Park). Tipperary (Cahir). **C.**—Sligo (near Sligo). **L.**—Dublin (Lucan). **U.**—Donegal (Coolmore; Dunleury; Gweedore; Lough Keel).

Distribution.—Great Britain (Devonshire, Inverness, &c.). Widely spread over Europe (except Spain), and probably more abundant in the north, extending from Lapland to north-western Siberia (*McLachlan*).

Stenophylax latipennis (Curt.) (*S. radiatus* Ramb.).

LEINSTER.

L.—Louth (Carlingford).

Distribution.—In Great Britain this species extends from Devonshire to the Shetlands. Abroad it is found from Lapland (*Sahlberg*) to Italy and Spain.

Stenophylax permistus McLach. (*S. concentricus* McLach., *nec* Zett.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Clare (Lahinch). **C.**—Sligo (near Sligo). **L.**—Dublin (Sandymount, flying to light in houses; Portmarnock; Rathmines). Westmeath (Killucan). **U.**—Armagh (Armagh). Antrim (gas lamps at Belfast).

Distribution.—Common in Great Britain (Devonshire to the Shetlands). Probably spread all over Europe, ranging from Lapland to Spain).

Micropterna sequax McLach. (*M. striata* Pict. *nec* Linn.).

LEINSTER. ULSTER.

L.—Dublin (Dodder banks between Templeogue and Tallaght). **U.**—Tyrone (Favour Royal). Armagh. Donegal (Coolmore).

Distribution.—Great Britain (not common, but ranging from Devon to Inverness). Jersey; Finland; Sweden; France; Germany; Switzerland (*Ris*); Austria; south Russia; Corsica.

Micropterna lateralis (Steph.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Torc Cascade). **C.**—Roscommon (Mote Park). Sligo (near Sligo and Keshcorran). **L.**—Kilkenny (Johnstown, *Haliday* MS.). Dublin (Howth). Westmeath (Shannon). **U.**—Tyrone (Favour Royal and Altadiawan). Armagh (Mullinure and Scarva). Donegal (near Kilmacrennan; Coolmore).

Distribution.—Great Britain (widely distributed, New Forest to Unst). Northern and central Europe.

Halesus radiatus (Curt.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Cloghereen; Horse's Glen). **C.**—Galway (Maam River). **L.**—Wicklow (Roundwood and Lough Dan). Dublin (Howth). Louth (Drogheda).

Distribution.—Great Britain (Devonshire to Shetlands). Jersey; northern and central Europe; Spain.

Drusus annulatus Steph.

CONNAUGHT.

C.—Galway (Castlekirk).

Distribution.—According to McLachlan, this is an alpine species inhabiting clear torrents in rocky and mountainous districts. It is widely spread in Britain, having been found in Devonshire and in the Shetlands. Abroad it would appear to be local, occurring in Germany (Schwarzwald, Harz, Riesengebirge, &c. *Ulmer*); Belgium; France.

***Chaetopteryx villosa** (Fab.) (*C. tuberculosa* Pict.).

MUNSTER. LEINSTER. ULSTER.

M.—Cork (Carrigrohane! *Standen*). **L.**—Kilkenny ("Dec. 1, Johnstown," *Haliday* MS.). Wicklow (Roundwood and Lough Dan, October, *Halbert*). **U.**—Antrim (lakes at Fair Head, September, *Halbert*).

A late autumn species, which has probably been overlooked in many localities.

Distribution.—Great Britain (south of England to Perthshire and Inverness); Russian Lapland; Finland; Scandinavia; western Russia; Germany; Austria; Belgium; Switzerland; France.

***Apatania Wallengreni** McLach. (*A. vestita* Kol.).

Ulster.

U.—Donegal (Cottian, females probably referable to this species, *King*).

Distribution.—Great Britain (English Lake District to Perthshire at least). Lapland; Finland. Ulmer does not include this species amongst the German Trichoptera (Die Süsswasserfauna Deutschlands, 1909).

Apatania fimbriata (Pict.).

Munster.

M.—Kerry (Windy Gap near Kenmare; lakes in the Gap of Dunloe; Coppagh Glen; Garagarry Lough).

Writing of the occurrence of this species in the Gap of Dunloe, where it was first discovered in the British Isles Mr. Morton says: "In Ireland it occurred at spots where the margins of the lakes were lined with huge blocks of rock, and we took it at rest on or flying amongst the rocks, and by sweeping the herbage on the banks. Usually at such places the only aquatic vegetation was a scattered growth of the pretty *Lobelia Dortmanna*" (*Entom. Monthly Mag.*, xxiv., 1887, p. 118).

Distribution.—This species is unknown in Great Britain. Abroad it inhabits the mountain regions of central Europe (*McLachlan*); Germany (Harz, Thüringen, &c.); France (Chamounix; Savoy; Haute Loire); Austria (Sudetic Chain; Carinthia; &c.); and probably other localities.

SERICOSTOMATIDAE.

Sericostoma personatum (Spence).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Owenreagh River; Muckross; Clogherreen; Gap of Dunloe; Parknasilla). Waterford (Cappoquin). **C.**—Galway (Cong). Mayo (Mount Brown; Cogaula and Knappagh Loughs; Carrowbeg River). **L.**—Wexford (Forth Mountains). Wicklow (Enniskerry). Dublin (River Dodder [illegible]; Templeogue and Tallaght). Westmeath (Shannon; Coosan). **U.**—Monaghan (Glaslough). Donegal (Coxtown; Keel, Sproule's, and Fern Loughs; Glenbeagh). Armagh (Coney Island in Lough Neagh).

Distribution.—Great Britain (common, Devon to Inverness). Isle of Man. Northern and central Europe.

Goëra pilosa (Fab.) (*G. flavipes* Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; River Flesk). Cork (Mallow). Waterford (Lismore). **C.**—Galway (Castlekirk). Roscommon (Yew Point). Mayo (Doo, Cushinsheeaun, Mount Brown and Kip Loughs; Carrowbeg River). Sligo (near Sligo). **L.**—Wexford (Edenvale). Wicklow (Calary). Westmeath (Coosan Point; Shannon; near Athlone; &c.). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Coolmore; Fern and Irvine's Loughs; Clonkillybeg). Armagh (Coney Island in Lough Neagh).

Distribution.—Great Britain (Devonshire, to the south of Scotland). Northern and central Europe.

Silo pallipes (Fab.).

MUNSTER. LEINSTER. ULSTER.

M.—Kerry (Devil's Punch-bowl; Muckross; Deenagh and Flesk Rivers; Torc; Kenmare; Loo Bridge). Cork (Glandore). Waterford (Glenshelane and Dromana). **L.**—Wexford (Edenvale). Wicklow (Enniskerry and Fassaroe). Dublin (River Dodder at Templeogue). **U.**—Armagh (near Armagh). Donegal (Ardara; Loughs Salt and Reelan; Lennan Bridge). Antrim (Colin Glen).

Distribution.—Great Britain (common; Devon and Kent to Inverness). Generally distributed in Europe from Lapland to western Russia, and France. Not recorded from Spain or Portugal.

Silo nigricornis (Pict.) (*S. fumipennis* McLach.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Deenagh and Flesk Rivers; Dinish). **C.**—Mayo (Mount Brown Lough and Carrowbeg River). **L.**—Dublin (River Dodder at Templeogue). Westmeath (Ballykeeran and Killinure).

Distribution.—Britain (local in the south, *McLachlan*). Germany; Austria; Switzerland; Holland; Belgium; France (Basses Pyrénées, &c.).

Crunoecia irrorata (Curt.).

MUNSTER. LEINSTER. ULSTER.

M.—Kerry (Torc Cascade). Waterford (Dromana and Cappoquin). **L.**—Wexford (Edenvale). **U.**—Donegal (Sproule's Lough). Antrim (Colin Glen).

Distribution.—Great Britain (Devon to Inverness). Germany; Switzerland; France (Pyrenees, &c.) Transylvania, to the Carpathians.

Lepidostoma hirtum (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Dinish; Cloghereen; Deenagh River, &c.). Waterford (Lismore; Salterbridge; and Cappoquin). **C.**—Galway (Maumwee Lough and Castlekirk). Roscommon (Yew Point; Summerhill).

Mayo (Carrowbeg River). Sligo (near Sligo). **L.**—Westmeath (Shannon; Coosan; Wineport; Waterstown). **U.** — Donegal (Dunleury Lough; Lennan Bridge; Cottian; Gweedore). Antrim (Cave Hill near Belfast; Shane's Castle, Lough Neagh).

Distribution.—Great Britain (Devon to Shetlands). Probably all over Europe as far north as Lapland; Spain (*Navás*).

LEPTOCERIDAE.

Beraea pullata (Curt.).

Connaught. Leinster. Ulster.

C.—Mayo (Carrowbeg River). **L.**—Wexford (Johnstown Castle grounds; Edenvale). Dublin (marshy places on Lambay Island). **U.**—Armagh (Lough Gilly and Mullinure).

Distribution.—Great Britain (Devonshire; Yorkshire; North Wales; Glasgow district; &c.). Isle of Man. Widely spread in western Europe (Norway to Portugal).

Beraea maurus (Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (near Kenmare: Ardagh: Cloghereen: Dinish: Tore). Cork (Glandore). **C.**—Mayo (Carrowbeg River and Knappagh Lough). **L.**—Wexford (Kilinrin and Edenvale). **U.**—Antrim (Cave Hill near Belfast).

Distribution.—Great Britain (Devon to Inverness). Scandinavia (not in Lapland) to Spain and northern Italy.

Molanna palpata McLach.

Leinster. Ulster.

L.—Westmeath (occurs in considerable numbers along the Shannon between Athlone and Lough Ree, *King*). **U.**—Armagh (Lowry's Lough near Armagh, in June, *Johnson*).

The occurrence of this species on the River Shannon is worthy of note. In Scotland it frequents peaty lakes.

Distribution.—Great Britain (Perthshire; Inverness; West Hebrides). Northern Lapland; Finland (*Sahlberg*); Russia; Siberia (district of the Yenisei, *Sahlberg*). Not included by Ulmer in the German fauna (1909).

Odontocerum albicorne (Scop.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Killarney, *Hope*: Deenagh River: Horse's Glen). Waterford (Glenshelane and Cappoquin). **C.**—Mayo (Mount Brown and Cogaula

Loughs). **L.**—Wexford (Edenvale). **U.**—Donegal (Clonkillybeg; Loughs Reelan and Gorteen; River Lennan; Glenbeagh; Cottian).

Distribution.—Great Britain (locally common, Devon to Inverness). Isle of Man. Recorded from many localities in central and southern Europe.

Leptocerus nigro-nervosus (Retz).

MUNSTER. ULSTER.

M.—Kerry (Ross Castle and Garagarry Lough). **U.**—Donegal (Salt and Gorteen Loughs).

Distribution.—Great Britain (widely spread; Thames; Rannoch; Outer Hebrides; &c.). Northern and central Europe, reaching Lapland.

Leptocerus fulvus (Ramb.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Cloghereen; Deenagh River; Gap of Dunloe; Garagarry Lough). **C.**—Galway (Castlekirk and Maumwee). Roscommon (Yew Point). Mayo (Prospect Lough and Carrowbeg River). **L.**—Westmeath (Shannon; Coosan; Hare Island). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Loughs Fern and Sproule).

Distribution.—Great Britain (south of England to the Shetlands). Russian Lapland to central Europe; Siberia.

Leptocerus senilis (Burm.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Coppagh Glen). Cork (Glandore). **C.**—Galway (Castlekirk). Mayo (Knappagh and Prospect Loughs; Newport River). **L.**—Westmeath (Shannon; Coosan; Twy River). **U.**—Donegal (Coolmore; Loughs Fern and Sproule; Clonkillybeg).

Distribution.—Great Britain (south of England to Wigtownshire). Finland; Russia; Germany; Belgium; Holland; France; Siberia.

Leptocerus albo-guttatus Hagen.

CONNAUGHT. LEINSTER. ULSTER.

C.—Mayo (Knappabeg Lough). **L.**—Kilkenny. Westmeath (on the Shannon below Athlone). **U.**—Monaghan (Emyvale). Donegal (Lennan Bridge; Lough Fern; Cottian).

Distribution.—Great Britain (Hants to Inverness, at least). Germany; Holland; Belgium; France; Portugal.

Leptocerus annulicornis Steph.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Windy Gap). **C.**—Roscommon (Shannon near Athlone). **L.**—Westmeath (Shannon near Athlone). **U.**—Donegal (Gorteen and Fern Loughs; Lennan River).

Distribution.—Great Britain (south of England to Perthshire at least). Finland; Germany; Saxony; Holland; Bohemia).

Leptocerus aterrimus Steph.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Coppagh Glen; Ardagh Lough; Muckross). Waterford (Cappagh Lough). **C.**—Roscommon (Yew Point and Summerhill). Mayo (common in the Westport and Newport districts). **L.**—Wexford (Rosslare; Edenvale; Johnstown Castle grounds). Westmeath (Shannon; Coosan; Wineport; Twy Lough). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Lowry's Lough near Armagh). Donegal (common in the Kilmacrennan district).

Distribution.—Great Britain (south of England to Inverness). Widely spread in Europe, ranging to Finland. Not recorded from Spain or Portugal.

Leptocerus cinereus Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney and Muckross districts; Devil's Punch-bowl; Gap of Dunloe, &c.). Cork (Mallow). Waterford (Lismore; Dromana; Cappoquin; Glenshelane). **C.**—Galway (Castlekirk; Maumwee Lough). Roscommon (Yew Point). Mayo (common on various loughs in the Westport and Newport districts). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Milford; Lowry's Lough; Coney Island, &c.). Donegal (Coolmore; common in the Kilmacrennan district; Loughs Keel, Gorteen, &c.).

Distribution.—Great Britain (Cornwall to north Shetlands). Finland to Portugal, and eastwards to Russia.

Leptocerus albifrons (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deer Park; Deenagh River; Coppagh Glen; Gap of Dunloe; Dinish). Cork (Mallow). Waterford (Dromana and Cappoquin). **C.**—Galway (Castlekirk; Lough Corrib; Maam). Roscommon (Yew Point and Summerhill). Mayo (Mount Brown and Knappabeg Loughs;

Newport River). **L.**—Dublin (Lucan demesne). Westmeath (Waterstown: Coosan Point; Hare Island; Ballykeeran). **U.**—Monaghan (Glaslough). Donegal (Lennan Bridge).

Distribution.—Great Britain (Devon to Inverness). Northern and central Europe.

Leptocerus commutatus (Rostock) McLach.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney district; near Kenmare; Loo Bridge). **C.**—Galway (Castlekirk). **L.**—Dublin (Lucan demesne). Westmeath (Glasson and Coosan Point). **U.**—Monaghan (Emyvale). Donegal (Ardara; Lennan Bridge; Lough Fern; Cottian).

Distribution.—Great Britain (Devonshire to Perthshire). Finland; Germany; Saxony; Belgium; France.

Leptocerus bilineatus (L.).

LEINSTER.

L.—Dublin (Lucan). Westmeath (Shannon).

Distribution.—Great Britain (local; Devon to Inverness). Lapland; Germany; France; Austria; Switzerland; Russia; Turkestan.

Leptocerus dissimilis Steph.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Devil's Punch-bowl; Deenagh River; Glena; &c.). **C.**—Galway (Castlekirk). Roscommon (Yew Point). Mayo (Carrowbeg River). **L.**—Dublin (Lucan). Westmeath (Shannon side; Coosan Point; Waterstown demesne; Wineport). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Gorteen, Reelan, and Fern Loughs; Glenbeagh; Lennan River; Cottian).

Distribution.—Great Britain (Devon to Inverness). Finland; Sweden; Russia; Germany; France.

Mystacides nigra (L.).

ULSTER.

U.—Monaghan (Glaslough). Down (River Lagan).

Distribution.—Great Britain (south of England to Inverness). Probably all over Europe, ranging from Lapland to Spain.

Mystacides azurea (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney district; Loo Bridge, &c.). Cork

(Glandore and Mallow). **C.**—Galway (Castlekirk and Maumwee Lough). Mayo (common in the Westport and Newport districts). **L.**—Wexford (Johnstown Castle grounds; Edenvale). Dublin (Lucan demesne; Tolka at Glasnevin). Westmeath (Coosan Point). **U.**—Monaghan (Glaslough). Armagh (Coney Island and Maghery, Lough Neagh). Donegal (Ardara; Kilmacrennan district, common).

Distribution.—Great Britain (Devonshire to the Shetlands). Widely distributed in western Europe; Lapland to Spain.

Mystacides longicornis (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle). Cork (Glandore). Waterford (Cappagh Lough). **C.**—Roscommon (Summerhill). Mayo (Westport and Newport districts). **L.**—Westmeath (Shannon; Coosan Point; Twy Lough; Bog of Allen; Deravaragh). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Loughs Fern and Keel). Armagh. Antrim (Portmore Lough, *Haliday* MS.).

Distribution.—Great Britain (Devon to Inverness). Northern and central Europe.

***Triaenodes conspersa** (Ramb.).

LEINSTER.

L.—Wexford (Rosslare, *King*).

Distribution.—England (rare; has been found in the counties of Devon, Hants, and Worcester, *Morton*). Finland; Sweden; Germany; Saxony; France; Spain; Sicily.

Triaenodes bicolor (Curt.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Ardagh Lough; Windy Gap). Cork (Glandore). Waterford (Cappagh Lough). **C.**—Galway (Castlekirk, Maumwee Lough). Mayo (Westport and Newport districts, common). **L.**—Wexford (Johnstown Castle grounds). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Sproule's and Askerry Loughs; Lennan River; Glenbeagh). Armagh (near Armagh; Coney Island in Lough Neagh).

Distribution.—Great Britain (Devon to Inverness). General over northern and central Europe.

***Adicella reducta** (Steph.) McLach.

MUNSTER.

M.—Kerry (Killarney, *Eaton*). Cork (Glandore, *Halbert*). Waterford (Blackwater near Lismore, *Halbert*).

Collected by Rev. A. E. Eaton in the Killarney district, June 12, 1902, and recorded by Mr. McLachlan (*Entom. Monthly Mag.*, 1903, p. 14).

Distribution.—Great Britain (small rivers and streams, especially in the south, *McLachlan*; Cornwall to Kent; North Wales and Perthshire, &c.). Abroad it is found in Germany (*Ulmer*); Saxony; Switzerland; France; Spain; Portugal. Ranges eastwards to the Carpathians (*Morton*).

Oecetis ochracea (Curt.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Ardagh Lough; Deenagh River). Cork (Glandore). **C.**—Galway (Cong). Roscommon (Yew Point). Mayo (Knappagh, Ballin and Kip Loughs). **L.**—Westmeath (Shannon; Coosan Point; Wineport; Waterstown; Bog of Allen). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Lowry's Lough, &c.). Donegal (Loughs Fern, Gorteen, and Reelan; Clonkillybeg).

Distribution.—Great Britain (south of England to the Shetlands). Northern and central Europe.

Oecetis furva (Ramb.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Dinish; Ardagh Lough; Gap of Dunloe). **C.**—Galway (Castlekirk and Maumwee Lough). Mayo (Doogan, Broad, Knappagh, and Prospect Loughs; Bleachyard). **L.**—Westmeath (Coosan; Killinure; Waterstown demesne). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Sproule's Lough).

Distribution.—Great Britain (south of England to Wigtownshire at least). Finland; Germany; Holland; Switzerland (*Ris*); France.

Oecetis lacustris (Pict.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Torc Cascade; Ardagh Lough; Horse's Glen). **C.**—Galway (Castlekirk). Roscommon (Yew Point). Mayo (Doogan, Prospect, and Knappagh Loughs). **L.**—Wexford (Johnstown Castle grounds). Westport (Shannon; Coosan Point; Wineport; Hare Island).

Distribution.—Great Britain (occurs as far north as Strathglass). Probably over most of Europe (not in Spain). Extending into N.-W. Siberia.

Oecetis notata (Ramb.).

MUNSTER. LEINSTER.

M.—Waterford (near Lismore). **L.**—Dublin (Lucan demesne).

Distribution.—Great Britain (Surrey to Inverness). Finland to Germany (Schlesien and Saxony); France; and Austria.

Oecetis testacea (Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle; Flesk and Deenagh Rivers; Muckross; Dinish; Torc; Cloghereen). **C.**—Mayo (Mount Brown Lough). **L.**—Wexford (Edenvale and Killurin). Wicklow (Enniskerry). Westmeath (Shannon; Killinure; Twy Lough; Waterstown). **U.**—Donegal (Keel, Gorteen, and Akibbon Loughs; Cottian; Glenbeagh; Clonkillybeg; Lennan Bridge).

Distribution.—Great Britain (south of England to Inverness). Finland (rare); Sweden; Holland; Germany; Saxony; Switzerland; France (Pyrenees); Portugal.

Setodes argentipunctella McLach.

Munster.

M.—Kerry (Muckross Abbey and Ross Castle).

This local species was captured by the Rev. A. E. Eaton, on the 18th of August, not far from the Abbey at Muckross. He reports it as swarming up in great quantities from the lake (*Entom. Monthly Mag.*, 1877). It also occurs in great profusion at Ross Castle.

Distribution.—Great Britain (occurs in the English Lake District and in Wigtownshire). Abroad this local species has recently been found in Belgium; south-western Germany (Hesse, *Ulmer*); Switzerland (*Ris*), and Navás records it from Fuencaliente in southern Spain (1908).

HYDROPSYCHIDAE.

Hydropsyche pellucidula (Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Cloghereen and Deenagh River). **C.**—Galway (Salthill), **L.**—Westmeath (Shannon). **U.**—Donegal (Reelan, Gorteen, Sproule's, and Irvine's Loughs; Lennan and Largy Rivers; Cottian).

Distribution.—Great Britain (Devonshire to Rannoch at least). Found all over Europe, Lapland to the Mediterranean Islands; Asia Minor.

Hydropsyche instabilis (Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Deenagh River; Cloghereen; Torc Cascade; Horse's Glen; Gap of Dunloe; &c.). **C.**—Galway (Lough Corrib near Galway; Cong; Maam River). Mayo (Mount Brown, Croft, Carrowbeg, Brocka, and Cogaula

Loughs; Carrowbeg River). **L.**—Kilkenny. King's County (Edenderry). Wicklow (Enniskerry). Dublin (Lucan; River Dodder between Templeogue and Tallaght). Westmeath (Shannon and Ballykeeran). Louth (Carlingford). **U.**—Monaghan (Emyvale). Donegal (Bundoran; Ardara; Cottian; Lennan Bridge; Lough Reelan; &c.).

Distribution.—Great Britain (Devonshire to Strathglass). Isle of Man. Widespread, ranging from Finland to the Pyrenees, Portugal, and central Italy.

Hydropsyche angustipennis (Curt.).

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (near Kenmare). Waterford (near Lismore). **C.**—Mayo (Mount Brown and Knappagh Loughs). **L.**—Westmeath (Twy River).

Distribution.—Great Britain (Devonshire to the Clyde district). Found in Finland and over most of Europe, but not recorded from Spain.

Hydropsyche guttata (Pict.).

MUNSTER. LEINSTER.

M.—Cork (Mallow). **L.**—Westmeath (Shannon).

Distribution.—Great Britain (Devonshire to Perthshire). Widespread in Europe.

Hydropsyche lepida (Pict.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney and Muckross districts). Cork (Mallow). Waterford (Lismore and Cappoquin). **C.**—Galway (Cong; Lough Corrib near Galway). **L.**—Wexford (Edenvale). Dublin (Lucan). Westmeath (Shannon). **U.**—Donegal (Lennan Bridge).

Distribution.—Great Britain (Devonshire to Lanarkshire at least). Probably in most of Europe, except the south of Italy, Greece, and the Mediterranean Islands (*McLachlan*).

Diplectrona felix (McLach).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Torc; Horse's Glen; Coppagh Glen; Gap of Dunloe). **C.**—Galway (Maam River). **L.**—Wicklow (Enniskerry). **U.**—Antrim (Cave Hill). Donegal (Lough Reelan).

Distribution.—Great Britain (Cornwall to Inverness). Germany; Saxony; Guernsey; France; Iberian Peninsula; central Italy.

Philopotamus montanus (Donov.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Devil's Punch-bowl; Tore Cascade; Horse's Glen; the Glen in Deer Park; Gap of Dunloe; Kenmare). Waterford (Salterbridge near Cappoquin; Glenshelane). **C.**—Galway (Castlekirk; Maam River; Clonbrock). Mayo (Clare Island; streams on Croagh Patrick; Carrowbeg River; Inishbofin). **L.**—Wexford. Wicklow (Enniskerry). Dublin (Howth and Tibradden). **U.**—Donegal (Ardara; Loughs Reelan and Salt). Antrim (Colin Glen).

Distribution.—Great Britain (in suitable localities from Cornwall to the Shetlands; St. Kilda). Isle of Man. Lapland to Spain, and northern Italy.

Var. **scoticus** McLach.

MUNSTER.

M.—Kerry (Killarney, *Hardy*; stream at Cloghereen, *King*).

Occurs in large numbers along the banks of a swiftly-flowing stream and a small spring in this locality, the waters of both being very cold even during August. No example of the type form could be found in this locality, although it was common on almost every stream in the district.

Distribution.—This well-marked variety has occurred at Rannoch in Scotland, and in north Wales, as well as at Killarney.

Wormaldia occipitalis (Pict.).

MUNSTER. CONNAUGHT. ULSTER.

M.—Kerry (Tore Cascade; Cloghereen; Horse's Glen; Gap of Dunloe; Dinish). Cork (Glandore). **C.**—Mayo (Clare Island; Carrowbeg River in Westport demesne). **U.**—Donegal (Clonkillybeg; Coxtown).

Distribution.—Great Britain (ranges from Cornwall to Inverness; not uncommon, especially in the north and west of England, *McLachlan*). Germany (East Prussia; Black Forest; &c., *Ulmer*; Saxony). Austria; Switzerland; Guernsey; France; Spain; and Greece.

Wormaldia mediana McLach.

LEINSTER.

L.—Wicklow (Enniskerry, *King*).

Distribution.—In Great Britain this species has been found at Pitlochry in Perthshire and at Strathglass in Inverness. Abroad it inhabits parts of central and southern Europe—Hungary; central Italy; Portugal; and Sicily. Ulmer does not include it in the German fauna (1909).

Wormaldia subnigra McLach.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Cloghereen; Torc Cascade; Gap of Dunloe). Waterford (Glenshelane; Salterbridge near Cappoquin). **C.**—Galway (Maam River). Mayo (Croft Lough; Carrowbeg River). **L.**—Wexford (Edenvale). Dublin (Lucan demesne). **U.**—Donegal (Clonkillybeg).

Distribution.—Great Britain (Devonshire and Surrey to Inverness). Isle of Man. Abroad it is found in Finland; Sweden; Denmark (*Petersen*); Germany (*Ulmer*); Switzerland; Saxony; Austria; and Holland.

Chimarrha marginata (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Flesk River; Gap of Dunloe; Dinish). Waterford (River Blackwater near Lismore). **C.**—Galway (*Haliday* MS.; Lough Corrib, near Galway). Mayo (Carrowbeg and Newport Rivers). **L.**—Wexford (Edenvale). Dublin (Lucan demesne). **U.**—Donegal (Bundoran; Ardara; River Lennan; Cottian). "Ireland, amongst waterfalls" (*Hagen, Entom. Annual*, 1860).

Common in suitable localities.

Distribution.—Great Britain (Devonshire to Inverness at least). Northern and central Europe, extending from Finland to Portugal.

Neureclipsis bimaculata (L.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Killarney; Horse's Glen; Dinish; Gap of Dunloe). Cork (lakes near Glandore). **C.**—Galway (Lough Corrib at Galway; Shannon near Athlone). Mayo (Knappagh and Mount Brown Loughs). **L.**—Dublin (abundant, *McLachlan*). Westmeath (Coosan Point and Twy Lough). **U.**—Donegal (Gorteen Lough).

Distribution.—Great Britain (McLachlan reports this as a common species, but there are few records. It ranges north at least to Perthshire). Widely distributed in Europe, extending to Lapland. Also occurs in western Siberia and North America (Hudson's Bay, Slave Lake). Only the one species of *Neureclipsis* has been described up to the present time.

Plectrocnemia conspersa Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Cloghereen; Devil's Punch-bowl). **C.**—Mayo (Clare Island; Carrowbeg River). Sligo (near Sligo; Lough Gill). **L.**—Westmeath

(Ballykeeran: Shannon near Athlone; Waterstown). **U.** — Donegal (Coolmore: Lough Reelan: Glenbeagh). Armagh (Armagh district; Poyntzpass).

Distribution.—Great Britain (Devon to north Shetlands). Isle of Man. Widely distributed in Europe from Russian Lapland to the Färöes: Spain: Corsica; &c.

Plectrocnemia geniculata McLach.

MUNSTER. ULSTER.

M.—Kerry (Horse's Glen). **U.**—Donegal (Lough Reelan). Armagh.

Distribution.—Great Britain (local; Cornwall to Rannoch. St. Kilda). Isle of Man. Guernsey; Switzerland; Belgium; Germany; France; Austria; Spain; Northern Italy; Corsica.

Polycentropus flavomaculatus (Pict.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney and Muckross districts; Devil's Punch-bowl; Kenmare; &c.) Waterford (Cappoquin). **C.**—Galway (Castlekirk, Maumwee Loughs). Roscommon (Yew Point). Mayo (Clare Island; Mount Brown and Beltra Loughs; Newport and Carrowbeg Rivers; Achill Island). **L.**—Wexford (Edenvale; Johnstown Castle grounds). Dublin (Lucan demesne; Tolka at Glasnevin). Westmeath (Coosan Point; Ballykeeran; Waterston; Shannon at Athlone; Killinure; Hare Island; Twy Lough). **U.**—Monaghan (Glaslough). Donegal (Kilmacrennan district; Lough Fern; &c.). Armagh (Coney Island in Lough Neagh, &c.). Antrim (Colin Glen).

Distribution.—Great Britain (Cornwall to Shetlands, and Outer Hebrides). Isle of Man. Probably distributed over most of Europe from Lapland to Corsica (*McLachlan*).

Polycentropus multiguttatus Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (common in the Killarney district; Gap of Dunloe; Tore; &c.). Waterford (Glenshelane near Cappoquin). **C.**—Galway (near Maam). Roscommon (Summerhill). Mayo (Knappagh, Prospect, and Mount Brown Loughs; Carrowbeg River). **L.**—Dublin (Lucan). Westmeath (Shannon and Ballykeeran). **U.**—Monaghan (Glaslough). Donegal (lakes and streams in the Kilmacrennan district).

Distribution.—Great Britain (common, extending to Perthshire). Widely distributed in Europe.

Polycentropus Kingi McLach.

MUNSTER. CONNAUGHT. ULSTER.

M.—Kerry (Torc Cascade; Glena; Horse's Glen; Gap of Dunloe). **C.**—Mayo (Carrowbeg River). **U.**—Antrim (Colin Glen).

Distribution.—Great Britain (North Wales and Lake District to Inverness). Isle of Man (*Morton*); Switzerland (*Felber*); Portugal and Sardinia (*McLachlan*).

Holocentropus dubius (Ramb.).

MUNSTER. CONNAUGHT. ULSTER.

M.—Kerry (Lough Crincaum). Cork (lakes near Glandore). **C.**—Mayo (Knappagh and Cushinsheeaun Loughs). **U.**—Monaghan (Glaslough).

Distribution.—Great Britain (local; Dorset to Inverness.). Northern and central Europe.

Holocentropus stagnalis (Albarda).

CONNAUGHT. ULSTER.

C.—Mayo (Doogan Lough, *King*). **U.**—Armagh (Lowry's Lough, *Johnson, fide McLachlan*).

A Holocentropus, evidently of this species, was taken at Doogan Lough.

Distribution.—Great Britain (range not ascertained; occurs in Suffolk and Worcestershire). Holland and Germany.

Holocentropus picicornis (Steph.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Horse's Glen; Torc; Gap of Dunloe; Kilbrean Lough; Glena; Parknasilla; near Kenmare). **C.**—Galway (Maumwee Lough). Mayo (Clare Island; Cushinsheeaun, Prospect, Knappabeg, and Doogan Loughs). Roscommon (Summerhill). **L.**—Dublin (River Dodder near Dublin; Santry demesne). Westmeath (Shannon; Coosan). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Loughs Keel, Askerry, Mnafin, and Gorteen). Armagh (Lowry's Lough, &c.).

Mr McLachlan records a variety of this species taken by Col. Yerbury at Parknasilla in July, 1901. At first sight it resembled a small *Silo* or large *Beraea*; but examination proved it to be a *Holocentropus*, with no structural characters to distinguish it from *H. picicornis*. The wings are totally black, with the pubescence of the anterior slightly rusty; and the antennae are without annulations (*Entom. Monthly Mag.*, (2) xiii., p. 112).

Distribution.—Great Britain (Devon to Perthshire). Abroad it is found from Lapland to Hungary.

Cyrnus trimaculatus (Curt.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Killarney and Muckross districts; Devil's Punch-bowl; Gap of Dunloe, &c.). **C.**—Galway (Castlekirk; Maumwee Lough). Roscommon (Summerhill and Yew Point). Mayo (Achill; lakes and streams in the Westport and Newport districts). **L.**—Wexford (Johnstown Castle grounds). Dublin (Lucan). Westmeath (Coosan; Wineport; Bog of Allen). **U.**—Monaghan (Glaslough and Emyvale). Armagh (Maghery, Lough Neagh). Donegal (Ardara; common in the Kilmacrennan district). Down (River Lagan).

Distribution.—Great Britain (widespread, extending to the Shetlands). Generally distributed over most of Europe. Not recorded from Spain.

Cyrnus flavidus McLach.

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Gap of Dunloe). **C.**—Galway (Maumwee Lough). Mayo (Knappagh and Prospect Loughs). **L.**—Westport (Coosan Point). **U.**—Armagh (Lowry's Lough). Donegal (Loughs Fern, Sproule, Mnafin, &c., in the Kilmacrennan district; Ardara).

Distribution.—Great Britain (local; Kent to Strathglass). Finland; Norway; Russia; Holland; Denmark; Switzerland; Germany.

Ecnomus tenellus (Ramb.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (Ross Castle and Ardagh Lough). **C.**—Mayo (Doogan, Prospect, Doo, and Knappagh Loughs). **L.**—Westmeath (Wineport and Waterstown). **U.**—Monaghan (Glaslough and Emyvale).

Distribution.—Great Britain (local, *McLachlan*; has not been found in Scotland). Widely spread in Europe; Asia Minor; Turkestan.

Tinodes Waeneri (L.).

Munster. Connaught. Leinster. Ulster.

M.—Kerry (frequent in the Killarney district; Gap of Dunloe; &c.; near Kenmare; Loo Bridge). Cork (lakes near Glandore). **C.**—Galway (Maumwee Lough; Maam River; Castlekirk). Mayo (lakes and streams in the Westport and Newport districts). **L.**—Wexford (Johnstown Castle grounds). Wicklow (Lough Dan). Dublin (Lucan; mountain streams). Westmeath (Shannon; Coosan; Wineport; Bog of Allen). **U.**—Monaghan

(Glaslough). Armagh (Camlough). Donegal (Loughs Keel, Salt, Fern, and Reelan; Glenbeagh; Largy River; Clonkillybeg).

Distribution.—Great Britain (Cornwall to North Shetlands). Common all over Europe.

Tinodes aureola (Zett.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Gap of Dunloe; Torc; The Glen in Deer Park; Spa Well; Flesk River). **C.**—Galway (Maam River). Mayo (Prospect Lough). **L.**—Dublin (Howth). Westmeath (Shannon). **U.**—Monaghan (Emyvale).

Distribution.—Great Britain (local, though widespread; Kent, Yorkshire, Glasgow, St. Kilda, &c.). Lapland; Germany (Schlesien, *Ulmer*); Austria (Silesia); Switzerland (*Ris*); Italy; Sicily; Corsica; and probably overlooked in other localities.

Tinodes maculicornis (Pict.).

LEINSTER. ULSTER.

L.—Westmeath (Coosan Point; Wineport; Glassan; Twy River). **U.**—Monaghan (Glaslough). Donegal (Lough Reelan).

Probably more widely spread than these records indicate. Mr. Morton found this species at Glaslough along with *Tinodes Waeneri*, which swarmed, by beating the bushes surrounding the lake.

Distribution.—Has not been observed in Great Britain. The continental range has not been ascertained, but it is known to occur in Switzerland (Geneva); France (Montpellier; Seine below Rouen); and Portugal (Cintra, *McLachlan*). Apparently not recorded from Germany.

***Tinodes unicolor** Pict.

ULSTER.

U.—Donegal (Coolmore, *fide McLachlan*).

Taken by the Rev. W. F. Johnson on the banks of a small stream at Coolmore amongst *Iris*, *Epilobium*, &c., in company with *Agapetus fuscipes* (*Entom. Monthly Mag.*; (2), v., p. 236, 1894).

Distribution.—Great Britain (Folkestone and Miller's Dale, Derbyshire, *McLachlan*). Germany (Black Forest, *Ulmer*). Switzerland (Geneva, *Pictet*). France, and probably Austria (*McLachlan*).

Lype phaeopa (Steph.).

MUNSTER. CONNAUGHT. ULSTER.

M.—Kerry (Ross Castle). **C.**—Mayo (Prospect Lough). **U.**—Monaghan (Glaslough).

Distribution.—Great Britain (Devonshire to the south of Scotland). Generally distributed over Europe.

Lype fragilis (Pict.).

CONNAUGHT. LEINSTER.

C.—Galway (Lough Corrib near Galway). Roscommon (Yew Point and Summerhill). **L.**—Westmeath (Coosan Point; Shannon side; Hare Island).

All of the available records of this species are from central Ireland.

Distribution.—Up to the present time *Lype fragilis* has not been observed in any part of Great Britain. It is apparently a local species on the Continent. McLachlan mentions the following localities:—Switzerland (Geneva, *Eaton*; Zurich, common on walls, *Brémi*); south France (Hyères, *Hagen*). Navás has recently recorded it from Albarracin in north-eastern Spain.

Psychomyia pusilla (Fab.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Flesk and Deenagh Rivers; Tore Cascade; Gap of Dunloe). Waterford (Lismore and Cappoquin). **C.**—Roscommon (Summerhill). **L.**—Wexford (Edenvale). Wicklow (Enniskerry). Dublin (Lucan). Westmeath (Wineport; Coosan; Ballykeeran). **U.**—Monaghan (Glaslough and Emyvale). Donegal (Kilmacrennan district; Lennan Bridge; Cottian; &c.). Armagh (Coney Island in Lough Neagh).

Distribution.—Great Britain (Devonshire to Inverness). Common in Europe, ranging from Spain northwards to Finland.

RHYACOPHILIDAE.

Rhyacophila dorsalis (Curt.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Flesk and Deenagh Rivers; Tore Cascade; Cloghereen; Horse's Glen). Cork (Blarney). Waterford (Glenshelane). **C.**—Galway (Maam River; Lough Corrib near Galway). Mayo (Carrowbeg River). **L.**—Wexford (Edenvale). Wicklow (Enniskerry). Dublin (Lucan demesne). Westmeath (Ballykeeran). Louth (Omeath). **U.**—Tyrone (Altadiawan). Donegal (Ardara; Loughs Reelan and Keel; Glenbeagh; Clonkillybeg; Lennan Bridge; &c.). Antrim (Colin Glen).

Distribution.—Great Britain (Cornwall to North Shetlands); Isle of Man. Widespread in western Europe. Faroes; Germany; Switzerland; Holland; Belgium; France; Spain.

Glossosoma vernale (Pict.).

MUNSTER. LEINSTER.

M.—Kerry (Ross Castle; Flesk and Deenagh Rivers; Torc Cascade; the Glen in Deer Park; near Kenmare). Waterford (Cappoquin and Glenshelane).

Distribution.—Great Britain (not uncommon in hilly districts, *McLachlan*; Devon to Inverness). Widely spread in Europe, ranging from Finland to Spain.

Agapetus fuscipes Curt.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Flesk and Deenagh Rivers; Muckross; Torc Cascade; Horse's Glen; Spa Well; Gap of Dunloe). **C.**—Galway (Maam River). Mayo (Carrowbeg River). Sligo (near Sligo). **L.**—Wexford (Johnstown Castle grounds). Dublin (Howth). **U.**—Donegal (Loughs Keel and Salt; Clonkillybeg; Coolmore). Antrim (Cave Hill).

Distribution.—Great Britain (Cornwall to North Shetlands). Denmark; Germany; Belgium; Guernsey; Switzerland; France; Spain; Corsica.

Agapetus comatus (Pict.).

MUNSTER. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Ardagh Lough; Valentia? *McLachlan*). Waterford (Glenshelane). **L.**—Wexford (Edenvale). Wicklow (Enniskerry). Dublin (Lucan demesne). Westmeath (Ballykeeran and Coosan Point). **U.**—Donegal (Largy and Lennan Rivers). Antrim—("*ciliatus* Lough Neagh," *Haliday* MS.).

Distribution.—Great Britain (local; Devonshire to Perthshire, *Morton*). Finland; Russian Lapland; Denmark; Switzerland; Belgium; Germany; Austria. Not recorded from Spain.

Agapetus delicatulus McLach.

MUNSTER. LEINSTER.

M.—Kerry (Deenagh River; Torc Cascade; Horse's Glen). **L.**—Wexford (Johnstown Castle grounds).

Distribution.—Great Britain (very local; recorded from Arran, off the west coast of Scotland, though it probably awaits discovery in other places). The species seems equally rare on the Continent; the only locality mentioned by McLachlan is in the Pyrenees.

HYDROPTILIDAE.

Agraylea multipunctata Curt.

MUNSTER. LEINSTER. ULSTER.

M.—Kerry (Ross Castle and Dinish). Waterford (Cappagh Lough). **L.**—Westmeath (Coosan Point). **U.**—Monaghan (Glaslough).

Distribution.—Great Britain (common; Devonshire to the Clyde district). Northern and central Europe.

Hydroptila sparsa Curt.

MUNSTER. CONNAUGHT. LEINSTER.

M.—Kerry (Ross Castle: Deenagh River: Cloghereen: Horse's Glen: Gap of Dunloe). **C.**—Mayo (Carrowbeg River: Mount Brown Lough; Cushinsheeaun Lough). **L.**—Dublin (River Tolka). Westmeath (Twy River).

Distribution.—Great Britain (south of England to the Shetlands). Finland to Italy and Algeria.

Hydroptila femoralis Eaton.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Horse's Glen: Gap of Dunloe: Ross Castle: Deenagh River: Cloghereen). **C.**—Roscommon (Summerhill). **L.**—Westmeath (Glassan and Twy River). **U.**—Monaghan (Glaslough). Donegal (Dunleury and Salt Loughs; Gweedore; River Lennan).

Distribution.—Great Britain (Scotland and north of England). Sweden (*McLachlan*). Lapland and Finland (*Sahlberg*); Denmark (*Peterson*); Germany (Hamburg and Odenwald, *Ulmer*); Switzerland (*Felber*); Italy (Lago di Como, *Eaton*).

Hydroptila forcipata Eaton.

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Flesk River: Horse's Glen: Gap of Dunloe). **C.**—Roscommon (Summerhill). **L.**—Westmeath (Glassan). **U.**—Monaghan (Glaslough). Donegal (Largy River).

Distribution.—Great Britain (the few records there are of this species show that it ranges from Devonshire to Inverness). Germany (Hesse, *Ulmer*); Switzerland (*Felber*); Italy (Turin).

*****Ithytrichia lamellaris*** Eaton.

ULSTER.

U.—Monaghan (Glaslough, *Morton* in *Entom. Monthly Mag.*, xxviii., p. 301, 1892).

Occurred on the Blackwater River at Glaslough.

Distribution.—Great Britain (Hants, Derbyshire, north Wales, Strathglass, &c.). Finland (*Sahlberg*). Germany (many localities, *Ulmer*). Hungary (*McLachlan*). Switzerland (*Eaton*). Basses Pyrénées (♀ ♀ possibly this species, *Eaton*).

Oxyethira costalis (Curt.).

MUNSTER. CONNAUGHT. LEINSTER. ULSTER.

M.—Kerry (Ross Castle; Deenagh River; Cloghereen; Horse's Glen; Coppagh Glen; Gap of Dunloe). **C.**—Galway; (Castlekirk; Maumwee Lough). Roscommon (Summerhill; Yew Point). Mayo (Mount Brown, Cushinsheaun, Knappagh, Prospect, and Ballin Loughs). **L.**—Dublin (Lucan; Tolka). Westmeath (Glassan; Twy River; Shannon Side). **U.**—Donegal (Loughs Keel and Fern).

Distribution.—Great Britain (south of England to north Shetlands). Northern and central Europe.

NOTE ADDED IN PRESS.

ADDITIONAL NOTES ON THE EUROPEAN DISTRIBUTION OF TRICHOPTERA.

The additional European stations subjoined are taken from Petersen's paper "Trichoptera Daniae," (Entom. Meddelelser, (2) III, 1907; and Felber's "Die Trichopteren von Basel . . ," Archiv fur Naturgeschichte, 74 Jahrg., 1908. These papers have only come into our hands since the foregoing pages were in type.

Phryganea obsoleta (Hagen) McLach.—Denmark (*Petersen*).

Limnophilus xanthodes McLach.—Denmark (*Petersen*); Switzerland (*Felber*).

Limnophilus fuscinervis Zett.—Denmark (*Petersen*).

Limnophilus nigriceps (Zett.).—Denmark (*Petersen*); Switzerland (*Felber*).

Limnophilus hirsutus Curt.—Denmark (*Petersen*); Switzerland (*Felber*).

Limnophilus luridus Curt.—Denmark (*Petersen*).

Micropterna sequax McLach.—Denmark (*Petersen*).

Chaetopteryx villosa (Fab.).—Denmark (*Petersen*).

Apatania fimbriata (Pict.).—Switzerland (Alps, *Felber*).

Silo nigricornis (Pict.).—Denmark (*Petersen*).

Crunoecia irrorata (Curt.).—Denmark (*Petersen*).

Leptocerus senilis (Burm.).—Denmark (*Petersen*); Switzerland (Zürich, *Felber*).

Leptocerus albo-guttatus Hagen.—Denmark (*Petersen*); Switzerland (Rheinau, *Felber*).

Leptocerus annulicornis Steph.—Denmark (*Petersen*); Switzerland (*Felber*).

Leptocerus dissimilis Steph.—Denmark (*Petersen*): Switzerland (Zürich, &c., *Felber*).

Triaenodes conspersa (Ramb.).—Switzerland (Bern, &c., *Felber*).

Adicella reducta (Steph.).—Denmark (*Petersen*).

Oecetis furva (Ramb.).—Denmark (*Petersen*).

Oecetis notata (Ramb.).—Switzerland (Rheinau, *Felber*).

Oecetis testacea (Curt.).—Denmark (*Petersen*).

INDEX.

III.

THE PICTURE-ROCK OR SCRIBED ROCK NEAR RATHMULLAN, IN THE COUNTY OF DONEGAL.

By GRENVILLE A. J. COLE, M.R.I.A., F.G.S.,

Director of the Geological Survey of Ireland.

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Mr. G. H. Kinahan, in the Memoir of the Geological Survey of Ireland on North-west and Central Donegal,[1] mentions the peculiar surface of a sheet of epidiorite, known as the "Scribed Rock," which lies in the extreme south of the townland of Oughterlin, some 2½ miles north-west of Rathmullan. He describes it as "blistered, pitted, and irregularly jointed or cracked, like the surface of a sheet of slag that has been poured out from an iron furnace"; and this analogy, which is hardly a correct one, leads him to regard the mass in this case as not intrusive, but as a lava-flow. The marks on the Scribed Rock, he tells us, were "commonly supposed to be due to the impressions of the feet of men, horses, cattle, sheep, and dogs, to which they have some resemblance."

It appears that this rock-face, though lying in a somewhat remote part of the hills, has attracted attention for many years, and is now locally known as the "Picture-Rock." In 1908, Captain Boyle Somerville, R.N., then engaged in surveying the coast in and near Lough Swilly, addressed an inquiry respecting it to the Director of the National Museum in Dublin, and furnished several outline drawings, produced, after the manner of rubbings, from the rock itself. He pointed out precisely the unusual form of the excavated portions, and the curious resemblance of some of the upstanding bosses to the footprints of animals, seen as casts in relief. In the summer of 1909, Dr. B. Windle, F.R.S., also visited the spot, and wrote to me at the office of the Geological Survey as to its puzzling features. His

[1] Mem. to sheets 3, 4, &c. (1891), p. 65.

sketches and descriptions, aided by two small specimens, made it fairly clear that some form of spheroidal weathering had taken place on a jointed surface of igneous rock; but it seemed well worth while that the mass should be examined geologically. It appeared, indeed, quite possible that human agency might in time be invoked to account for the singular nature of the markings.

During a visit to northern Ireland on behalf of the Geological Survey in October, 1909, I was so fortunate as to find the Admiralty surveying vessel still in Lough Swilly, off Rathmullan. Captain Boyle Somerville very kindly guided me across the hills to the Picture-Rock, which lies one mile north-east of Glenalla House, and one-third of a mile north-east of Lough Rogan on the south-western spurs of Croaghan Hill. It is formed by one of the steeply tilted intrusive sheets in the Dalradian shales and sandstones; and its dip-slope faces approximately south-east. The dip is about 50°.

Fig. 1.—Structures seen on the exposed face of the Picture-Rock, from a photograph. About one-fortieth natural size.

A large part, but by no means the whole, of the exposed face shows the "blistered" structure noted by Mr. G. H. Kinahan in the Memoir, and on his manuscript map in the office of the Survey. Grey lichen-covered spheroids project from it out of deep, roughly rectangular, box-like hollows. Between the "boxes" the rock rises to the same general level as the protuberant face of the spheroids; and the walls of the compartments into which the rock is thus divided clearly depend upon an original structure of two series of joints crossing at right angles. The spheroids depend on the characteristic onion-like jointing of basic rocks, which has arisen within each box-like compartment, just as it arises within the drums of basaltic columns.

The division of an intrusive sheet into rectangular rather than hexagonal columns has been noted by Mr. J. Volney Lewis[1] in the ophitic dolerites of the Palisades along the Hudson River. Mr. Lewis also describes a spheroidal system of joints occurring within the rectangular columns. The main joints in the Picture-Rock might have been attributed to torsion, were it not that they are clearly contemporaneous with the onion-like structure. The intrusive rhyolite of Tardree Mountain, in the county of Antrim, is similarly divided into sheet-like masses, rather than into columns, by a system of predominant joints, the cross-jointing being at right angles to these, and giving the effect of square columns in places. Probably such rectangular jointing may be more common than is generally recognised in intrusive sheets and sills, the edges of which appear columnar when exposed.

Where spheroidal jointing has also taken place, decay usually goes on inwards from the main rectilinear joints; and the spheroidal features become more and more manifest, as limonitic crusts are formed over the successive curving surfaces. In time a crumbling clayey material, full of detached crystals, separates the spheroids, and the residual cores of the latter ultimately lie loosely in a sort of loam. The abrupt contrast between the decayed outer layers and the unaltered central core has led in some cases to the suggestion that such spheroids are volcanic bombs thrown out into a bed of ash.[2]

We must bear this contrast in mind when we attempt to explain the features of the Picture-Rock. The upstanding spheroids, connected with the main mass by their back surfaces only, are of various sizes, and of somewhat irregular form. Some are distinctly flattened from one side to another; and the shape of each one depends on the proportions of the compartment in which it has arisen. A large spheroid measures 20 cm. in its longest diameter. The hollow round the spheroids may extend 6 cm. deep into the rock. In several cases a spheroid has fallen out altogether, leaving a mere empty box-like compartment. It is clear that the soft loam resulting from the decay of the outer shells has been completely washed away. The growth of lichens over the residual cores seems to show, on the other hand, that decay is now slow, if not arrested. I should regard this as due in some cases to the absence of further curving joint-surfaces. The unjointed core has been reached by the removal of all the outer layers, except at the back of the spheroid, where rain penetrates with difficulty. Such spheroids will now

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[1] "Petrography of the Newark Igneous Rocks," Geol. Survey of New Jersey, Ann. Report, 1908, p. 107.

[2] See references in G. Cole, "The Red Zone in the Basaltic Series of the county of Antrim." Geol. Mag., 1908, p. 341.

only weather back like the general surface of the igneous sheet. Some of the spheroids, however, show a distinct tendency to flaking and onion-structure, even under their lichen-covered surface. When cut across by the rock-slicing machine, a zone of soft decomposed rock a millimetre or so thick is seen, and shows that alteration is still operating from the surface.

The fact that original joints determine such onion-like weathering is clearly seen near Carrick-a-rede, in the county of Antrim, where the fresh basalt can be broken up into balls of various sizes, some of which are only two centimetres or so in diameter. The structure, in fact, is a coarse representative of the delicate perlitic structure of glassy igneous rocks. Even in glassy rocks, as G. P. Scrope showed long ago in the Ponza Islands,[1] globular structure may appear on a coarse scale. Scrope describes the pitchstone of the Chiaja di Luna as having "a tendency to the columnar division, the columns separating into large globes or ellipsoids, placed one above the other. These balls, when they have been exposed a short time to the weather, desquamate at a touch into numerous concentric coats, like those of a bulbous root, inclosing a compact nucleus, of which the laminæ have not been sufficiently loosened by decomposition; though the application of a ruder blow will produce a still further exfoliation. The globes vary from a few inches to three feet in diameter. . . . These varieties of natural division are certainly not produced by decomposition, which has evidently only assisted in disclosing an original configuration."

Robert Mallet pointed out a similar tendency to divide into globes in a "trap-rock"[2] near Galway. Here no decomposition had reached the mass, and the structure was unsuspected until the rock was blasted by gunpowder during quarrying operations.

Weathering action from the exposed surface, aided by the battering of rain, has doubtless produced the hollows that surround the spheroids of the P[illegible]-Rock. Had the destructive agent been subterranean, as in the case of the rotting of rock-masses to produce kaolin, the cores of the spheroids would have become entirely detached.

The walls that stand up round each compartment of the rock are evidently due to some strengthening of the groundmass by material infiltered from the joint-surfaces. The resisting ridges are sometimes worn away to a knife-edge, but are sometimes 3 cm. or more in width. Each is marked near the centre by a plane of weakness, along which it divides when struck with the

[1] "Notice on the Geology of the Ponza Isles." Trans. Geol. Soc., London, ser. 2, vol. ii. (1827), p. 205.

[2] "On an unobserved structure in Trap Rocks of county Galway." Trans. R. Irish Acad., vol. xviii. (1837), p. 75; and Proc. R. Irish Acad., vol. i. (1836-40), p. 56.

hammer. This plane formed one side or other of the original joint-crack, and the crack itself has been filled by crystalline material. During the infilling of the cracks, chemical changes must have taken place in the rock to varying distances on either side. This action may be judged, from field-inspection, to be hydrothermal, and to have gone on when the mass lay buried deeply underground. Such infiltrations, however, whereby original planes of weakness become strengthened, may take place even in calcareous shales. Several interesting examples were dug up some ten years ago near Harold's Cross, Dublin. The shale had crumbled away, except where cemented by calcium carbonate on either side of the joints, which formed two series crossing approximately at right angles. The layers of rock thus presented an open lattice-structure or meshwork of remarkable regularity, and detached pieces formed perfect crosses of stone.

On examination in the laboratory, the igneous sheet of the Picture-Rock proves to be a fine-grained dolerite, almost andesitic on its surface, where it originally contained some glassy matter.

It has been subjected to extensive alteration. In its present condition, rich in chlorite, it is a typical diabase, in Hausmann's sense of the term.[1] The specific gravity of two spheroids is 3·05 and 3·07 respectively, giving an average of 3·06. That of one of the strengthened layers along the joint-surfaces is 2·91. This difference in density is not one on which stress can be laid, as a greater degree of hydration probably now prevails among the minerals near the joint-surfaces than among those near the centre of the spheroids. When the rock is broken along a joint-surface, abundant limonite is seen. Pyrite is a common constituent of the infilling of the joints, and has been introduced freely in specks into the rock on either side.

In microscopic section, the veins now occupying the joints are seen to consist of fibrous green amphibole (hornblende or actinolite) granular quartz, pyrite altering into limonite, and occasional small rounded granules with high refractive index, which are very probably sphene. The aspect is that of a mineral vein on a small scale; and it is clear that the agents which brought up the infilling materials exerted considerable influence upon the bounding walls. I have elsewhere[2] referred to the mineralizing effect of a granite magma on its surroundings, and to the production of considerable crystals of amphibole. The hydrothermal action that led to the filling of the narrow veins throughout the Picture-Rock seems, however, to have actually imported

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[1] Rosenbusch has unfortunately appropriated the term 'diabase' for unaltered pyroxene-plagioclase rocks.

[2] "On the growth of crystals in the contact-zone of Granite and Amphibolite," Proc. Roy. Irish Acad., vol. xxv., sect. B (1905), p. 117.

amphibolic material into the diabase. On either side of the vein, prisms of green amphibole have shot out at right angles to its walls. These have now become chloritic, like the groundmass. The adjacent rock has become partially foliated, and has assumed the shimmer of a fine-grained hornblende-schist; but it is difficult to suggest pressure as the cause of so local a phenomenon. The felspathic constituent of the diabase has disappeared; and the rock is a dense mass of granules of pyroxene, abundant tufts of chlorite, brown mica, and a trace of colourless matter; here and there a crystal of amphibole passes across it like a blade. The rock has been darkened on either side of the vein by an exceptional development of brown mica.

Fig. 2.—Thin section of joint-crack converted into a mineral vein, with chloritised amphibole penetrating the diabase on either side. Picture-Rock, Co. Donegal. × 11.

Sections of the spheroids show how, even here, the felspar crystals have been entirely changed. They can be seen as small white rods with the naked eye, but are now composed of minute prisms of zoisite, lying in all directions, an occasional granule of epidote, and chlorite. This chlorite must be an importation from the groundmass, in which it is abundant, together with brown mica, probably as the product of the alteration of granular pyroxene, as well as of undifferentiated glassy matter. Dr. J. S. Hyland, in his very accurate notes on the petrography of Donegal,[1] states that the felspars in the epidiorites of the region rarely retain traces of twin-structure, and have

[1] Geol. Surv. Ireland, Mem. to sheets 3, 4, &c. (1891), p. 153.

commonly been converted into zoisite, calcite, and other minerals. In the Picture-Rock, they are now, through the introduction of chlorite, pseudomorphs rather than reconstructions.

The epidiorite condition does not seem reached in this particular intrusive sheet, except in the neighbourhood of the rectilinear joints. There, however, as we have seen, material has been added to the rock, and the bars of amphiole have led to a local toughening. They have thus enabled it to resist decay; and it is satisfactory to have this microscopic evidence to explain the outstanding walls of the compartments, which are so conspicuous a feature of the Picture-Rock.

IV.

A CENSUS CATALOGUE OF IRISH FUNGI.

By J. ADAMS, M.A., and G. H. PETHYBRIDGE, Ph.D., B.Sc.

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CONTENTS.

Historical Introduction.—While an enumeration of the species of all other groups of plants found in Ireland has at some time or other been made, this has never been attempted in the case of Fungi; and yet the group embraces by far the largest section of the Flora as regards number of species, and, moreover, is of great importance from an economic point of view.

Still it would not be correct to assume that the study of Irish Fungi has been neglected. A reference to the Bibliography at the end will show that a very considerable amount of attention has been devoted to the group. But much still remains to be done; and it is very probable that we are at present acquainted with not more than half the number of species which will ultimately be found to be natives of this country.

Threlkeld, in his "Synopsis Stirpium Hibernicarum," published in 1726, mentions the names of sixteen species of Fungi found in Ireland; but no descriptions or localities are given. In the Appendix to the above work three additional species are mentioned.

The next reference to Irish Fungi occurs in "The Antient and Present State of the County of Down," published in 1744, where four species are described as having been found in that county.

Rutty's "Natural History of County Dublin," published in 1772, mentions two species of Fungi, one of these being the Truffle in County Meath.

But the credit of being the first serious investigator of the group belongs to Templeton, who collected and named 232 species prior to the year 1800. No account of this collection, however, was given to the world until the year 1840, when Dr. Taylor re-examined Templeton's specimens, and published an account of them in the "Annals of Natural History" under the title "Catalogue of the species of Fungi obtained in the North of Ireland by John Templeton, Esq., of Cranmore, Belfast.

Much earlier, however, as regards the date of publication, was a list of fifty-four species, chiefly from County Dublin, published by Wade, in his "Plantae Rariores," in 1804.

The next advance was made in the south, when a list of 218 species for the County of Cork was prepared by Mr. Denis Murray, and published, in 1845, in the "Fauna and Flora of County Cork."

A few years later, in 1852, W. T. Alexander published a list of 256 species found in the neighbourhood of Cloyne in the same county.[1]

The next extension of our knowledge was made by the late Mr. Greenwood Pim, in connexion with the visit of the British Association to Dublin in 1878, when a list of 470 species found in Dublin and Wicklow was prepared for the "Handbook" issued in that year.

In the North of Ireland a still further advance was made by Lett, in his "Fungi of the North of Ireland," published a few years later, in which 580 species are recorded; while, about the same time, Pim published an important paper on the "Fungi of Glengariff and Killarney."

Extensive additions to the Fungal Flora of Counties Dublin and Wicklow were made subsequently by Pim and McWeeney, in a series of papers from 1883 to 1898; while McWeeney added many new species in connexion with the excursions of the Dublin Naturalists' Field Club to different parts of the country.

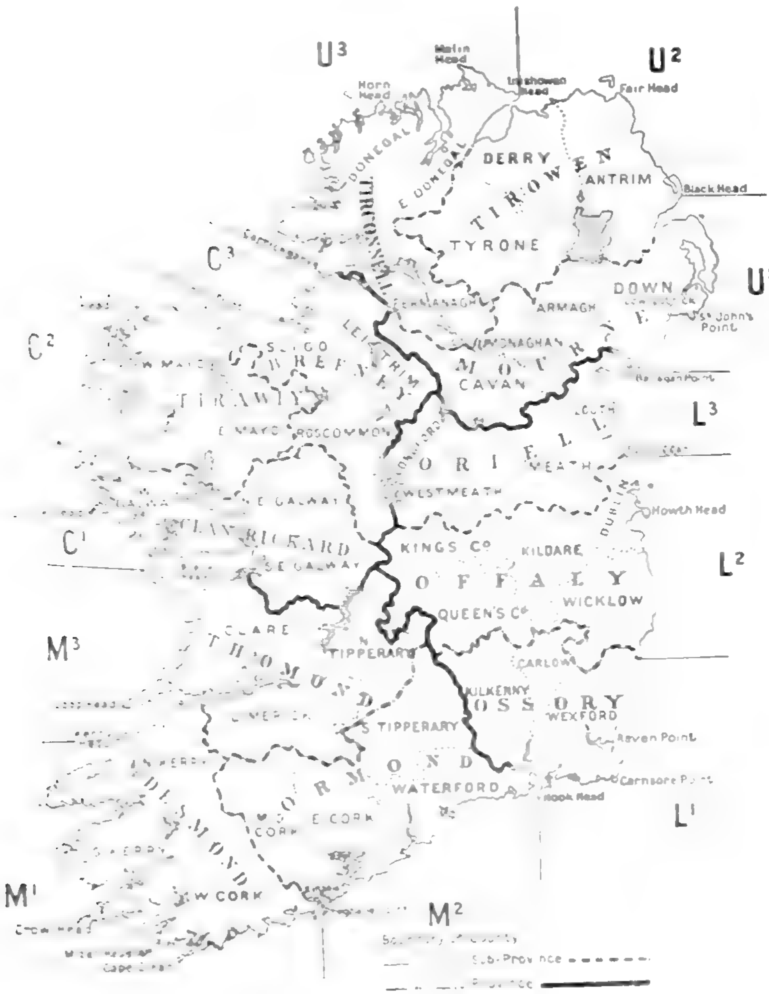
An important list by Carleton Rea of 160 species additional to those already known for Dublin and Wicklow was the outcome of the British Mycological Society's visit to Dublin in 1898.

Since that date Johnson and Pethybridge have been working chiefly at the parasitic species attacking cultivated plants; while a few other investigators have added new species from time to time. Special mention must be made of an important paper by Father Torrend, in 1908, containing 70 species not previously recorded for the Counties of Dublin and Wicklow.

The foregoing are the most important sources of our information relating to the distribution of Fungi in Ireland. Other shorter contributions to the subject will be found in the Bibliography

[1] We are indebted to Miss M. C. Knowles for calling our attention to the existence of this list.

Distribution in Ireland.—To indicate the distribution of each species in Ireland the subdivisions of the country and the symbols proposed by Adams in the "Irish Naturalist" for August, 1908, and January, 1909, have been adopted. Each of the four provinces of Ireland is divided into three sections, which are numbered from 1 to 3, that numbered 1 extending furthest south, that numbered 3 extending furthest north, while number 2 is intermediate in position. The first letter of each province is used as an abbreviation for the name of that province. The twelve sub-provinces are as follows, and are shown on the accompanying map:—



MUNSTER.

M 1 Kerry and West Cork.
M 2 Mid-Cork, East Cork, Waterford, South Tipperary.
M 3 North Tipperary, Limerick, Clare.

CONNAUGHT.

C 1 Galway.
C 2 Mayo.
C 3 Sligo, Leitrim, Roscommon.

LEINSTER.

L 1 Wexford, Carlow, Kilkenny.
L 2 Wicklow, Dublin, Kildare, Queen's County, King's County.
L 3 Louth, Meath, Westmeath, Longford.

ULSTER.

U 1 Down, Armagh, Monaghan, Cavan.
U 2 Antrim, Derry, Tyrone.
U 3 Fermanagh, Donegal.

In a few cases the exact locality where the species occurred is not known; and in consequence it cannot be referred to any of the sub-provinces. All that it is possible to do in such cases is to indicate the province, using the symbol ×, as, for example, M ×. In some cases the province is not known, and it is only possible to indicate the distribution by the word "Ireland."

Census of Species.—In the following tables will be found the number of species belonging to the different groups of Fungi recorded in each of the twelve sub-provinces, in the four provinces, and in the whole of Ireland:—

TABLE I.

Number of Species recorded in each Sub-Province.

GROUP.	M1	M2	M3	C1	C2	C3	L1	L2	L3	U1	U2	U3
Myxomycetes,	5	14	0	10	1	0	0	51	5	8	16	1
Phycomycetes,	3	6	0	1	1	0	0	34	3	5	5	0
Hemiascomycetes,	0	0	0	0	0	0	0	1	0	0	0	0
Euascomycetes,	27	90	3	24	0	1	4	234	24	72	82	4
Hemibasidii,	0	3	0	2	1	0	0	8	3	3	2	1
Protobasidiomycetes,	15	40	0	27	0	0	0	86	28	46	32	0
Autobasidiomycetes,	166	174	1	23	0	0	1	550	66	243	182	1
Fungi Imperfecti,	6	16	1	7	0	1	3	140	8	14	9	2
TOTALS,	222	343	5	94	3	2	8	1104	137	391	328	9

TABLE II.

Number of Species recorded in each Province and in the whole of Ireland.

Group.	Munster.	Connaught.	Leinster.	Ulster.	Ireland.
Myxomycetes, . . .	17	10	52	20	61
Phycomycetes, . . .	8	2	35	9	46
Hemiascomycetes, . . .	0	0	1	0	2
Euascomycetes, . . .	109	25	240	125	344
Hemibasidii, . . .	3	4	11	5	13
Protobasidiomycetes, . .	45	27	89	56	105
Autobasidiomycetes, . .	290	23	557	324	711
Fungi Imperfecti, . . .	23	7	143	23	182
Totals, . .	495	98	1128	562	1464

It will be evident from Table I. that hardly anything is known of the Fungi occurring in half the sub-provinces of Ireland; while Table II. shows that the same thing is true of the Province of Connaught. The total species so far found in Ireland, namely 1464, probably represent less than half the fungal flora of the country, as nearly 6,000 species have been found in Great Britain.

Several of the parasitic species—as, for example, *Phytophthora infestans* de Bary, *Venturia inaequalis*, Wint. and others—are certainly far more widely distributed than is indicated by the actual records of their occurrence. Many of them are, without doubt, universally distributed over Ireland, but actual records of their occurrence are still wanting.

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LIST OF FAMILIES, GENERA, AND SPECIES

All species of Fungi hitherto published as occurring in Ireland up to the end of 1909 are, so far as known to us, included in the subjoined list. In addition to these, however, some records of species are now published for the first time. One of the copies of the "Fauna and Flora of Cork," in the National Library at Dublin, contains marginal notes of a number of species found at various places in County Cork, and these have been incorporated in the present list.

The classification adopted is that of Engler and Prantl, as given in the latest edition (1907) of their "Syllabus der Pflanzenfamilien." In the case of the Agaricaceae, however, the species are arranged in the order given in Worthington G. Smith's "British Basidiomycetes" (1908). To facilitate reference, the species under each genus are arranged in alphabetical order. An alphabetical index of Genera is given at the end of this paper.

We have to acknowledge with grateful thanks considerable assistance in elucidating synonyms and obscure species from Miss A. Lorrain Smith, of the British Museum (Natural History), South Kensington.

MYXOMYCETES.

Phytomyxinae.

Plasmodiophora Alni *Möll.* L 2
  Brassicae *Wor.* Ireland
Spongospora subterranea *Johnson* M 1 C 1 2 L 2 U 3

Ceratiomyxaceae.

Ceratiomyxa mucida *Schroet.* C 1 L 2

Liceaceae.

Licea flexuosa *Pers.* L 2.
Tubulina fragiformis *Pers.* L 2 U 2
Alwisia Bombarda *Berk. et Br.* L 3

Clatroptychiaceae.

Enteridium olivaceum *Ehr.* L 2

Cribrariaceae.

Dictydium umbilicatum *Schrad.* L 2 U 2
Cribraria argillacea *Pers.* M 2
  aurantiaca *Schrad.* L 2
  rufescens *Pers.* L 2

Trichiaceae.

Perichaena depressa *Lib.* L 2
  populina *Fr.* L 2 U 2
Arcyria albida *Pers.* M 2 L 2
  flava *Pers.* L 2
  incarnata *Pers.* M 1 C 1 L 2 U 1 2
  punicea *Pers.* M 2 C 1 L 2 3
Lycogala miniatum *Pers.* M 1 2 C 1 L 2 U 1 2
Trichia affinis *de Bary.* L 2
Trichia Botrytis *Pers.* C 1
  fallax *Pers.* L 2
  favoginea *Pers.* M 1 2 L 2 3 U 2
  persimilis *Karst.* L 2
  varia *Pers.* L 2 U 2
Hemitrichia clavata *Rost.* L 2
  Karstenii *List.* L 2
  Serpula *Rost.* U 1
Prototrichia flagellifera *Rost.* L 2

Reticulariaceae.

Reticularia Lycoperdon [*Bull.*] M 2 L 2
Amaurochaete atra *Rost.* L 2
Dictydiaethalium plumbeum *Rost.* L 2 U 2

Stemonitaceae.

Enerthenema elegans *Bowm.* L 2
Lamproderma echinulatum *Rost.* C 1
Comatricha laxa *Rost.* L 2
  obtusata *Preuss.* M 2 L 2 3 U 2
  Persoonii *Rost.* L 2
  typhoides *Rost.* L 2 U 2
Stemonitis ferruginea *Ehr.* L 2
  fusca *Roth.* M 2 C 1 L 2 U 1 2
  splendens *Rost.* M 1 C 1 L 2

Spumariaceae.

Spumaria alba *DC.* M 2 L 2 U 1 2

Didymiaceae.

Didymium difforme *Duby.* L 2
  effusum *Link.* L 2

Didymium farinaceum *Schrad.* U 1
nigripes *Fr.* M 2 L 2
Chondrioderma globosum *Rost.* M 2 L 2
lucidum *Cooke.* L 2
niveum *Rost.* L 2
spumarioides *Rost.* L 2

PHYSARACEAE.

Leocarpus vernicosus *Link.* M 2 L 2
Craterium leucocephalum [*Ditm.*] M 2
pedunculatum *Trent.* M 2 L 2 U 1 2
Physarum bivalve [*Pers.*] U 2
cinereum *Pers.* C 1 U 1
nutans *Pers.* L 2 U 2
penetrale *Rex.* L 2
psittacinum *Ditm.* L 2
viride *Pers.* L 2
Badhamia utricularis *Berk.* L 2
Fuligo septica *Gmel.* L 2 3 U 2

EUMYCETES.

I. PHYCOMYCETES.

1. Zygomycetes.

MUCORACEAE.

Mucor amethysteus *Berk.* U 1
caninus *Pers.* M 2 U 2
clavatus [*Link.*] L 2
mucedo *Linn.* M 2 L 2 U 2
stercoreus *Link.* M 2 L 2
Sporodinia Aspergillus *Schroet.* L 2 3
Thamnidium elegans *Link.* L 2
Rhizopus nigricans *Ehrenb.* M 2 L 2
Pilaira anomala *Schroet.* L 2
Pilobolus crystallinus *Tode.* M 2 L 2 U 2
longipes *van Tiegh.* L 2

CHAETOCLADIACEAE.

Chaetocladium Brefeldii *van Tiegh. et Lemon.* L 2

ENTOMOPHTHORACEAE.

Empusa muscae *Cohn.* L 2

2. Oomycetes.

ALBUGINACEAE.

Cystopus candidus *Lév.* M 1 2 L 2 U 1 2
Lepigoni *de Bary.* L 2
Tragopogonis *Schroet.* L 2

PERONOSPORACEAE.

Phytophthora infestans *de Bary.* L 2 U 1
Peronospora affinis *Rossm.* C 2 L 2
arborescens *de Bary.* L 2
Peronospora calotheca *de Bary.* L 2
candida *Fuck.* L 2 U 1
effusa *Rabenh.* L 2
Lamii *de Bary.* L 2
parasitica *de Bary.* C 1 L 2
Schachtii *Fuck.* L 2
Schleideni *Ung.* L 2
Trifoliorum *de Bary.* L 2
Urticae *de Bary.* L 2
Plasmopara densa *Schroet.* L 3
nivea *Schroet.* L 2
pygmaea *Schroet.* L 2

SAPROLEGNIACEAE.

Saprolegnia androgyna *Arch.* Ireland
ferax *Nees.* L 2
monoica *Pringsh.* Ireland
Achlya cornuta *Arch.* Ireland
Leptolegnia caudata *de Bary.* M 1
Aphanomyces stellatus *de Bary.* Ireland

OLPIDIACEAE.

Olpidium sphacellum *Kny.* Ireland
tumefaciens *Berl. et de Ton.* L 2
Asterocystis radicis *de Wild.* U 2
Chrysophlyctis endobiotica *Schilb.* U 1

SYNCHYTRIACEAE.

Synchytrium Taraxaci *de Bary et Wor.* L 2 3

I. Phycomycetes—*continued.*

Rhizidiaceae.

Eurychasma Dicksonii *Magnus.* L 2

Cladochytriaceae.

Physoderma menyanthis *de Bary.* L 2

Oochytriaceae.

Diplophysa Saprolegniae *Schroet.* M 1

Pythiaceae.

Pythium de Baryanum *Hesse.* L 2

II. HEMIASCOMYCETES.

Protomycetaceae.

Protomyces macrosporus *Ung.* L 2

Saccharomycetaceae.

Saccharomyces cerevisiae *Meyen.* Ireland

III. EUASCOMYCETES.

Exoascaceae.

Exoascus deformans *Fuck.* L 2
 Pruni *Fuck.* L 2
Taphrina aurea *Fr.* M 2
 Johansonii *Sad.* U 2

Stictidaceae.

Stegia ilicis *Fr.* M 1 2 L 3 U 1 2
Propolis faginea *Karst.* C 1 L 2
Melittosporium lichenicolum *Mass.* Ireland.
Stictis radiata [*Pers.*] M 2

Tryblidiaceae.

Heterosphaeria Patella *Grev.* L 2 U 1 2

Phacidiaceae.

Phacidium multivalve *Kze. et Schum.* U 1
Trochila buxi *Capron.* U 1
 craterium *Fr.* U 1
 ilicis *Crouan.* L 2
 Lauro-cerasi *Fr.* L 2 U 1 2
Schizothyrium Ptarmicae *Desm.* L 2
Coccomyces coronatus [*de Not.*] L 2 U 2
Rhytisma acerinum *Fr.* M 1 2 L 2 3 U 1 2
 Andromedae *Fr.* L 2
 salicinum *Fr.* M 1 L 2

Pezizaceae.

Sphaerospora asperior *Sacc.* L 2
 binominata *Mass.* U 3
 brunnea *Mass.* U 2
 hinnulea *Mass.* L 2
 trechispora *Sacc.* L 2 3 U 1
Plicariella Crouani *Rehm.* L 2
Lachnea bulbocrinita *Phil.* L 2
 dalmeniensis *Phil.* L 2
 hemisphaerica *Gill.* C 1 L 2
 hirta [*Gill.*] M 2
 hybrida *Phil.* L 2
 scutellata *Gill.* M 1 L 2 3 U 2
 stercorea *Gill.* M 1 2 C 1 L 2 U 1 2
 umbrorum *Gill.* L 2
Humaria carbonigena *Sacc.* L 2
 congrex *Karst.* L 2
 domestica *Mass.* L 2
 exidiiformis *Sacc.* M 2 L 2
 granulata *Sacc.* M 1 2 C 1 L 2 U 1 2
 humosa *Sacc.* M 2 L 2 U 2
 rutilans *Sacc.* M 2 L 2
 violacea *Sacc.* L 2
Peziza Adae *Sadler.* U 2
 ammophila *D. & M.* L 2
 badia *Pers.* M 2 L 2 3 U 1 2
 cerea [*Sow.*] L 2
 coccinea *Jacq.* L 2 U 1 2

III. EUASCOMYCETES—*continued.*

Peziza cupularis *Linn.* L 2
reticulata *Grev.* L 2
saniosa *Schrad.* L 2
subumbrina *Boud.* L 3
venosa *Pers.* L 2 U 1
vesiculosa *Bull.* M 2 L 2 U 2
Otidea aurantia *Mass.* M 1 2 L 2 U 2
cochleata *Fuck.* M 2 L 1 2 U 2
leporina *Fuck.* L 2 U 2
onotica *Fuck.* L 2

ASCOBOLACEAE.

Ascophanus argenteus *Boud.* L 2
carneus *Boud.* L 2
equinus *Mass.* L 2
Saccobolus violascens *Boud.* L 2
Ascobolus atrofuscus *Phil. et Plow.* L 2
furfuraceus *Pers.* M 2 L 2 3 U 1 2
glaber *Pers.* L 2
vinosus *Berk.* L 2

HELOTIACEAE.

Chlorosplenium aeruginosum *de Not.* M 1 L 2 U 1 2
Ciboria caucus *Fuck.* L 2
ochroleuca *Mass.* L 2
pseudotuberosa *Sacc.* L 2
Sclerotinia parasitica *Cav.* L 2
sclerotiorum *Mass.* C 1 L 2 U 3
Arachnopeziza aurelia *Fuck.* L 2
Lachnella cerina *Phill.* L 2
corticalis *Fr.* C 1
echinulata *Phill.* L 2
nivea *Phill.* L 3 U 2
Schumacheri *Phill.* L 2
Dasyscypha aspidiicola *Sacc.* L 2
bicolor *Fuck.* M 2 L 2
calycina *Fuck.* M 2 L 1 2 U 1 2
calyculaeformis *Rehm.* L 2
canescens *Mass.* L 2
ciliaris *Sacc.* L 2
clandestina *Fuck.* L 2
hyalina *Mass.* L 2
Dasyscypha nivea *Mass.* L 2
papillaris *Mass.* M 2 U 2
sulfurea *Mass.* L 2
virginea *Fuck.* M 2 C 1 L 2 3 U 1 2
Trichopeziza plano-umbilicata *Sacc.* M 2
Erinella apala *Mass.* L 2
juncicola *Sacc.* L 2
Hymenoscypha calyculus *Phill.* U 2
cyathoidea *Phill.* M 2 L 2
Cyathicula coronata *de Not.* U 2
Helotium aciculare [*Pers.*] M 2 U 2
bolare *Mass.* L 2
citrinum *Fr.* M 1 L 2 3 U 2
claro-flavum *Berk.* M 2 L 2
conigenum *Fr.* L 2
cyathoideum *Karst.* L 2
epiphyllum *Fr.* L 2
fagineum *Fr.* M 2 L 2
imberbe *Fr.* L 2
lenticulare *Fr.* U 2
lutescens *Fr.* L 2
renisporum *Ellis.* L 2
rhizophilum *Cooke.* U 1
scutula *Karst.* L 2
tuba [*Fr.*] L 2
virgultorum *Karst.* M 2 L 2
Ombrophila brunnea *Phil.* L 2
clavis *Cooke.* L 2
Coryne atrovirens *Sacc.* L 2
sarcoides *Tul.* M 1 L 2 3 U 1 2

MOLLISIACEAE.

Mollisia arundinacea *Phil.* L 2
atrata *Karst.* M 1 L 2
atrocinerea *Phil.* L 2
chrysostigma *Mass.* L 2
cinerea *Karst.* M 2 C 1 L 2 U 2
discolor *Phill.* L 2
fallax *Gill.* L 2
filicum *Phill.* L 2
flaveola *Phill.* L 2
melaleuca *Sacc.* C 1

III. Euascomycetes—*continued.*

Pseudopiziza Ranunculi *Fuck.* L 2
Trifolii *Fuck.* L 2
Orbilia auricolor *Sacc.* L 2
leucostigma *Fr.* L 2
rubella *Karst.* L 2
vinosa *Karst.* L 2
xanthostigma *Fr.* L 2
Calloria diaphana *Phill.* M 2
fusarioides *Fr.* L 2 U 2

Patellariaceae.

Durella carestiae *Sacc.* L 2
Patellaria atrata *Fr.* U 1 2
lecideola *Karst.* U 2

Cenangiaceae.

Cenangium abietis *Rehm.* M 2
Bulgaria polymorpha *Wetts.* L 2 U 1 2

Geoglossaceae.

Mitrula cucullata *Fr.* M 2 L 2
olivacea *Sacc.* L 2
phalloides *Chev.* M 2 L 2 U 1 2
viridis *Karst.* L 2
Geoglossum difforme *Fr.* L 2
glabrum *Pers.* M 2 L 2 U 2
glutinosum *Pers.* M 1
hirsutum *Pers.* M 2 L 2 U 1
Leotia lubrica *Pers.* M 1 2 L 2 3 U 2
Spathularia clavata *Sacc.* L 2
Vibrissea Guernisaci *Crouan.* L 2
truncorum *Fr.* M 1 L 2

Helvellaceae.

Morchella conica *Pers.* L 2
crassipes [*Pers.*] L 2
elata *Fr.* C 1 L 2
esculenta *Pers.* M 2 L 2 U 2
gigas *Pers.* L 2
semilibera *DC.* C 1
Helvella crispa *Fr.* M 1 2 L 2 3 U 1
lacunosa *Afzel.* L 2 U 2

Hypodermatacea.

Hypoderma commune *Duby.* L 2
hederae *de Not.* L 2 U 1 2
virgultorum *DC.* M 2 U 2
Lophodermium arundinaceum *Chev.* L 2
hysterioides *Sacc.* M 2
juniperinum *de Not.* U 2
pinastri *Chev.* M 2 L 2 U 2

Dichaenaceae.

Dichaena faginea *Fr.* M 2
strobilina *Fr.* M 2 U 1

Hysteriaceae.

Glonium lineare *de Not.* M 2
Hysterium angustatum [*A. & S.*] M 2
conigenum *Moug. et Nestl.* M 2 U 2
pulicare *Pers.* M 2 U 2
Hysterographium fraxini [*de Not.*] M 2 U 2
Lophium elatum [*Grev.*] M 2
mytilinum [*Fr.*] M 2

Acrospermaceae.

Acrospermum compressum *Tode.* M L 2
graminum *Lib.* L 2

Eutuberaceae.

Hydnotrya Tulasnei *B. & Br.* L 2
Tuber aestivum *Vitt.* M 2 3 C 1 L 2 3
dryophilum *Tul.* M 3

Gymnoascaceae.

Gymnoascus Reesii *Baran.* L 2
Myxotrichum chartarum *Kunze.* L 2

Aspergillaceae.

Aspergillus candidus *Link.* L 2 U 1
glaucus *Link.* M 2 L 2 U 1 2
Penicillium bicolor *Fr.* L 2
candidum *Link.* L 2
glaucum *Link.* M 2 L 2
sparsum [*Grev.*] M 2

Onygenaceae.

Onygena equina *Pers.* U 2

Elaphomycetaceae.

Elaphomyces cervinus *Schrot.* U 2
variegatus *Vitt.* M 2 U 1

III. Euascomycetes—*continued.*

Myriangiaceae.

Myriangium Duriaei *Mont. & Berk.* M 1 2

Erysiphaceae.

Sphaerotheca castagnei *Lév.* M 1 L 2
  mors-uvae *Berk.* M 1 2 C 1 L 1 2 3 U 1 2 3
  pannosa *Lév.* L 2
Podosphaera Oxyacanthae *de Bary.* L 2
Erysiphe cichoracearum *DC.* M 2 L 2
  galeopsidis *DC.* L 2
  graminis *DC.* M 2 L 2
  polygoni *DC.* M 1 L 2 U 1
  tortilis *Fr.* L 2
  umbelliferarum *Lév.* L 2
Microsphaera Berberidis *Lév.* L 2 U 1
  evonymi *Sacc.* L 3
  grossulariae *Lév.* M 1 L 2 U 1 2
Phyllactinia corylea *Karst.* L 2
Uncinula Aceris *DC.* L 2 3
  necator *Burr.* L 2
  Prunastri *Sacc.* L 2
  Salicis *Wint.* L 2

Microthyriaceae.

Asterina veronicae *Cooke.* L 2

Hypocreaceae.

Hypomyces aurantius *Tul.* L 2 3 U 2
  cervinus *Tul.* L 2
  rosellus *Tul.* L 2
Melanospora leucotricha *Corda.* U 1
Nectria Aquifolii *Berk.* L 2 U 1
  aurantium *Kickx.* L 2
  bicolor *B & Br.* L 2
  cinnabarina *Fr.* M 1 2 L 2 U 1 2
  coccinea *Fr.* M 2 L 2 U 1 2
  cucurbitula *Fr.* U 1
  dacrymella *Nyl.* L 2
  ditissima [*Tul.*] L 2
  ochracea *Fr.* M 2
  Pandani *Tul.* L 2
  Peziza *Fr.* M 2 L 2
  sanguinea *Fr.* L 2
  sinopica *Fr.* L 2 U 1
Calonectria luteola *Sacc.* L 2
Gibberella pulicaris *Sacc.* L 2
Sphaerostilbe flavo-viridis [*Fuck*]. L 2
Polystigma rubrum *DC.* M 3 C 1 L 2
Hypocrea farinosa *B. & Br.* U 2
  rufa *Fr.* L 2 3
  splendens [*Phil. et Plow.*] L 2
Epichloe typhina *Tul.* M 2 C 1 L 2 U 1 2
Cordyceps capitata *Link.* M 2
  entomorhiza [*Fr.*] L 2
  militaris *Link.* M 2 C 1 L 2 U 1 2
  ophioglossoides *Link.* M 2
Claviceps Junci *Adams.* L 2
  microcephala *Tul.* M 1 L 2 3
  purpurea *Tul.* C 1 L 2

Dothideaceae.

Rhopographus filicinus *Fuck.* L 2 U 1
Phyllachora graminis *Fuck.* L 2
  Podagrariae *Karst.* C 1
  ulmi *Fuck.* U 1
Dothidella ulmi *Fr.* L 2

Sordariaceae.

Hypocopra fimicola *Sacc.* C 1
  stercoraria *Sacc.* M 2

Chaetomiaceae.

Chaetomium chartarum *Ehrb.* M 1
  comatum *Fr.* M 2 L 2

Sphaeriaceae.

Trichosphaeria pilosa *Fuck.* L 2
Lasiosphaeria canescens *Karst.* L 2
  hirsuta *Ces. et Not.* M 2 L 2
  ovina *Ces. et Not.* L 2
  spermioides *Ces. et Not.* M 2 U 2
Herpotrichia Keitii [*Sacc.*]. L 2
  macrotricha *Sacc.* L 2
Chaetospheria tristis *Schröt.* U 1
Bertia moriformis *Ces. et Not.* L 2 U 2
Rosellinia aquila *de Not.* L 2 U 2
  mammaeformis *Ces. et Not.* C 1 L 2 U 1
  thelena *Rab.* L 2

III. Euascomycetes—*continued.*

Zignoëlla pulviscula *Sacc.* L 2
Melanomma pulvis-pyrius *Fuck.* M 2 L 2 U 2

Cucurbitariaceae.

Nitschkia tristis *Fuck.* L 2
Gibbera vaccinii *Fr.* U 2
Cucurbitaria Berberidis *Gray.* L 2
elongata *Grev.* M 2 U 2
Laburni *Ces. et Not.* L 2 U 1

Mycosphaerellaceae.

Mycosphaerella Brassicae *Johnson.* C 3
latebrosa *Cooke.* U 1
maculaeformis *Cooke.* U 1
ostruthii *Fr.* U 1
pinodes *Niessl.* U 1
punctiformis *Rabenh.* M 2 U 2
tabifica *Prill. et Del.* Ireland
taxi *Cooke.* L 2 3
Stigmatea Nicholsoni *Cooke.* M 2
ostruthii *Oudem.* L 2
Robertiani *Fr.* L 2
Tichothecium calcaricolum *Arnold.* Ireland
gemmiferum *Körb.* Ireland
leucomelarium *Berl. et Vogl.* M 2
perpusillum *Arnold.* C 1
pygmaeum *Körb.* U 1
rimosicolum *Arnold.* M 1 C 1
Sphaerulina taxi *Cooke.* L 2 3

Pleosporaceae.

Physalospora gregaria *Sacc.* C 1
Venturia bryophila *Sacc.* M 1
Geranii *Wint.* U 2
ilicifolia *Cooke.* L 2
inaequalis *Wint.* L 2
Leptosphaeria acuta *Karst.* M 2 L 2 U 2
arundinacea *Sacc.* L 2
culmifraga *Ces. et Not.* L 2
Doliolum *de Not.* L 2
Pyrenophora phaeocomes *Sacc.* M 2
Pleospora herbarum *Rabenh.* M 2
scirpicola *Karst.* U 1
trichospora *Diedick.* M 2 L 1
Ulmi *Wallr.* M 2

Massariaceae.

Massaria pupula *Tul.* U 1

Gnomoniaceae.

Gnomonia erythrostoma *Auersw.* M 2
Gnomon *Schröt.* U 2
setacea *Ces. et Not.* L 2

Valsaceae.

Valsa eunomia *Nitsch.* M 2
Eutypa *Wint.* L 2
flavovirescens *Wint.* M 2 U 2
lata *Nitsch.* M 2 L 2 U 1
leiphemia *Wint.* U 1
leucostoma *Fr.* U 1
Prunastri *Wint.* Ireland
salicina *Fr.* U 2
stellulata *Fr.* U 1

Melanconidaceae.

Valsaria Tiliae *de Not.* U 2
Melanconis lanciformis *Tul.* U 2

Diatrypaceae.

Diatrype bullata *Fr.* U 1 2
corniculata *B. & Br.* M 2
disciformis *Fr.* M 2 L 2 U 1 2
stigma *Fr.* M 2 U 2
Diatrypella nucleata *Sacc.* U 1
pulvinata *Nits.* U 1 2
strumella *Fuck.* U 1
verrucaeformis *Fuck.* U 1 2

Melogrammataceae.

Sillia ferruginea *Karst.* U 1

Xylariaceae.

Nummularia Bulliardi *Tul.* L 2
Hypoxylon atropurpureum *Fr.* U 1
coccineum *Bull.* M 2 U 1 3
cohaerens *Fr.* U 1
fuscum *Fr.* M 2 L 2 3 U 1 2

III. Euascomycetes—*continued.*

Hypoxylon multiforme *Fr.* C 1 L 2
rubiginosum *Fr.* M × L 2 3 U 1
serpens *Fr.* U 2
udum *Fr.* L 2
Ustulina vulgaris *Tul.* M 2 L 2 U 1 2
Daldinia concentrica *Ces. et Not.* M 1 L 2

Xylaria carpophila *Fr.* L 2 U 2
corniformis *Fr.* L 2 U 1
hypoglossa *Grev.* L 2
Hypoxylon *Grev.* M 1 2 L 2 U 1 2
polymorpha *Grev.* L 2
rhopaloides *Mont.* L 2

IV. BASIDIOMYCETES.

1. Hemibasidii.

Ustilaginaceae.

Ustilago Avenae *Jens.* C ×
Caricis *Fuck.* L 3
longissima *Tul.* C 2 L 3 U 3
Scabiosa *Wint.* M 2
segetum *Dittm.* M 2 C 1 L 2 U 1 2
Tragopogi *Schroet.* M 2 L 2
Vaillantii *Tul.* L 2 U 1

Tilletiaceae.

Tilletia Rauwenhofii *F. de Waldh.* L 3
striiformis *Magnus.* L 2
Tritici *Wint.* L 2 U 2
Entyloma Ranunculi *Schroet.* L 2
Urocystis Anemones *Schroet.* L 2 U 1
Violae *Fisch.* C 1 L 2

2. Eubasidii.

(1) *Protobasidiomycetes.*

Endophyllaceae.

Endophyllum Euphorbiae *DC.* M 2 U 1

Melampsoraceae.

Melampsora betulina *Tul.* M 1 2 L 2 U 1
circaeae *Schum.* L 2
epitea *Thum.* L 2
farinosa *Schroet.* M 2 C 1 L 2 3 U 1
Helioscopiae *Cast.* M 1 2 L 2 U 1
Hypericorum *Schroet.* C 1 L 2 3 U 1
lini *Tul.* M 2 C 1 L 2 3 U 1 2
populina *Lév.* M 2 L 2
Vacciniorum *Schroet.* L 2
Vitellinae *Thum.* M 2

Coleosporium Campanulae *Lév.* M 2 U 2
Euphrasiae *Wint.* M 2 C 1 L 2 3 U 1
Senecionis *Fr.* M 2 C 1 L 2 3
Sonchi *Lév.* M 1 2 C 1 L 2 3 U 1
Calyptospora Goeppertiana [*Kühn.*] U 2

Pucciniaceae.

Gymnosporangium clavariiforme *Rees.* M 2 L 2 U 1 2
juniperinum *Fr.* M 2 C 1 L 2
Sabinae *Wint.* M 2 L 2
Uromyces Alchemillae *Fuck.* L 2 U 2
Anthyllidis *Schroet.* C 1 L 2
Betae *Kühn.* L 2
Dactylidis *Otth.* M 2 L 2 U 1 2
Dianthi *Niessl.* L 2
Fabae *de Bary.* M 1 2 L 2 U 1
Ficariae *Lév.* L 2 U 1
Geranii *Otth.* L 2 3
Parnassiae *DC.* L 2
Rumicis *Wint.* M 2 L 2 U 1 2
Scillarum *Wint.* U 1 2
Trifolii *Lév.* C 1
Valerianae *Fuck.* C 1 L 3
Puccinia aegra *Grove.* U 1
Aegopodii *Link.* U 1 2
Agrostidis *Plow.* U 1
Angelicae *Fuck.* L 3
annularis *Wint.* L 2
Baryi *Wint.* L 2
bullata *Schroet.* L 2 3 U 1
Bunii *Wint.* L 2
Buxi *DC.* L 2 3 U 1 2
Calthae *Link.* L 2 U 1

IV. Basidiomycetes—*continued.*

Puccinia Caricis *Rebent.* C 1 L 2
Circaeae *Pers.* M 2 L 2 3 U 2
coronata *Corda.* L 2 3 U 2
Epilobii *DC.* M 2 C 1 L 2 U 2
Fergussoni *B. & Br.* L 2
fusca *Relh.* L 2 U 1
Galii *Schwein.* L 2
Glechomatis *DC.* L 2 3 U 1
glomerata *Grev.* L 2 U 1 2
graminis *Pers.* M 1 2 L 2 U 1 2
Hieracii *Mart.* M 2 C 1 L 2 3 U 1 2
Hydrocotyles *Cooke.* L 2
Lapsanae *Fuck.* L 2
Malvacearum *Mont.* L 2 3 U 1
Menthae *Pers.* M 2 L 2 3 U 1 2
Moliniae *Tul.* C 1 L 2
oblongata [*Wint.*] M 2 L 2
obscura *Schroet.* L 2
Phalaridis *Plow.* L 2 U 1
Phragmitis *Korn.* L 2 U 1 2
Pimpinellae *Link.* M 2 C 1 L 2 3
Poarum *Niels.* M 2 L 2 3 U 1
Polygoni *Wint.* M 2 L 3
Prenanthis *Fuck.* U 2
Primulae *Duby.* M 2 C 1 L 2 3 U 2
pringsheimiana *Klebahn.* M 2 L 2 U 1 2
Pruni *Pers.* L 2
Rubigo-vera *Wint.* L 2
Saniculae *Grev.* C 1 L 2 U 1
Saxifragae *Schlecht.* M 1 L 2
sessilis *Schneid.* L 2 U 1
Silenes *Schroet.* L 2
silvatica *Schroet.* U 1 2
Smyrnii *Corda.* L 2 U 1
suaveolens *Rostr.* M 2 L 2 3 U 1 2
Taraxaci *Plow.* C 1 L 2 3
uliginosa *Juel.* L 2
Umbilici *Guep.* L 2 U 2
Veronicae *Wint.* L 2 3
Vincae *DC.* M 1 L 2
Violae *DC.* M 1 2 C 1 L 2 3 U 2

Phragmidium Fragariastri *Schroet.* C 1 L 2
Potentillae *Karst.* M 2 L 2 U 1 2
Rubi *Wint.* M 2 L 2
Rubi-idaei *Karst.* M 2 L 2 U 1 2
Sanguisorbae *Schroet.* C 1
subcorticatum *Wint.* C 1 L 2
Tormentillae *Fuck.* L 2
violaceum *Wint.* C 1 L 2
Triphragmium Ulmariae *Link.* M 1 C 1 L 2 3

Auriculariaceae.

Auricularia mesenterica *Fr.* M 2 L 2
Hirneola Auricula-Judae *Berk.* M 2 L 2 U 1 2

Pilacraceae.

Stilbum vulgare *Tode.* L 2 U 2

Tremellaceae.

Exidia albida *Bref.* M 1 2 L 2 3 U 1 2
glandulosa *Fr.* M 1 2 C 1 L 2
recisa *Fr.* M 1
Ulocolla foliacea *Bref.* L 2 U 1 2
Tremella fimbriata *Pers.* M 2 U 1
indecorata *Sommf.* M 1 C 1 L 2
intumescens *Sow.* M 1 2 U 1
mesenterica *Retz.* M 1 2 C 1 L 2 3 U 1 2
viscosa *Berk.* L 2
Naematilia encephala *Fr.* U 1

(2) *Autobasidiomycetes.*

Dacromycetaceae.

Dacromyces deliquescens *Duby.* L 2
macrosporus *B. & Br.* L 2
stillatus *Nees.* M 2 C 1 L 2 3 U 1 2
Guepinia merulina *Quel.* L 2
Calocera cornea *Wint.* L 2 U 2
viscosa *Fr.* L 2

Exobasidiaceae.

Exobasidium Vaccinii *Wor.* L 2 3

Hypochnaceae.

Tomentella ferruginea *Pers.* L 2

IV. BASIDIOMYCETES—*continued.*

THELEPHORACEAE.

Corticium arachnoideum *Berk.* U 1 2
calceum *Fr.* M 2 L 2 U 2
cinereum *Pers.* M 2
coeruleum *Pers.* L 2 U 2
comedens *Fr.* U 1
confluens *Fr.* M 2 U 2
evolvens *Fr.* U 1
ferrugineum *Pers.* L 2
lacteum *Fr.* U 2
laeve *Fr.* L 2 U 1 2
nudum *Fr.* U 1
ochraceum *Fr.* M 2
Sambuci *Fr.* L 2
vagum *B. & C.* Ireland
Coniophora byssoidea *Karst.* M 2
puteana *Mass.* L 2
sulphurea *Mass.* L 2
Stereum ferrugineum *Fr.* Ireland
hirsutum *Fr.* M 1 2 L 2 3 U 1 2
purpureum *Pers.* M 2 L 2 U 1 2
rugosum *Pers.* M 2
sanguinolentum *Fr.* M 2 U 1
Thelephora anthocephala *Fr.* L 2
caesia *Pers.* L 2 U 1
caryophyllea *Pers.* M 2
cristata *Fr.* L 2 U 1
intybacea [*Pers.*]. M 2
laciniata *Pers.* M 2 L 2 U 2
mollissima *Pers.* U 1
setacea *Berk.* L 2
terrestris *Ehr.* L 2
undulata *Fr.* M 2
Craterellus clavatus *Fr.* L 2
cornucopioides *Fr.* L 2 U 1
lutescens *Fr.* M 2
sinuosus *Fr.* L 2 U 1
Cyphella capula *Fr.* L 2
dochmiospora *B. & Br.* L 2
Goldbachii *Weinm.* L 2
Pimii *Phill.* L 2
villosa *Karst.* M 2 L 2 U 2
Solenia anomala *Fr.* L 2
Peniophora cinerea *Cooke.* L 2
quercina *Cooke.* M 1 2 L 2 U 1
rosea *Mass.* L 2
velutina *Cooke.* U 1 2
Hymenochaete avellana *Lév.* M 2
corrugata *Lév.* L 2
rubiginosa *Lév.* M 2 L 2 U 1 2

CLAVARIACEAE.

Typhula erythropus *Fr.* M 2 U 2
gyrans [*Fr.*]. M 2 L 2
tenuis *Sow.* M 2
Clavaria abietina *Schum.* M 2 L 2
acuta *Sow.* M 2
argillacea *Fr.* M 2
cinerea *Bull.* M 1 L 2 U 2
contorta *Holmsk.* L 2
coralloides *Linn.* M 1 2 L 2 U 1 2
cristata *Holmsk.* M 1 2 L 2
fastigiata *Linn.* M 1 2 L 2 3 U 1 2
fragilis *Holmsk.* M 1 2 L 2 U 1
fusiformis *Sow.* M 1 2 L 2 3 U 1
inaequalis *Fl. Dan.* M 1 L 2 U 2
juncea *Fr.* M 1 L 2
pistillaris *Linn.* U 2
purpurea *Müll.* L 2
rugosa *Bull.* M 2 L 2 U 1 2
stricta *Pers.* M 1
tuberosa *Sow.* U 2
uncialis *Grev.* M 2 L 2
vermicularis *Scop.* M 2 L 2
Pistillaria culmigena *Fr.* L 2
micans *Fr.* U 1
puberula *Berk.* U 2
quisquiliaris *Fr.* M 2 L 2
Sparassis laminosa [*Fr.*] U 2

HYDNACEAE.

Phlebia contorta *Fr.* L 2
Grandinia granulosa *Fr.* M 2 L 2 U 1
Odontia barba-Jovis *Fr.* M 2 L 2
fimbriata *Pers.* L 2

IV. Basidiomycetes—*continued.*

Radulum laetum *Fr.* L 2
orbiculare *Fr.* L 2 U 1
quercinum *Fr.* L 2
Hydnum alutaceum *Fr.* L 2
auriscalpium *Linn.* M 2 L 2
cinereum *Bull.* L 2
cyathiforme [*Schaeff.*] M 2
denticulatum *Pers.* L 2
farinaceum *Pers.* M 1
ferrugineum *Fr.* L 2
graveolens *Del.* U 1
imbricatum *Linn.* M 1
niveum *Pers.* L 2
ochraceum *Pers.* M 2 L 2
plumosum *Duby.* L 2
pudorinum *Fr.* L 2
repandum *Linn.* M 1 2 L 2 3 U 1 2
rufescens *Pers.* L 2
udum *Fr.* M 2 L 2
zonatum *Batsch.* M 2
Irpex fusco-violaceus *Fr.* L 2
heterodon *Sacc.* L 2
obliquus *Fr.* L 2 U 1

Polyporaceae.

Merulius corium *Fr.* M 2 L 2 3 U 2
lachrymans *Fr.* M 2 L 2 U 2
Poria bombycina *Fr.* L 2
ferruginosa *Mass.* M 1 2 L 2 U 2
hibernica *B. & Br.* L 2
medulla-panis *Cooke.* U 1 2
mollusca *Pers.* M 2
obducens *Pers.* L 2
purpurea *Cooke.* U 1
radula *Fr.* L 2
sanguinolenta [*A. & S.*] L 2
vaporaria *Fr.* M 1 L 2 3 U 1
violacea *Cooke.* U 1
vitrea *Pers.* L 2
vulgaris *Fr.* M 2 L 2 U 2
Fomes annosus *Fr.* L 2 U 1 2
applanatus *Wallr.* L 2
Fomes cytisinus *Berk.* L 2
fomentarius *Fr.* M 1 L 2 3 U 1 2
fraxineus *Fr.* L 2 U 2
fulvus *Fr.* L 2
igniarius *Fr.* M 1 2 L 2 U 1
Ribis *Fr.* L 2
salicinus *Fr.* M 2 L 2
ulmarius *Fr.* L 2
variegatus *Secr.* C 1
Polyporus adustus *Fr.* M 2 L 2 U 1
amorphus *Fr.* L 2
armeniacus *Berk.* M 2 L 2
betulinus *Fr.* M 1 L 2 U 1
brumalis *Fr.* L 2 U 1
chioneus *Fr.* L 2 U 2
dryadeus *Fr.* M 2 L 2 U 1 2
elegans *Fr.* L 2
frondosus *Fr.* M 2
fumosus *Fr.* L 2 U 1
giganteus *Fr.* M 2 L 2 3 U 1 2
hispidus *Fr.* L 2
lentus *Berk.* L 2 U 2
melanopus *Fr.* L 2
nidulans *Fr.* M 2
pallescens *Fr.* U 2
perennis *Fr.* M 1 2 L 2 U 1 2
picipes *Fr.* L 2
pinicola *Wint.* M 2
rufescens *Fr.* L 2
salignus *Fr.* U 1 2
spumeus *Fr.* U 1 2
squamosus *Fr.* M 1 2 L 2 3 U 1 2
sulphureus *Fr.* L 2
varius *Fr.* L 2 U 1
Polystictus abietinus *Fr.* M 2 L 2 U 1
fibula *Fr.* U 2
radiatus *Fr.* L 2 U 1 2
velutinus *Fr.* L 2 U 1
versicolor *Fr.* M 2 L 2 U 1 2
Wynnei *B. & Br.* L 2
Trametes mollis *Fr.* L 2
Daedalea quercina *Pers.* L 2 U 2

IV. Basidiomycetes—*continued.*

Daedalea unicolor *Fr.* M 1 2 L 2
Lenzites betulina *Fr.* L 2
Fistulina hepatica *Fr.* M 2 L 2 U 1 2
Boletus aestivalis *Fr.* U 1
  aurantiporus *Fr.* L 2
  badius *Linn.* L 2
  bovinus *Linn.* M 2 L 2 U 1 2
  calopus *Fr.* M 1
  castaneus *Bull.* U 1
  chrysenteron *Fr.* L 2 3 U 1
  crassus *Mass.* L 2
  cyanescens *Bull.* L 2
  edulis *Bull.* M 2 L 2 U 1 2
  elegans *Schum.* M 1 L 2 U 1
  flavus *With.* M 1 2 C 1 L 2 3 U 1 2
  fragrans *Vitt.* U 1
  granulatus *Linn.* L 2 U 1
  impolitus *Fr.* U 1 2
  laricinus *Berk.* M 1 C 1 L 2 3 U 1
  luridus *Schaeff.* M 1 2 L 2 3 U 1 2
  luteus *Linn.* M 1 2 C 1 L 2 3 U 1 2
  Mac Weeneyi *W. G. Sm.* L 2
  olivaceus *Schaeff.* L 2
  pachypus *Fr.* M 1 L 2 U 1 2
  parasiticus *Bull.* L 2
  piperatus *Bull.* M 1 L 2 U 2
  porphyrosporus *Fr.* L 2
  satanas *Lenz.* M 1 L 2 U 1 2
  scaber *Fr.* M 1 L 2 U 1
  subtomentosus *Linn.* M 2 L 2 U 1 2
  sulphureus [*Fr.*] L 2
  variecolor *B. & Br.* U 1
Ceriomyces albus *Sacc.* L 2

Agaricaceae.

Amanita aspera [*Fr.*] M 2
  excelsa *Fr.* L 2
  lenticularis [*W. G. Sm.*] L 2
  mappa *Fr.* L 2 U 1
  muscaria *Fr.* M 1 2 L 2 3 U 1 2
Amanita pantherina *Fr.* L 2 U 1
  phalloides *Fr.* M 2 L 2 U 1 2
  porphyria *Fr.* L 2
  rubescens *Fr.* M 1 L 2 U 1 2
  spissa *Fr.* M 1 L 2
  strobiliformis *Vitt.* L 2
Amanitopsis adnata *W. G. Sm.* U 1
  strangulata *Roze.* L 2 U 1
  vaginata *Roze.* L 2 U 1 2
Lepiota acutesquamosa *Weinm.* L 2
  amianthina *Scop.* L 2
  Badhami *Berk.* M 1
  cepaestipes *Sow.* M 2 L 2
  clypeolaria *Bull.* M 2 U 2
  cristata *A. & S.* M 1 L 2 3 U 2
  delicata *Fr.* L 2
  excoriata *Schaeff.* L 2
  felina *Pers.* C 1 L 2
  gracilenta *Kromb.* U 1
  granulosa *Batsch.* L 2 U 1
  holosericea *Fr.* L 2
  mesomorpha *Bull.* L 2
  procera *Scop.* M 2 L 2 3 U 1 2
  rachodes *Vitt.* U 1
  sistrata *Fr.* L 2
Armillaria mellea *Vahl.* M 1 2 L 2 U 1 2
  mucida *Schrad.* L 2 U 1 2
  ramentacea *Bull.* L 2
Tricholoma albellum *Fr.* M 1
  albobrunneum [*Pers.*] U 1
  album *Schaeff.* L 2 U 1
  atrosquamosum *Chev.* M 1
  brevipes *Bull.* L 2
  caelatum *Fr.* L 2
  cinerascens *Bull.* L 2
  colossum *Fr.* U 1
  columbetta *Fr.* M 1 L 2 U 2
  cuneifolium *Fr.* M 1
  flavobrunneum *Fr.* M 1 L 2 U 1
  fulvellum *Fr.* L 2
  gambosum *Fr.* L 2 U 1 2

IV. Basidiomycetes—*continued.*

Tricholoma grammopodium *Bull.* M 2 L 2 U 1
humile *Pers.* M 1 L 2
imbricatum *Fr.* M 1 L 2 U 1
immundum *Berk.* L 2
inamoenum *Fr.* L 2
lascivum *Fr.* L 2
luridum *Fr.* L 2
melaleucum *Pers.* L 2
militare *Lasch.* U 1
murinaceum *Bull.* L 2
nictitans *Fr.* M 1 L 2
nudum *Bull.* M 1 L 2 U 1
panaeolum *Fr.* M 1 L 2
personatum *Fr.* M 1 L 2 U 1 2
pes-caprae *Fr.* M 2
resplendens *Fr.* L 2
rutilans *Schaeff.* M 2 L 2 3 U 1 2
saponaceum *Fr.* L 2
scalpturatum *Fr.* L 2
Schumacheri *Fr.* L 2 3
sordidum *Fr.* M 1
spermaticum *Fr.* M 1
subpulverulentum *Pers.* M 1 L 2
sulphureum *Fr.* M 1 2
terreum *Schaeff.* M 1 2 L 2 3 U 2
ustale *Fr.* M 1
vaccinum *Fr.* L 2
virgatum *Fr.* L 2
Clitocybe bella *Pers.* L 2 U 1
brumalis *Fr.* L 2 U 1
candicans *Pers.* M 1 L 2
cerussata *Fr.* M 1 2 L 2 U 1
cyathiformis *Bull.* M 2 L 2 U 1 2
dealbata *Sow.* L 2 U 2
ectypa *Fr.* L 2 U 1
elixa *Sow.* U 1
flaccida *Sow* M 2 U 1
fragrans *Sow.* M 1 2 L 2 U 1 2
fumosa *Pers.* M 1 L 2 U 1
gallinacea *Scop.* M 1 L 2
geotropa *Bull.* M 1 L 2 U 1
Clitocybe gilva *Pers.* M 1 U 1
infundibuliformis *Schaeff.* M 1 L 2
inornata *Sow.* L 2
inversa *Scop.* L 2 U 1
laccata *Scop.* M 1 2 L 2 3 U 1 2
maxima *Fr.* U 1
nebularis *Batsch.* L 2 U 1 2
odora *Sow.* L 2 U 1
tumulosa *Kalch.* M 1
Collybia acervata *Fr.* L 2
atrata *Fr.* L 2
butyracea *Bull.* L 2 U 1 2
caulicinalis *Bull.* U 1 2
clavus *Linn.* L 2 U 2
collina *Scop.* L 2
confluens *Pers.* L 2 U 1 2
conigena *Pers.* M 2 L 2
dryophila *Bull.* M 1 L 2 3 U 1 2
fusipes *Bull.* M 2 L 2
inolens *Fr.* M 1
longipes *Bull.* L 2
maculata *A & S.* L 2 3 U 1
nitellina *Fr.* L 2
platyphylla *Fr.* L 2
plexipes *Fr.* L 2
protracta *Fr.* L 2
radicata *Relh.* M 1 2 L 2 3 U 1
tenacella *Pers.* L 2
tuberosa *Bull.* M 2 L 2
velutipes *Fr.* M 2 L 2 U 1 2
Mycena acicula *Schaeff.* L 2
alkalina *Fr.* M 1 L 2 U 1
amicta *Fr.* L 2
ammoniaca *Fr.* L 2
capillaris *Fr.* L 2
cohaerens *Fr.* U 2
corticola *Fr.* L 2 U 1 2
cruenta *Fr.* L 2 U 2
dissiliens *Fr.* M 1
elegans *Pers.* L 2 U 2
epipterygia *Scop.* M 2 L 2 U 1
filopes *Bull.* C 1 L 2

IV. BASIDIOMYCETES—*continued.*

Mycena galericulata *Scop.* M 1 2 L 2 U 1 2
galopus *Fr.* M 1 2 L 2
haematopus *Pers.* L 2
hiemalis *Osbeck.* L 2
iris *Berk.* L 2
juncicola *Fr.* C 1
lactea *Pers.* L 2 U 1
leucogala *Cooke.* L 2
pelianthina *Fr.* M 1 U 2
pelliculosa *Fr.* U 1
polygramma *Bull.* M 1 2 L 2
prolifera *Sow.* M 1
pterigena *Fr.* L 2
pullata *Berk. & Cooke.* L 2
pura *Pers.* M 1 2 L 2 U 1 2
rorida *Fr.* U 1
rugosa *Fr.* L 3
sanguinolenta *A. & S.* M 2 L 2
speirea *Fr.* L 2
stylobates *Pers.* C 1 L 2 U 1
tenella *Fr.* U 1
tenerrima *Berk.* M 1 C 1 L 2 3
tintinnabulum *Fr.* L 2
vitilis *Fr.* M 1 L 2
vulgaris *Pers.* M 1 L 2
Omphalia fibula *Bull.* M 1 2 C 1 L 2 U 1
grisea *Fr.* U 1
integrella *Pers.* L 2
muralis *Sow.* M 1 L 2
pyxidata *Bull.* M 1 L 2 U 2
rustica *Fr.* L 2
stellata *Fr.* U 2
telmatiaea *Berk. & Cooke.* L 2
umbellifera *Linn.* M 1 L 2 U 1 2
Pleurotus acerosus *Fr.* C 1 L 2 U 2
applicatus *Batsch.* M 2 U 2
corticatus *Fr.* L 2 U 1
craspedius *Fr.* L 2
dryinus *Pers.* L 2 U 1
lignatilis *Fr.* M 1
Pleurotus mitis *Pers.* M 1 L 2
salignus *Pers.* U 1
septicus *Fr.* L 2
subpalmatus *Fr.* L 2
ulmarius *Bull.* L 2 U 1
Volvaria bombycina *Fr.* U 2
parvula *Fr.* L 2
speciosa *Fr.* L 2 U 2
Pluteus cervinus *Schaeff.* L 2 3 U 1
Entoloma ameides *B. & Br.* U 1
clypeatum *Linn.* U 2
costatum *Fr.* L 3
helodes *Fr.* M 1 C 1 U 1
jubatum *Fr.* L 2 U 1
nidorosum *Fr.* L 2 U 1
rhodopolium *Fr.* L 3 U 1
sericellum *Fr.* L 2
sericeum *Fr.* L 2 U 1
sinuatum *Fr.* U 2
Clitopilus carneoalbus *With.* L 2
cretatus *B. & Br.* L 2
prunulus *Scop.* L 2 U 2
Leptonia aethiops *Fr.* M 1 L 2
chalybaea *Pers.* M 2 U 2
incana *Fr.* L 2
lampropus *Fr.* L 2
solstitialis *Fr.* M 1
Nolanea pascua *Pers.* M 1 2 L 2 U 2
pisciodora *Cesati* L 2
rufo-carnea *Berk.* U 1
Eccilia griseorubella *Lasch.* L 2
Claudopus depluens *Batsch.* C 1 L 2
variabilis *Pers.* M 2 L 2 U 1 2
Pholiota adiposa *Fr.* L 2
aurea *Matt.* M 2 L 2 U
aurivella *Batsch.* L 2
caperata *Pers.* U 2
capistrata *Cooke.* L 2
dura *Bolton.* L 2
erebia [*Fr.*] L 2
Junonia *Fr.* U 1
marginata *Batsch.* L 2

IV. Basidiomycetes—*continued.*

Pholiota mutabilis *Schaeff.* L 2 U 2
praecox *Pers.* L 2
spectabilis *Fr.* L 2 U 1 2
squarrosa *Müll.* M 1 2 L 2 U 1 2

Inocybe asterospora *Quél.* L 2
calamistrata *Fr.* L 2 U 1
cincinnata *Fr.* L 2
Curreyi *Berk.* L 2
destricta *Fr.* L 2
eutheles *B. & Br.* M 1 L 2
fastigiata *Schaeff.* M 1 L 2
fibrosa *Sow.* M 1 L 2 U 1
flocculosa *Berk.* M 1
geophylla *Fr.* M 1 2 L 2 U 1 2
hiulca *Fr.* M 1
lanuginosa *Bull.* M 1 U 1
perlata *Cooke.* L 2
plumosa *Bolton.* M 1 U 1
pyriodora *Pers.* M 1 L 2
rimosa *Bull.* M 1 2 L 2 3 U 2
scabra *Fr.* L 2 U 2

Hebeloma crustuliniforme *Bull.* M 1 L 2 U 1
fastibile *Fr.* M 1 L 2 U 1 2
longicaudum *Pers.* M 1 L 2
mesophaeum *Fr.* M 1
sinapizans *Fr.* U 1 2
testaceum *Batsch.* L 2

Flammula flavida *Schaeff.* L 2 U 2
inopus *Fr.* M 2 L 2
lenta *Pers.* M 1 L 2
sapinea *Fr.* U 1

Naucoria badipes *Fr.* L 2
conspersa *Pers.* M 1 L 2
crinacea *Fr.* L 2
escharoides *Fr.* L 2 U 1 2
melinoides *Fr.* L 2
pediades *Fr.* M 1 L 2
scolecina *Fr.* L 2
semiorbicularis *Bull.* L 2
sideroides *Bull.* L 2

Galera hypnorum *Batsch.* M 1 2 C 1 L 2 3 U 1
mniophila *Lasch.* L 2
ovalis *Fr.* L 2
rubiginosa *Pers.* L 2
tenera *Schaeff.* M 2 L 2 U 1 2

Tubaria furfuracea *Pers.* L 2
paludosa *Fr.* L 2
pellucida *Bull.* M 2

Crepidotus alveolus *Lasch.* L 2
chimonophilus *B. & Br.* L 3
mollis *Fr.* L 2 U 1

Psalliota arvensis *Schaeff.* L 2 3 U 1 2
campestris *Linn.* M 1 2 C 1 L 1 2 3 U 1 2
haemorrhoidaria *Magnus.* L 2
silvatica *Quél.* M 1 L 2
xanthoderma *Genev.* L 2

Stropharia aeruginosa *Curt.* M 2 L 2 U 1 2
albocyanea *Desm.* L 2
inuncta *Fr.* L 2
semiglobata *Batsch.* M 1 2 C 1 L 2 U 1 2
stercoraria *Fr.* L 2

Hypholoma appendiculatum *Bull.* L 2 U 1
dispersum *Fr.* L 2
egenulum *B. & Br.* L 2
epixanthum *Fr.* L 2 3
fasciculare *Huds.* M 1 2 L 2 3 U 1 2
hydrophilum *Bull.* L 2
lacrymabundum *Fr.* U 1
sublateritum *Schaeff.* L 2 3 U 2
velutinum *Pers.* L 2

Psilocybe areolata *Klotsch.* L 2 3
cernua *Mull.* M 1
clivensis *B. & Br.* L 2
ericacea *Pers.* M 2 L 2
foenisecii *Pers.* L 2 U 1
semilanceata *Fr.* M 1 L 2
spadicea *Fr.* L 2

IV. BASIDIOMYCETES—*continued.*

Psilocybe sublateritius *Fr.* M 2
Psathyra corrugis *Pers.* L 2
spadiceogrisea *Schaeff.* L 2
Anellaria fimiputris *Karst.* M 1 C 1 L 2 U 1 2
separata *Karst.* L 2 U 1 2
Panaeolus campanulatus *Linn.* L 2
papilionaceus *Fr.* L 2
phalaenarum *Fr.* C 1 L 2 3
Psathyrella atomata *Fr.* L 2
disseminata *Pers.* M 2 L 2 3 U 1 2
gracilis *Fr.* L 2
hiascens *Fr.* U 1
Coprinus atramentarius *Fr.* M 1 L 2 U 1 2
comatus *Fr.* M 2 L 2 3 U 1 2
congregatus *Fr.* M 2
deliquescens *Fr.* L 2
domesticus *Fr.* L 2
ephemerus *Fr.* C 1 L 3
extinctorius *Fr.* L 2
fuscescens *Fr.* U 1
hemerobius *Fr.* L 2 U 1
lagopus *Fr.* L 2
micaceus *Fr.* M 2 L 2 3 U 1 2
niveus *Fr.* M 2 L 2 U 1
ovatus *Fr.* U 2
picaceus *Fr.* U 1
plicatilis *Fr.* M 2 L 2 U 1 2
radiatus *Fr.* M 2 L 2
tomentosus *Fr.* L 2
Bolbitius Boltonii *Fr.* U 2
fragilis *Fr.* L 2 U 2
tener *Berk.* L 2 3 U 1
Cortinarius (Phlegmacium) claricolor *Fr.* M 1
fulgens *Fr.* L 2
glaucopus *Fr.* L 2
infractus *Fr.* L 2
largus *Fr.* L 2
purpurascens *Fr.* L 2 U 1
scaurus *Fr.* U 2
Cortinarius talus *Fr.* L 2
testaceus *Cooke.* M 2
turbinatus *Fr.* L 2
varius *Fr.* M 2 L 2 U 1
(Myxacium) collinitus *Fr.* L 2 U 2
elatior *Fr.* L 2
(Inoloma) alboviolaceus *Fr.* L 2
Bulliardii *Fr.* U 2
callisteus *Fr.* U 1
camphoratus *Fr.* M 1
cyanites *Fr.* U 1
pholideus *Fr.* M 1
sublanatus *Fr.* L 2 U 2
violaceus *Linn.* M 2 L 2
(Dermocybe) anomalus *Fr.* L 2 U 1
caninus *Fr.* L 2
cinnamomeus *Fr.* M 1 2 L 2 U 1 2
militinus *Fr.* L 2
sanguineus *Fr.* M 2 L 2
uliginosus *Berk.* L 2
(Telamonia) evernius *Fr.* U 2
gentilis *Fr.* U 2
helvolus *Fr.* M 2
hemitrichus *Fr.* L 2
hinnuleus *Fr.* L 2
iliopodius *Fr.* M 2
paleaceus *Fr.* L 2
torvus *Fr.* L 2
(Hydrocybe) acutus *Fr.* L 2 U 2
armeniacus *Fr.* M 1 L 2
castaneus *Fr.* L 2
dilutus *Fr.* U 2
leucopus *Fr.* L 2
(Gomphidius) glutinosus *Fr.* L 2 U 1
gracilis *Berk.* L 2
viscidus *Fr.* L 2 3 U 1 2
(Paxillus) giganteus *Fr.* M 2 U 2
involutus *Fr.* M 1 2 L 2 U 1 2
panaeolus *Fr.* L 2
pannoides *Fr.* L 2

IV. Basidiomycetes—*continued.*

Hygrophorus (Limacium) eburneus *Bull.* L 2 U 1 2
hypothejus *Fr.* M 2
(Camarophyllus) nemoreus *Fr.* L 3
niveus *Fr.* L 2 3 U 1
ovinus *Bull.* M 1 2 L 2 U 2
pratensis *Fr.* M 1 L 2 3 U 1
russocoriaceus *B. & Br.* L 3
virgineus *Wulf.* M 1 2 L 2 U 1
(Hygrocybe) calpytraeformis *Berk.* M 1 L 2 3
ceraceus *Wulf.* M 1 2 L 2 U 1
chlorophanus *Fr.* L 2 3 U 1 2
coccineus *Schaeff.* M 2 L 2 3 U 1 2
conicus *Fr.* M 1 L 2 3 U 1 2
Houghtonii *Fr.* M 1
intermedius *Pass.* U 3
laetus *Fr.* M 1 L 2
miniatus *Fr.* M 1 L 2 U 1
nitratus *Pers.* L 2
obrusseus *Fr.* U 1 2
psittacinus *Schaeff.* M 1 2 L 2 3 U 1 2
puniceus *Fr.* M 2 L 2 U 2
unguinosus *Fr.* L 2
Lactarius acer *Fr.* M 2
blennius *Fr.* M 1 L 2 3 U 1
camphoratus *Fr.* L 2
chrysorrheus *Fr.* L 2
cilicioides *Fr.* U 2
circellatus *Fr.* L 2
controversus *Pers.* M 2 U 1
deliciosus *Fr.* M 1 2 L 2 U 1 2
fuliginosus *Fr.* L 2
glyciosmus *Fr.* M 1 L 2 1
hysginus *Fr.* L 2 U 1.
insulsus *Fr.* M 1 L 2
mitissimus *Fr.* M 1 U 1
pallidus *Fr.* M 1 L 2 U 1 2
pergamenus *Fr.* U 1
piperatus *Fr.* L 2 U 1
pyrogalus *Fr.* M 1 L 2
Lactarius quietus *Fr.* M 1 L 2 U 1 2
rufus *Scop.* L 2 U 1 2
scrobiculatus *Fr.* M 2 L 2
serifluus *Fr.* M 1 L 2 U 1 2
subdulcis *Fr.* M 1 L 2 3 U 1 2
subumbonatus *Lindgr.* L 2
theiogalus *Fr.* M 2 U 1
torminosus *Schaeff.* M 1 L 2 U 1 2
turpis *Fr.* M 1 L 2 U 1
vellereus *Fr.* M 1 L 2 U 1
volemus *Fr.* M 1 L 2 U 1
zonarius *Fr.* L 2 U 1 2
Russula adusta *Fr.* M 2 L 2 U 1
alutacea *Fr.* M 1 L 2 U 2
armeniaca *Cooke.* L 2
consobrina *Fr.* L 2
cyanoxantha *Schaeff.* L 2
decolorans *Fr.* L 2
delica *Fr.* L 2 3
depallens *Fr.* L 2
drimeia *Cooke.* L 2 U 1
emetica *Fr.* M 1 2 L 2 U 1 2
fellea *Fr.* L 2
foetens *Fr.* L 2
fragilis *Fr.* M 1 L 2 U 1
furcata *Fr.* M 1 L 2
galochroa *Fr.* L 2
granulosa *Cooke.* L 2
heterophylla *Fr.* M 1 L 2 U 2
integra *Fr.* L 2 U 1
lepida *Fr.* L 2
lutea *Fr.* M 2 L 2
nigricans *Fr.* M 1 L 2 U 1 2
ochroleuca *Fr.* M 1 L 2
puellaris *Fr.* L 2
Queletii *Fr.* L 2
rosacea *Fr.* M 1
rubra *Fr.* L 2 U 1 2
sardonia *Fr.* M 1 L 2
subfoetens *W. G. Sm.* L 2
vesca *Fr.* L 2

IV. BASIDIOMYCETES—*continued.*

Russula virescens *Fr.* M 1 L 2 U 1

Cantharellus albidus *Fr.* C 1
aurantiacus *Fr.* L 2 U 1
cibarius *Fr.* M 1 2 L 2 U 1 2
cinereus *Fr.* L 2
lobatus *Fr.* M 2 L 2 U 2
muscigenus *Fr.* L 2
retirugus *Fr.* L 2
tubaeformis *Fr.* L 2

Nyctalis asterophora *Fr.* L 2
parasitica *Fr.* L 2

Marasmius androsaceus *Fr.* M 2 C 1 L 2 U 2
caulicinalis *Fr.* L 2
epiphyllus *Fr.* L 2
erythropus *Fr.* U 1
graminum *Berk.* L 2
Hudsonii *Pers.* L 2
impudicus *Fr.* L 2
institius [*Fr.*] L 2
oreades *Fr.* M 2 L 2 3 U 1
perforans *Fr.* M 2
peronatus *Fr.* L 2 U 1
ramealis *Fr.* M 2 C 1 L2
rotula *Fr.* M 1 2 L 2 3 U 1 2
terginus *Fr.* L 2
urens *Fr.* M 1 L 2 U 1
Vaillantii *Fr.* L 2

Lentinus cochleatus *Fr.* M 2
flabelliformis *Fr.* U 2
lepideus *Fr.* M 2 L 2
tigrinus *Fr.* U 2

Panus stypticus *Fr.* L 2
torulosus *Fr.* L 2

Schizophyllum commune *Fr.* M 2

CLATHRACEAE.

Clathrus cancellatus *Tournef.* M ×

PHALLACEAE.

Mutinus caninus *Fr.* L 2

Ithyphallus impudicus *Fisch.* M 1 2 L 2 3 U 1 2

HYMENOGASTRACEAE.

Hymenogaster vulgaris *Tul.* L 2

Octaviania asterosperma *Vitt.* L 2

LYCOPERDACEAE.

Lycoperdon Bovista *Linn.* M 2 L 2 3 U 1 2
caelatum *Bull.* M 1 L 2 U 1 2
excipuliforme [*Pers.*] M 2
gemmatum *Batsch.* M 1 2 L 2 3 U 1 2
pyriforme *Schaeff.* M 2 L 2 3 U 1 2
saccatum *Vahl.* M 1 L 2 U 1

Bovista nigrescens *Pers.* M 1 2 L 2 U 1 2
plumbea *Pers.* M 2 L 2 U 1
pusilla *Pers.* M 2 U 2

Geaster fimbriatus *Fr.* M 2 3 L 2
Michelianus *W. G. Sm.* L 2
rufescens *Pers.* M 2 L 2

NIDULARIACEAE.

Nidularia pisiformis *Tul.* L 2

Crucibulum vulgare *Tul.* M 2 L 2 U 2

Cyathus striatus *Hoffm.* M 2 L 2 U 2
vernicosus *DC.* M 2 L 2 U 2

SCLERODERMATACEAE.

Scleroderma Bovista *Fr.* M 1 L 2 U 2
cepa [*Pers.*] M 2
Geaster [*Fr.*] L 2
verrucosum *Pers.* M 2 L 2
vulgare *Fr.* M 1 2 L 2 3 U 1 2

SPHAEROBOLACEAE.

Sphaerobolus stellatus *Tode.* M 2 L 2 U 2

V. FUNGI IMPERFECTI.

1.—Sphaeropsidales.

SPHAERIOIDACEAE.

Phyllosticta atro-zonata *Voss.* L 2
Phoma asteriscus *Bull.* L 2
concentricum *Desm.* U 1
Grossulariae *Schulz et Sacc.* Ireland
solanicola *Pril. et Del.* L 2
Cicinnobolus Ulicis *Adams.* L 2
Asteroma reticulatum *Berk.* U 1
rosae *DC.* M 1 L 2
Vermicularia Dematium *Fr.* L 2
Cytospora carphosperma *Fr.* M 2
leucosperma *Pers.* M 2
Ceuthospora lauri *Grev.* U 2
Ascochyta dianthi *Berk.* U 1
graminicola *Sacc.* L 2
Diplodina Salicis *West.* M 3
Diplodia herbarum *Lév.* L 2
Ilicis *Fr.* U 2
Taxi *de Not.* U 2
Dichomera Saubinetii *Cooke.* L 2
Septoria aceris *B. & Br.* L 2
Castanicola *Desm.* U 1
Petroselini *Desm.* Ireland
Veronicae *Desm.* L 2

LEPTOSTROMATACEAE.

Piggottia astroidea *B. & Br.* L 2
gladioli *Pim.* L 2
Actinothyrium graminis *Kunze.* M 2

EXCIPULACEAE.

Dinemasporium graminum [*Lév.*]. L 2
Discella carbonacea *B. & Br.* U 1

2.—Melanconiales.

MELANCONIACEAE.

Gloeosporium ficariae *Berk.* L 2
fructigenum *Berk.* L 2
Orchidearum *Karst. et Har.* L 2
Melanconium bicolor *Nees.* U 1
Pandani *Lév.* L 2
Coryneum Beijerinckii *Oudem.* L 2
disciforme *Kunze.* U 1

3.—Hyphomycetes.

MUCEDINACEAE.

Oospora crustacea *Sacc.* L 2
fasciculata *S. & V.* L 2
lactis *Sacc.* Ireland
microsperma *S. & V.* L 2
Monilia aurea *Gmel.* C 1 L 2
racemosa *Purt.* U 2
Oidium chrysanthemi *Rabenh.* L 2
farinosum *Cooke.* L 2
fasciculatum *Berk.* M 2
monilioides *Link.* L 2
Fusidium griseum *Link.* L 2
Cylindrium flavovirens *Bon.* L 2
heteronemum *Sacc.* L 2
Geotrichum candidum *Link.* L 2
Rhopalomyces candidus *B. & Br.* L 2
pallidus *B. & Br.* L 2
Cephalosporium Acremonium *Corda.* L 2
Papulospora sepedonioides *Preuss.* L 2
Trichoderma viride *Pers.* M 2
Botryosporium diffusum *Corda.* C 1 L 2
pulchrum *Corda.* L 2 3
Alliaspora Sapuçaya *Pim.* L 2
Haplaria grisea *Link.* L 2
Acremonium verticillatum *Link.* L 2
Rhinotrichum repens *Preuss.* C 1 L 2
Sporotrichum flavissimum *Link.* L 2
laxum *Link.* M 2
Botrytis cana *K. & Schm.* L 2 U 1
dichotoma *Corda.* L 2
effusa *Grev.* M 2
parasitica *Cav.* Ireland
Tilletii *Desm.* L 2
vera *Berk.* U 2
vulgaris *Fr.* L 2
Sepedonium chrysospermum *Fr.* M 2 L 2
roseum *Fr.* M 1
Verticillium alboatrum *Rke. et Berth.* L 2
aspergillus *B. & Br.* L 2

V. Fungi Imperfecti—*continued.*

Verticillium lateritium *Berk.* L 2
nanum *B. & Br.* L 2
Rexianum *Sacc.* L 2
Clonostachys Araucaria *Corda.* L 2
Trichothecium obovatum *Sacc.* L 2
piriferum *Sacc.* L 2
roseum *Link.* M 1 L 2 3
Arthrobotrys rosea *Mass.* L 2
Diplocladium macrosporium *Mass.* L 2
minus *Bon.* L 2
Mycogone rosea *Link.* L 2
Macrosporium cheiranthi *Fr.* L 2
Ramularia calcea *Ces.* L 2
cryptostegiae *Pim.* L 2
rapae *Pim.* L 2
urticae *Ces.* L 2
Septocylindrium Bonordenii *Sacc.* L 2
elongatisporium *Sacc.* L 2
Helicomyces roseus *Link.* L 2

Dematiaceae.

Torula expansa *Pers.* L 2
herbarum *Link.* L 2
ovalispora *Berk.* L 2
parasitica *Pim.* L 2
pinophila *Chev.* L 2
pulveracea *Corda.* L 2
pulvillus *B. & Br.* L 2
sporendonema *B. & Br.* L 2
Echinobotryum atrum *Corda.* L 2
Stachybotrys atra *Corda.* M 1 L 2
lobulata *Berk.* L 2
Periconia byssoides *Pers.* L 2 U 1
calicoides *Berk.* L 2
Zygodesmus fuscus *Corda.* L 2
Glenospora Curtisii *Berk.* L 2
Monotospora sphaerocephala *B. & Br.* L 2
Acremoniella fusca *Sacc.* L 2
Haplographium delicatulum *B. & Br.* L 2
Myxotrichella deflexum *Sacc.* L 2
Menispora ciliata *Corda.* L 2 3
lucida *Corda.* L 2
Pimina parasitica *Grove,* L 2
Stachylidium bicolor *Link.* M 2
cyclosporum *Grove.* C 1 L 2
diffusum *Fr.* M 2 U 1 2
Cladotrichum Passiflorae *Pim.* Ireland.
Bispora monilioides *Corda.* L 2
Passalora bacilligera *Mont. et Fr.* L 2
Polythrincium Trifolii *Kunze.* L 2
Cladosporium compactum *Sacc.* U 1
epiphyllum *Nees.* L 2 3
fasciculare *Fr.* M 2
fulvum *Cooke.* M 2
herbarum *Link.* M 2 C 1 L 2 U 1 2
nodulosum *Corda.* L 2
Clasterosporium opacum *Sacc.* L 2
Septonema irregulare *B. & Br.* L 2
Napicladium Brunaudii *Sacc.* U 3
Helminthosporium echinulatum *Berk.* L 2
gymnostachyii *Pim.* L 2
molle *B. & C.* L 2
simplex *Kunze.* L 2
tiliae *Fr.* M 2 L 2
velutinum *Link.* L 2
Heterosporium echinulatum *Cooke.* L 2
exasperatum *Berk.* L 2
Spondylocladium atrovirens *Harz.* C 1
Dendryphium comosum *Wallr.* L 2
Sporoschisma mirabile *B. & Br.* L 2
Coniothecium effusum *Corda.* L 2
Sporidesmium Solani *Vañha.* Ireland.
Speira toruloides *Corda.* L 2
Tetraploa aristata *B. & Br.* L 2
Mystrosporium Stemphylium *Corda.* U 1
Septosporium bulbotrichum *Corda.* L 2
Alternaria tenuis *Nees.* L 1
Cercospora Bloxamii *B. & Br.* M 1 C 1 3 L 2 U 3

V. Fungi Imperfecti—*continued.*

Cercospora resedae *Fckl.* Ireland.
Fumago vagans *Pers.* L 2

Stilbaceae.

Stilbella bicolor *Lind.* U 2
erythrocephalum *Lind.* L 2 3
fimetarium *Lind.* L 2
tomentosum *Lind.* L 2 3
Lasioderma flavo-virens *Dur. et Mont.* L 2
Ceratium hydnoides *A. & S.* M 1 L 2 U 2
Isaria farinosa *Fr.* M 2
fuciformis *Berk.* L 2
Graphium Grovei *Sacc.* L 2 3
Sporocybe byssoides *Bon.* L 2
Stysanus putredinis *Corda.* L 2
Stemonitis *Corda.* L 2 U 1
ulmariae *McW.* L 2 3

Tuberculariaceae.

Tuberculina persicina *Sacc.* L 2
vinosa *Sacc.* L 2
Aegerita candida *Pers.* L 2
Tubercularia Aesculi *Opiz.* L 2
confluens *Pers.* M 2
Dendrodochium rubellum [*Sacc.*] L 2
Volutella ciliata *Fr.* L 2
hyacinthorum *Berk.* L 2
phaii *Pim.* L 2
roseola *Cooke.* L 2
setosa *Berk.* L 2
Bactridium flavum *Kunze & Schum.* L 2
Fusarium solani *Sacc.* L 1
Pionnotes Betae *Sacc.* L 1
Epicoccum neglectum *Desm.* L 2
purpurascens *Ehr.* L 2
Myrothecium cinereum *Cooke.* L 2
inundatum *Tode.* L 2

APPENDIX I.

Uncertain or Doubtful Records or Insufficiently Named Species, or Species whose Classification is Doubtful.

Many of the species in this list were recorded with no authors' names; hence it is impossible to be certain what species they really represent. Many others are probably recorded with incorrect authors' names, and in one or two cases the species themselves are doubtful. Both genera and species are arranged in alphabetical order.

Aecidium confertum [*Grev.*]
crassum var. periclymeni *DC.* U 1 2
periclymeni *DC.* M 2 L 2
rubellum U 2
taraxaci M 2
Agaricus amethystinus *Sow.* L 2
aurantius Ireland
baccatus M 2
caespitosus L 1
campanulatus *With.* L 2
Agaricus campropus *Fr.* L 3
castaneus *Bolton.* L 2
cinereus Ireland.
comatus *Mull.* M 1 2
corticola *Bull.* M 2
crassipes *Sow.* L 2
cretaceus *Sow.* L 2
cristatus *Fr.* L 3
eburneus *Sow.* L 2
epiphyllus *Pers.* M 2

UNCERTAIN OR DOUBTFUL SPECIES—*continued.*

Agaricus floccosus M 1
Georgii *With.* M 2
granulosus *Scop.* M 2 L 2
integer *With.* L 2
macrophorus M 2
Mariae *Klotzsch.* M 2
nebulosus U 2
nimophilus *Lasch.* L 2
papyraceus M 2
pluteus *Batsch.* M 2
ruber M 2
rubescens *Pen.* M 2 L 2
scaber *Bull.* M 2
scaber *Sow.* L 2
semiovatus M 2
stercorarius *Bull.* M 2
strobiliformis *Fr.* L 2 3
tortilis *Bolton.* Ireland
trilobus *Bolton.* L 2
vulgaris M 2
zonarius *With.* M 2
Amanita aspera (*Fr.*) M 2
ceciliae *B. & Br.* L 2 U 1
lenticularis (*W. G. Sm.*) L 2
vaginata (*Bull.*) L 2 U 1 2
Anthina flammea [*Fr.*] M 2
Arcyria nutans *Bull.* M 2 U 2
Boletus esculentus M 2
igniarius L 2
squamosus L 2
suberosus L 2
versicolor (*Rostk.*) Ireland
Briarea orbiculata *Bon.* L 2
Capnodium citri [*Penz.*] Ireland
Chalara sp. L 2
Chytridium barkerianum *Arch.* L 2
Clavaria corniculata M 2
vermiculata *Scop.* U 1 2
Clitocybe ovina M 2
Clitopilus phlebophorus M 2
Coprinus congregatus (*Fr.*) M 2
Cryptosphaeria acuminata M 2
acuta M 2
aegopodii M 2
arundinacea M 2
bifrons M 2
duplex M 2
hederae M 2
Lauri M 2
Lonicerae M 2
semi-immersa M 2
subconfluens M 2
taxi M 2
Cylindrosporium concentricum M 2
Daedalea biennis M 1
Didymium album *Nees.* M 2
cinereum *Batsch.* M 2
farinaceum *Fr.* M 2 L 2
hemisphaericum *Bull.* M 2
nutans *Pers.* M 2
physaroides *Pers.* M 2 U 2
Elaphomyces granulatus *Alb. et Schw.* M 2
Foenaria sanguinea *Pim.* L 2
Gymnoascus fraxini *de Not* L 2
Hebeloma scabrum *Mull.* U 2
Helvella mitra L 2
Heterosphaeria sclerodermis *Mass.* L 2
Himantia candida *Pers.* M 2
Humaria auriflava *Cooke.* L 2
Hydnum cyathiforme (*Schaeff.*) M 2
imbricatum (*Linn.*) M 1
stenodon *Pers.* L 2
uber L 2
Hymenochaete ferruginea *Bres.* L 2
Hypholoma fasciculatum L 2
Hysterium gramineum M 2.
Irpex pachyodon *Bres.* L 2
Laestadia Rabenhorstii *Sacc.* U 1
Leptolegnia bandoniensis *Swan.* M 1
Leptomitus pisidicola L 2
Lycoperdon excipuliforme [*Pers.*] M 2

UNCERTAIN OR DOUBTFUL SPECIES—*continued.*

Lycoperdon Proteus *With.* Ireland
Macrosporium Solani Ireland
Merulius androsaceus *Sow.* L 2
cantharellus *Sow.* L 2
squamula *Sow.* L 2
umbelliferus *Bolton.* L 2
Mortierella sp. L 2
Mycena spinipes M 2
Myxotrichum deflexum *Berk.* L 2
Nectria lagenae *Mass.* L 2
Nodularia harveyana L 2
Odontia crinalis *Fr.* L 2
uda *Fr.* L 2
Omphalia ericetorum M 2
Peronospora nivea *Ung.* L 2 U 1
schleideniana *de Bary.* L 2
Peziza atrobrunnea *Phill.* C 1
Phallus esculentus L 1
Phialea chrysocoma M 2
cinerea M 2
claro-flava M 2
conigena M 2
herbarum M 2
pedicellata M 2
vulgaris *var.* β. diaphana M 2
Phlebia livida *Bres.* L 2
mesenterica *Dicks.* M 2
Phragmidium bulbosum *Link.* M 1 U 1 2
mucronatum *Link.* U 1 2
Pilobolus roridus *Schum.* M 2 L 2
Polyporus calopus M 2
lucidus (*Fr.*) M 1
luridus M 2
luteus M 2
suaveolens *Linn.* M 2
Polysticta carmichaelianus M 2
Poria sanguinolenta (*A.* & *S.*) L 2
Psilocybe bullata *Bull.* L 3
Puccinia circaeae *Pers.* M 2 L 2 3 U 2
Puccinia compositarum *Schlecht.* U 1 2
fallens *Cooke.* U 1 2
glomerata *Link.* U 1
graveolens *Pers.* L 3
lychnidearum *Link.* C 1 L 3 U 1
silenes *Scv.* L 2
tumida [*Grev.*] M 2
umbelliferum M 2
Reticularia hydnoides Ireland
Rhacodium cellulare [*Pers.*] L 2
Rhizomorpha divergens *Grev.* M 2
subcorticalis *Pers.* M 2
Rhytisma corrugatum M 2
Russula lepias L 2
Saprolegnia philomukes *W. Sm.* L 2
Scleroderma geaster (*Fr.*) L 2
Sclerotium durum [*Pers.*] M 2
pteridis M 2
varium *Pers.* M 2
Sparassis laminosa (*Fr.*) U 2
Sphaeria botryosa *Fr.* L 2
ocellata *B.* & *Br.* U 2
profusa *Sow.* M 2
Sphaeronema subulatum M 2
Sporotrichum sulphureum [*Grev.*] M 2
tenuissimum M 2
Stagnospora pini U 1
Stemonitis fasciculata M 2
Thelephora calcea M 2
corium M 2
fraxinea M 2
incrastans M 2
intybacea (*Pers.*) M 2
Tremella ferruginea M 1
intestina Ireland
tremella *Fr.* M 1
Trichia nuda L 2
Typhula gyrans (*Fr.*) M 2
Uredo frumenti L 1
Verticillium epimyces *B.* & *Br.* L 2

APPENDIX II.

LIST OF SYNONYMS.

These are arranged in alphabetical order. The name given first is that under which the species was originally recorded, while the second is the one under which the species is recorded in the foregoing list. Authors' names in square brackets denote that these authors' names were not quoted in the original record; but there is every reason to believe that they are correct.

Acrosporium fasciculatum *Grev.* = Oospora fasciculata *S. & V.*
Aecidium Allii *Grev.* = Puccinia sessilis *Schneid.*
  Aquilegiae [*Pers.*] = Puccinia Agrostidis *Plow.*
  Ari *Berk.* = Puccinia Phalaridis *Plow.*
  Berberidis *Pers.* = Puccinia graminis *Pers.*
  Calthae *Grev.* = Puccinia Calthae *Link.*
  cancellatum *Pers.* = Gymnosporangium Sabinae *Wint.*
  compositarum var. Tussilaginis *P.* = Puccinia poarum *Nielsen.*
  ,, ,, Jacobaeae *Grev.* = Puccinia sylvatica *Schröt.*
  cornutum [*Gmel.*] = Gymnosporangium juniperinum *Fr.*
  crassum *Pers.* = Puccinia coronata *Corda.*
  Epilobii *DC.* = Puccinia Epilobii *DC.*
  Euphorbiae *Pers.* = Endophyllum Euphorbiae *DC.*
  Grossulariae *Schum.* = Puccinia pringsheimiana *Klebahn.*
  laceratum *Sow.* = Gymnosporangium clavariiforme *Rees.*
  leucospermum [*DC.*] = Puccinia fusca *Relh.*
  Menthae *DC.* = Puccinia Menthae *Pers.*
  Pini [*Pers.*] = Coleosporium Senecionis *Fr.*
  Primulae *DC.* = Puccinia Primulae *Duby.*
  Ranunculacearum *DC.* = Uromyces Dactylidis *Otth.*
  Sonchi *West* = Coleosporium Sonchi *Lev.*
  Taraxaci *K. et Schm.* = Puccinia Prenanthis *Fuck.*
  Tussilaginis [*Gmel.*] = Puccinia poarum *Nielsen.*
  Urticae *DC.* = Puccinia Caricis *Reb.*
  Violae *Schum.* = Puccinia Violae *DC.*
Aethalium septicum *Fr.* = Fuligo septica *Gmel.*
Agaricus lateritius *Schaeff.* = Psilocybe sublateritius *Fr.*
  tortilis *Bolt.* = Clitocybe tortilis *Bolt.*
Aleuria granulata *Bull.* = Humaria granulata *Sacc.*
  humosa *Fr.* = Humaria humosa *Sacc.*
Amanita adnata *Sm.* = Amanitopsis adnata *W. G. Sm.*

List of Synonyms—*continued.*

Amanita ceciliae *B. & Br.* = Amanitopsis strangulata *Rosl.*
cristata *Fr.* = Lepiota cristata *A. & S.*
vaginata *Bull.* = Amanitopsis vaginata *Bull.*
Arcyria cinerea *Schum.* = A. albida *Pers.*
Aregma bulbosum *Fr.* = Phragmidium Rubi *Pers.*
gracile *Grev.* = Phragmidium Rubi-idaei *Pers.*
Ascomyces deformans *Berk.* = Exoascus deformans *Fuck.*
Ascophora Mucedo *Tode* = Rhizopus nigricans *Ehrenb.*
Asterophora agaricola *Corda* = Nyctalis asterophora *Fr.*
Auricularia ferruginea [*Bull*] = Stereum ferrugineum *Fr.*

Barlaea Crouani *Mass.* = Plicariella Crouani *Rehm.*
Boletus Grevillei *Kl.* = B. flavus *With.*
suberosus [*Sow.*] = Fomes cytisinus *Berk.*
Bulgaria inquinans *Fr.* = B. polymorpha *Wett.*

Calloria chrysostigma [*Phill,*] = Pezizella chrysostigma *Sacc.*
vinosa *A. & S.* = Orbilia vinosa *Karst.*
xanthostigma *Fr.* = Orbilia xanthostigma *Fr.*
Cantharellus lutescens [*Fr.*] = Craterellus lutescens *Fr.*
undulatus [*Fr.*] = Thelephora undulata *Fr.*
Cenangium ferruginosum [*Fr.*] = C. abietis *Rehm.*
Chaetomium elatum *Kunze* = C. comatum *Fr.*
Chaetosphaeria phaeostroma *Fuck.* = C. tristis *Schröt.*
Clavaria cornea *Fr.* = Calocera cornea *Wint.*
ericetorum [*Pers. b.*] = C. argillacea *Fr.*
hypoxylon [*Linn.*] = Xylaria hypoxylon *Grev.*
pratensis *Pers.* = C. fastigiata *Berk.*
Clitocybe gigantea *Fr.* = Paxillus giganteus *Fr.*
Coleosporium petasites *Lév.* (*& DC.*) = C. Sonchi *Pers.*
rhinanthacearum *Lév.* = C. Euphrasiae *Schm.*
sonchi-arvensis *Lév.* = C. Sonchi *Pers.*
tussilaginis *Lév.* = C. Sonchi *Pers.*
Comatricha Friesiana *de Bary* = C. obtusata *Preuss.*
Corticium quercinum *Pers.* = Peniophora quercina *Cooke.*
roseum *Pers.* = Peniophora rosea *Mass.*
velutinum *Fr.* = Peniophora velutina *Cooke.*
Cortinarius caperatus *Fr.* = Pholiota caperata *Pers.*
Craterium minutum *Fr.* = C. pedunculatum *Trent.*
Cribraria micropus [*Schrad.*] = C. argillacea *Pers.*
Cryptosphaeria faginea [*Grev.*] = Dichaena faginea *Fr.*
herbarum = Pleospora herbarum *Rabh.*

LIST OF SYNONYMS—*continued.*

Cryptosphaeria millepunctata [*Grev.*] = Valsa eunomia *Vitset.*
punctiformis [*Pers.*] = Mycosphaerella punctiformis *Rabh.*
strobilina = Dichaena strobilina *Fr.*
Cucurbitaria coccinea [*Grev.*] = Nectria coccinea *Fr.*

Dactylium dendroides *Fr.* = Hypomyces rosellus *Tul.*
Dematium articulatum [*Pers.*] = Cladosporium fasciculare *Fr.*
Diatrype ferruginea *Fr.* = Sillia ferruginea *Karst.*
nucleata *Curr.* = Diatrypella nucleata *Sacc.*
quercina *Tul.* = Diatrypella pulvinata *Nits.*
strumella *Fr.* = Diatrypella strumella *Fuck*
verrucaeformis *Fr.* = Diatrypella verrucaeformis *Fuck.*
Diderma globosum [*Pers.*] = Chondrioderma globosum *Rost.*
vernicosum *Pers.* = Leocarpus vernicosus *Link.*
Didymium furfuraceum *Fr.* = Physarum nutans *Pers.*
melanopus *Fr.* = Didymium farinaceum *Schrad.*
Dothidea filicina *Fr.* = Rhopographus filicinus *Fuck.*
typhina *Pers.* = Epichloe typhina *Tul.*
ulmi *Fr.* = Phyllachora Ulmi *Fuck.*
Eccilia variabilis *Pers.* = Claudopus variabilis *Pers.*
Elaphomyces granulatus *Fr.* = E. cervinus *Schröt.*
muricatus *Fr.* = E. variegatus *Vitt.*
Erineum aureum [*Pers.*] = Taphrina aurea *Fr.*
Erysiphe communis *Schl.* = E. cichoracearum *DC.*
lamprocarpa*Lév.* = E. Galeopsidis *DC.*
Martii *Link.* = E. Polygoni *DC.*
Montagnei *Lév.* = E. cichoracearum *DC.*
Eurotium herbariorum *Link.* = Aspergillus glaucus *Link.*
Eutypa Acharii *Tul.* = Valsa eutypa *Wint.*
flavovirescens *Tul.* = Valsa flavovirescens *Wint.*
lata *Tul.* = Valsa lata *Nitsch.*
Eutypella Prunastri [*Pers.*] = Valsa Prunastri *Wint.*
stellulata *Sacc.* = Valsa stellulata *Fr.*

Fusicladium dendriticum *Wallr.* = Venturia inaequalis *Aderh.*

Galera sphagnorum *Pers.* = G. hypnorum *Batsch.*
Ganoderma applanatum *Fr.* = Fomes applanatus *Wallr.*
Geopyxis ammophila *Sacc.* = Peziza ammophila *D. & M.*
coccinea *Mass.* = Peziza coccinea *Jacq.*
cupularis *Sacc.* = Peziza cupularis *Linn.*
Gnomoniella vulgaris *Sacc.* = G. Gnomon *Schröt.*
Gyrodon rubellus *McW.* = Boletus McWeenyi *W. G. Sm.*

LIST OF SYNONYMS—*continued.*

Hebeloma calamistrata *Fr.* = Inocybe calamistrata *Gill.*
euthela *B. & Br.* = Inocybe eutheles *Quél.*
fastigata *Fr.* = Inocybe fastigata *Quél.*
fibrosa *Sow.* = Inocybe fibrosa *Gill.*
flocculenta *Bull.* = Inocybe lanuginosa *Quél.*
flocculosa *Berk.* = Inocybe flocculosa *Sacc.*
geophylla *Sow.* = Inocybe geophylla *Quél.*
hiulca *Fr.* = Inocybe hiulca *Gill.*
plumosa *Bolt.* = Inocybe plumosa *Quél.*
pyriodora *Pers.* = Inocybe pyriodora *Quél.*
rimosa *Bull.* = Inocybe rimosa *Quél.*
Helminthosporium gramineum *Rabh.* = Pleospora trichostoma *Died.*
Helotium aeruginosum *Fr.* = Chlorosplenium aeruginosum *de Not.*
calyculus *Fr.* = Hymenoscypha calyculus *Phill.*
Helvella mitra [*Schaeff.*] = Helvella lacunosa *Afz.*
Humaria hinnulea *B. & Br.* = Sphaerospora hinnulea *Mass.*
Hymenoscypha tuba *Bolt.* = Helotium tuba *Fr.*
Hypochnus ferrugineus *Pers.* = Corticium ferrugineum *Pers.*
Hypoxylon concentricum *Grev.* = Daldinia concentrica *Ces. et Not.*
Hysterium arundinaceum [*Schrad.*] = Lophodermium arundinaceum *Chev.*
foliicolum [*Fr.*] = Lophodermium hysterioides *Sacc.*
fraxini *Pers.* = Hysterographium fraxinum *de Not.*
juniperinum *D.N.* = Lophodermium juniperinum *de Not.*
lineare [*Fr.*] = Glonium lineare *de Not.*
pinastri *Schrad.* = Lophodermium pinastri *Chev.*
rubi [*Pers.*] = Hypoderma virgultorum *DC.*
virgultorum *DC.* = Hypoderma virgultorum *DC.*

Laccaria bella *Pers.* = Clitocybe bella *Fr.*
laccata *Scop.* = Clitocybe laccata *Scop.*
Lachnea bicolor [*Bull.*] = Dasyscypha bicolor *Fuck.*
coccinea *Jacq.* = Geopyxis coccinea *Mass.*
hinnulea *B. & Br.* = Sphaerospora hinnulea *Mass.*
papillaris [*Phill.*] = Dasyscypha papillaris *Mass.*
plano-umbilicata [*Grev.*] = Trichopeziza plano-umbilica *Sacc.*
trechispora *B. & Br.* = Sphaerospora trechispora *Sacc.*
umbrosa [*r.*] = L. umbrorum *Gill.*
virginea [*Batsch.*] = Dasyscypha virginea *Fuck.*
Lactarius exsuccus *Otto* = Russula delica *Fr.*
Lecythea lini *Lév.* = Melampsora Lini *Pers.*
Lepista nuda *Bull.* = Tricholoma nudum *Quél.*
personata *Fr.* = Tricholoma personatum *Quel.*

LIST OF SYNONYMS—*continued.*

Licea cylindrica *Fr.* = Dictydiaethalium plumbeum *Rost.*
fragiformis *Fr.* = Tubulina fragiformis *Pers.*
Lycogala epidendrum *Fr.* = L. miniatum *Pers.*
Lycoperdon giganteum *Batsch.* = L. Bovista *Linn.*
globosum *Bolton* = Bovista nigrescens *Pers.*
nigrescens *Vitt.* = Bovista nigrescens *Pers.*
plumbeum *Pers.* = Bovista plumbea *Pers.*
pratense *Pers.* = L. gemmatum *Batsch.*
pusillum *Batsch.* = Bovista pusilla *Pers.*

Melampsora euphorbiae *Cast.* = M. Helioscopiae *Pers.*
salicina *Lév.* = M. farinosa *Pers.*
Microsphaera comata *Lév.* = M. Evonymi *Sacc.*
Mitrophora gigas *Lév.* = Morchella gigas *Pers.*
semilibera *Lév.* = Morchella semilibera *DC.*
Mitrula abietis [*Fr.*] = M. cucullata *Fr.*
paludosa *Fr.* = M. phalloides *Chev.*
Mucor stolonifer *Ehr.* = Rhizopus nigricans *Ehr.*

Nemaspora crocea *Pers.* = Sphaeria profusa *Sow.*
Nidularia campanulata *With.* = Cyathus vernicosus *DC.*
crucibulum [*Fr.*] = Crucibulum vulgare *Tul.*
striata *Bull.* = Cyathus striatus *Hoffm.*
Nolanea aethiops *Fr.* = Leptonia aethiops *Fr.*

Oidium balsamii *B. & Br.* = Erysibe Polygoni *DC.*
lactis [*Fres.*] = Oospora lactis *Sacc.*
Tuckeri *Berk.* = Uncinula necator *Burr.*
Olpidiopsis Saprolegniae *Cornu.* = Diplophysa Saprolegniae *Schroet.*

Panaeolus fimiputris *Bull.* = Anellaria fimiputris *Karst.*
separatus *Linn.* = Anellaria separata *Karst.*
Patellaria Carestiae *de Not.* = Durella Carestiae *Sacc.*
Penicillium crustaceum *Fr.* = P. glaucum *Link.*
olivaceum *Corda.* = Briarea orbicula *Bon.*
Peronospora gangliformis *Berk.* = Bremia Lactucae *Regel.*
pygmaea *Ung.* = Plasmopara pygmaea *Schroet.*
Peziza acicularis *Bull.* = Helotium aciculare *Pers.*
atrata *Pers.* = Mollisia atrata *Karst.*
aurantia *Fr.* = Otidea aurantia *Mass.*
bicolor *Bull.* = Dasyscypha bicolor *Fuck.*
brunnea *A. & S.* = Sphaerospora brunnea *Mass.*
calycina *Schum.* = Dasyscypha calycina *.Fuck*

LIST OF SYNONYMS—*continued.*

Peziza cinerea *Batsch.* = Mollisia cinerea *Karst.*
  claroflava *Grev.* = Helotium claroflavum *Berk*
  coccinea *Jacq.* = Geopyxis coccinea *Mass.*
  cochleata *Linn.* = Otidea cochleata *Fuck.*
  cyathoidea *Bull.* = Hymenoscypha cyathoidea *Phill.*
  exidiiformis *B. & Br.* Humaria exidiiformis *Sacc.*
  faginea *Pers.* = Helotium fagineum *Fr.*
  fructigena *Bull.* = Helotium virgultorum *Karst.*
  fusarioides *Berk.* = Calloria fusarioides *Fr.*
  granulata *Fr.* = Humaria granulata *Bull.*
  hinnulea *B. & Br.* = Sphaerospora hinnulea *Mass.*
  humosa *Fr.* = Humaria humosa *Sacc.*
  inflexa *Bolt.* = Cyathicula coronata *De Not.*
  leporina *Batsch.* = Otidea leporina *Fuck.*
  nivea *Fr.* = Lachnella nivea *Phill.*
  papillaris *Bull.* = Dasyscypha papillaris *Mass.*
  postuma *Berk. & Wilson* = Sclerotinia sclerotiorum *Mass*
  rutilans *Fr.* = Humaria rutilans *Sacc.*
  sclerotiorum [*Lib.*] = Sclerotinia sclerotiorum *Mass.*
  scutellata *Linn.* = Lachnea scutellata *Gill.*
  stercorea *Pers.* (*& Fr.*) = Lachnea stercorea *Gill.*
  trechispora *B. & Br.* = Sphaerospora trechispora *Sacc.*
  villosa *Pers.* = Cyphella villosa *Karst.*
  violacea *Pers.* = Humaria violacea *Sacc.*
  virginea *Batsch.* = Dasyscypha virginea *Fuck.*
  Wilkommii *Hartig.* = Dasyscypha calycina *Fuck.*
Pezizella chrysostigma *Sacc.* = Mollisia flaveola *Phill.*
Phacidium coronatum *Fr.* = Coccomyces coronatus *De Not.*
  ilicis *Fr.* = P. multivalve *Kunz. et Schum.*
  trifolii *Boud.* = Pseudopeziza Trifolii *Fuck.*
Phallus esculentus *Sow.* = Morchella esculenta *Sow.*
  impudicus *Linn.* = Ithyphallus impudicus *Fisch.*
Phoma Betae *Frank.* = Mycosphaerella tabifica *Prill. et Del.*
Phragmidium gracile *Grev.* = P. Rubi-idaei *Pers.*
  obtusatum *Fr.* = P. Tormentillae *Fuck.*
  obtusum *Link.* = P. Potentillae *Karst.*
Phyllachora aegopodii *Fuck.* = P. Podagrariae *Karst.*
Phyllactinia guttata *Lév.* = P. corylea *Karst.*
Physarum bulbiforme *Schum.* = P. nutans *Pers.*
  sinuosum [*Bull.*] = P. bivalve *Pers.*
Pleospora herbarum *Pers.* = Laestadia Rabenhorsti *Sacc.*
Pluteus nidorosus *Fr.* = Entoloma nidorosum *Fr.*

LIST OF SYNONYMS—*continued.*

Podisoma juniperi *Fr.* = Gymnosporangium clavariaeforme *Rees.*
 juniperi-sabinae *Fr.* = Gymnosporangium clavariaeforme *Rees.*
Podosphaera clandestina *Lév.* = P. oxyacanthae *de Bary.*
 myrtillina *Kunze.* = P. oxyacanthae *de Bary.*
Polyporus abietinus [*Fr.*] = Polystictus abietinus *Cooke.*
 annosus *Fr.* = Fomes annosus *Cooke.*
 ferrugineus *Fr.* = Poria ferruginosa *Karst.*
 fibula *Fr.* = Polystictus fibula *Fr.*
 fomentarius *Fr.* = Fomes fomentarius *Karst.*
 fraxineus *Fr.* = Fomes fraxineus *Cooke.*
 hibernicus *B. & Br.* = Poria hibernica *Cooke.*
 igniarius *Linn.* = Fomes igniarius *Fr.*
 molluscus *Pers.* = Poria mollusca *Cooke.*
 obducens *Fr.* = Poria obducens *Cooke.*
 purpureus *Fr.* = Poria purpurea *Cooke*
 radiatus *Fr.* = Polystictus radiatus *Cooke.*
 salicinus *Grev.* = Fomes salicinus *Karst.*
 vaporarius *Fr.* = Poria vaporaria *Cooke.*
 velutinus *Fr.* = Polystictus velutinus *Cooke.*
 versicolor *Linn.* = Polystictus versicolor *Fr.*
 violaceus *Fr.* = Poria violacea *Cooke.*
 vitreus [*Pers.*] = Poria vitrea *Pers.*
 vulgaris *Pers.* = Poria vulgaris *Cooke.*
 Wynnei [*B. & Br.*] = Polystictus Wynnei *Cooke.*
Polystictus hibernica *B. & Br.* = Poria hibernica *Cooke.*
 perennis *Fr.* = Polyporus perennis *Fr.*
Protomyces menyanthis *de Bary.* = Physoderma menyanthis *de Bary.*
Psathyra disseminata *Fr.* = Psathyrella disseminata *Quél.*
 hiascens *Fr.* = Psathyrella hiascens *Quél.*
Ptychogaster albus *Corda.* = Ceriomyces albus *Sacc.*
Puccinia anemones [*Pers.*] = P. fusca *Relh.*
 apii *Corda.* = P. bullata *Schroet.*
 arundinacea *Hedw.* = P. phragmitis *Schum.*
 centaureae *Mart.* = P. Hieracii *Schum.*
 fabae *Link.* = Uromyces fabae *Pers.*
 globosa [*Grev.*] = Uromyces fabae *Pers.*
 gracilis [*Grev.*] = Phragmidium Rubi-idaei *Karst.*
 luzulae [*Lib.*] = P. oblongata *Link.*
 Potentillae [*Pers.*] = Phragmidium Potentillae *Karst.*
 pulverulenta *Grev.* = P. Epilobii *DC.*
 rubi [*Sow.*] = Phragmidium Rubi *Pers.*
 striola *Link.* = P. Caricis *Schum.*

LIST OF SYNONYMS—*continued.*

Puccinia variabilis *Grev.* = P. Hieracii *Schum.*
veronicarum *DC.* = P. Veronicae *Wint.*
violarum *Link.* = P. violae *Schum.*

Reticularia umbrina *Fr.* = R. Lycoperdon *Bull.*
Rhizophydium Dicksonii *E. P. Wright.* = Eurychasma Dicksonii *Magnus.*
Roestelia lacerata *Tul.* = Gymnosporangium clavariiforme *Rees.*
Rosellinia mastoidea *Fr.* – R. mammaeformis *Ces. et Not.*

Schinzia Alni *Wor.* = Plasmodiophora Alni *Möll.*
Septoria Ulmi [*Fr.*] = Pleospora Ulmi *Wallr,*
Soppittiella caesia *Mass.* = Thelephora caesia *Pers.*
cristata *Mass.* = Thelephora cristata *Fr.*
sebacea *Mass.* = Thelephora sebacea *Berk.*
Sordaria fimicola *Ces. et de Not.* = Hypocopra fimicola *Sacc.*
Sphaeria acuta *Hoff.* (*& Moug.*) = Leptosphaeria acuta *Karst.*
aquila *Fr.* = Rosellinia aquila *de Not.*
canescens *Pers.* = Lasiosphaeria canescens *Karst.*
capitata *Holmsk.* = Cordyceps capitata *Link.*
cinnabarina *Tode.* = Nectria cinnabarina *Fr.*
coccinea *Pers.* = Nectria coccinea *Fr.*
deusta *Hoff.* = Ustulina vulgaris *Tul.*
disciformis *Hoff,* = Diatrype disciformis *Fr.*
fragiformis *Pers.* = Hypoxylon coccineum *Bull.*
gnomon *Tode.* = Gnomoniella vulgaris *Sacc.*
hirsuta [*Fr.*] = Lasiosphaeria hirsuta *Ces. et de Not.*
hypoxylon *Linn.* Xylaria Hypoxylon *Grev.*
Keitii *B. & Br.* = Herpotrichia Keitii *Sacc.*
lata *Pers.* = Eutypa lata *Tul.*
macrotricha *B. & Br.* = Herpotrichia macrotricha *Sacc.*
mammiformis *Pers.* = Rosellinia mammiformis *Ces. et de Not.*
militaris *Linn.* = Cordyceps militaris *Link.*
moriformis *Tode* = Bertia moriformis *de Not.*
ochracea *Grev.* = Nectria ochracea *Fr.*
ophioglossoides *Ehr.* = Cordyceps ophioglossoides *Link.*
Peziza [*Tode*] = Nectria Peziza *Fr.*
phaeocomes *Reb.* = Pyrenophora phaeocomes *Sacc.*
phaeostroma *Mont.* = Chaetosphaeria phaeostroma *Fuck.*
pinodes *B. & Blox.* = Sphaerella pinodes *Niessl.*
pulvinus-pyrius *Pers.* = Melanomma Pulvis-pyrius *Fuck.*
scirpicola *DC.* = Pleospora scirpicola *Karst.*
spermioides *Hoffm.* = Lasiosphaeria spermioides *Ces. et de Not.*
stercoraria [*Sow.*] = Hypocopra stercoraria *Sacc.*

LIST OF SYNONYMS—*continued.*

Sphaeria stigma *Hoff.* = Diatrype stigma *Fr.*
taxi [*Sow.*] = Diplodia Taxi *de Not.*
tiliae *Pers.* = Hercospora Tiliae *Tul.*
tuberculosa [*Sow.*] = Hypoxylon fuscum *Fr.*
Spongospora solani *Brunch* = S. subterranea *Johns.*
Stemonitis obtusata *Fr.* = Comatricha obtusata *Preuss.*
ovata *Pers.* = Comatricha obtusata *Preuss.*
typhoides [*Auct.*] = Comatricha typhoides *Rost.*
Stictis lichenicola *Mont.* = Melittosporium lichenicolum *Mass.*
Stigmatea geranii *Fr.* = Venturia Geranii *Wint.*
ranunculi *Fr.* = Pseudopeziza Ranunculi *Fuck.*
Stilbum bicolor *Pers.* = Stilbella bicolor *Lind.*
erythrocephalum [*Ditm.*] = Stilbella erythrocephala *Lind.*
fimetarium *B. & Br.* = Stilbella fimetaria *Lind.*
tomentosum *Schr.* = Stilbella tomentosa *Lind.*
Stromatosphaeria corniculata [*Grev.*] = Diatrype corniculata *B. & Br.*
decorticata [*Grev.*] = Diatrype stigma *Fr.*
deusta [*Grev.*] = Ustulina vulgaris *Tul.*
disciformis [*Grev.*] = Diatrype disciformis *Fr.*
elliptica [*Grev.*] = Hypoxylon rubiginosum *Fr.*
fusca [*Grev.*] = Hypoxylon fuscum *Fr.*
lata [*Grev.*] = Valsa lata *Nitsch.*
multiceps [*Grev.*] = Valsa flavovirescens *Wint.*

Thelephora avellana *Boiss.* = Hymenochaete Avellana *Lév.*
byssoides *Pers.* = Coniophora byssoidea *Karst.*
calcea [*Eng. Fl.*] = Corticium calceum *Fr.*
cinerea *Pers.* = Corticium cinereum *Pers.*
epidermea *Pers.* = Corticium confluens *Fr.*
granulosa *Pers.* = Grandinia granulosa *Fr.*
hirsuta *Willd.* = Stereum hirsutum *Fr.*
ochracea *Fr.* = Corticium ochraceum *Fr.*
purpurea *Pers.* = Stereum purpureum *Pers.*
quercina *Pers.* = Peniophora quercina *Cooke.*
rubiginosa *Schrad.* = Hymenochaete rubiginosa *Lév.*
rugosa *Pers.* = Stereum rugosum *Pers.*
sanguinolenta *A. & S.* = Stereum sanguinolentum *Fr.*
Tilletia caries *Tul.* = T. tritici *Wint.*
Togaria aurea *Bull.* = Pholiota aurea *Matt.*
Torrubia militaris *Fr.* = Cordyceps militaris *Link.*
Tremella albida *Huds.* = Exidia albida *Bref.*
arborea [*Huds.*] = Exidia glandulosa *Fr.*

List of Synonyms—*continued.*

Tremella foliacea *Pers.* = Ulocolla foliacea *Bref.*
  indecorata *Sommf.* = Exidia indecorata *Karst.*
  sarcoides *With.* = Ombrophila sp.
Trichia chrysosperma *DC.* = T. favoginea *Pers.*
  serotina *Schrad.* = Alwisia Bombarda *B. & Br.*
  serpula *Pers.* = Hemitrichia Serpula *Rost.*
  turbinata *With.* = T. favoginea *Pers.*
Trichobasis petroselini *Berk.* = Puccinia bullata *Pers.*
  rumicum *DC.* = Uromyces Rumicis *Schum.*
  suaveolens *Lév.* = Puccinia suaveolens *Pers.*
Tuber cibarium [*Sow.*] = T. aestivum *Vitt.*
Tubercularia vulgaris *Tode* = Nectria cinnabarina *Fr.*
Tubulina cylindrica *Rost.* = T. fragiformis *Pers.*

Uncinula adunca *Lév.* = U. Salicis *Wint.*
  bicornis *Lév.* = U. Aceris *Sacc.*
  spiralis *Berk. et Curt.* = U. necator *Burr.*
  Wallrothii *Lév.* = U. Prunastri *Sacc.*
Uredo bifrons *Grev.* = Uromyces Rumicis *Wint.*
  campanulae [*Pers.*] = Coleosporium Campanulae *Lév.*
  candida *Pers.* = Cystopus candidus *Lév.*
  cichoracearum [*DC.*] = Puccinia Hieracii *Schum.*
  euphorbiae *Reb.* = Melampsora Helioscopiae *Cast.*
  farinosa [*Pers.*] = Melampsora farinosa *Schroet.*
  flosculorum [*DC.*] = Ustilago Scabiosa *Wint.*
  gyrosa *Reb.* = Phragmidium Rubi-idaei *Karst.*
  Helioscopiae [*Pers.*] = Melampsora Helioscopiae *Cast.*
  Heraclei [*Grev.*] = Puccinia Pimpinellae *Strauss.*
  hypericorum *DC.* = Melampsora hypericorum *DC.*
  Labiatarum [*DC.*] = Puccinia Menthae *Pers.*
  linearis [*Lév.*] = Puccinia graminis *Pers.*
  Lini [*DC.*] = Melampsora Lini *Tul.*
  oblongata [*Grev.*] = Puccinia oblongata *Link.*
  ovata [*Grev.*] = Melampsora betulina *Tul.*
  Populina [*Grev.*] = Melampsora populina *Jacq.*
  potentillarum *DC.* = Phragmidium Potentillae *Karst.*
  primulae *DC.* = Puccinia Primulae *Duby.*
  Rhinanthacearum [*DC.*] = Coleosporium Euphrasiae *Wint.*
  rosae *DC.* = Phragmidium subcorticatum *Wint.*
  Ruborum [*DC.*] = Phragmidium Rubi *Wint.*
  Rumicum [*DC.*] = Uromyces Rumicis *Wint.*
  segetum *Pers.* = Ustilago segetum *Ditm.*

LIST OF SYNONYMS—*continued.*

Uredo senecionis *Sch.* = Coleosporium Senecionis *Fr.*
suaveolens [*Pers.*] = Puccinia suaveolens *Rostr.*
Tussilaginis [*Schum.*] = Coleosporium Sonchi *Lév.*
violarum *DC.* = Puccinia Violae *DC.*
vitellinae [*DC.*] = Melampsora Vitellinae *Thüm.*
Urocystis pompholygodes *Schlecht.* = U. Anemones *Wint.*
Uromyces apiculosa *Lév.* = U. Rumicis *Wint.*
appendiculata *Lév.* = U. Fabae *Pers.*
concentrica *Lév.* = U. Scillarum *Wint.*
intrusa *Lév.* = U. Alchemillae *Pers.*
poae *Rabh.* = U. Dactylidis *Otth.*
Ustilago carbo *Tul.* = U. segetum *Wint.*
flosculorum *DC.* = U. Scabiosa *Wint.*
receptaculorum *Fr.* = U. Tragopogi *Schroet.*

Vibrissea margarita *White* = V. truncorum *Fr.*

Xyloma concavum [*Grev.*] = Stegia Ilicis *Fr.*

INDEX OF GENERA.

INDEX OF GENERA—*continued.*

INDEX OF GENERA—*continued.*

INDEX OF GENERA—*continued.*

V.

A LIST OF SYNONYMS OF IRISH ALGAE, WITH SOME ADDITIONAL RECORDS AND OBSERVATIONS.

By J. ADAMS, M.A.

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CONTENTS.

Introduction.

About two years ago I published a "Synopsis of Irish Algae," giving a list of the species observed in this country during a period of rather more than a hundred years. As the old name under which the species was first mentioned is in many cases quite different from that in use at the present time, a list of these names, with their modern equivalents, will obviously be of much service to future investigators of the group. Such a list is now available, the names of the genera and species in each group being arranged in alphabetical order, and the fresh-water species being given in a separate list from the marine species.

Great difference of opinion prevails among botanists as to the actual limits of a species. In the "Synopsis" I followed De Toni's "Sylloge Algarum" for the most part; but it is now more than twenty years since the first volume of that work was published. In 1908 the third volume of West's "Monograph of the British Desmidiaceae" appeared; and as that publication is likely to remain for a long time the standard work on the Desmids of the British Isles, it seems advisable to follow the views expressed therein on the limits of species and varieties. As several volumes, however, have still to appear, Professor West, of Birmingham, has kindly revised for me not only the Desmids, but the whole of the fresh-water species. As a result, a considerable number of names which were considered as species by De Toni, but which Professor West regards as only varieties, will disappear from the list. Furthermore, in a list containing over two thousand names, errors were bound to creep in. Some few species were included twice under a different name, and in several cases a marine species was put among the fresh-water species. These and some other errors are indicated in a separate section. Since the "Synopsis" was published a few additional sources of information on the distribution of Algae in Ireland have been discovered, of which the most important is Gough's Paper on the "Plankton collected at Irish Light Stations." Altogether new species to the number of 102 have been added, and these are given in a separate section. In addition to new species, a considerable number of new localities have been found for species already listed in the "Synopsis." In some other cases the records of distribution in the Provinces have been deleted, as the evidence in favour of their retention was regarded as insufficient. I have not thought it advisable to give a list of these new or deleted localities in the present Paper. There is, however, appended a revised census of species, giving the figures as they stand at present. There is, finally, a list of additional Bibliographical items, which, it is hoped, makes this section complete to the end of the year 1909.

LIST OF SYNONYMS.

The name in the first column is that under which the species was previously recorded in Ireland, while the name in the second column is that in use at the present time. The symbol = means that the specimen is identical with or is included under the name which follows.

A.—FRESH-WATER SPECIES.

I. Peridinieae.

Peridinium
 alatum Garbini = P. Willei *Huitfeldt-Kaas.*

II.—Diatomaceae.

Achnanthes
 flexella *Bréb.* = Achnanthidium flexellum *Bréb.*

Achnanthidium
 coarctatum *Bréb.* = Achnanthes coarctata *Grun.*
 lanceolatum *Bréb.* = Achnanthes lanceolata *Grun.*
 lineare *W. Sm.* = Achnanthes linearis *Grun.*
 microcephalum *Kütz.* = Achnanthes microcephala *Grun.*

Amphora
 affinis *Kütz.* = A. ovalis *Kütz.*
 minutissima *W. Sm.* = A. ovalis *Kütz.*

II.—DIATOMACEAE—*continued.*

Campylodiscus
costatus *W. Sm.* = C. hibernicus *Ehr,*
spiralis *W. Sm.* = Surirella spiralis *Kütz.*

Ceratoneis
Amphioxys *Rabh.* = C. Arcus *Kütz.*

Cocconeis
Thwaitesii *W. Sm.* = Achnanthidium flexellum *Bréb.*

Cocconema
cistula *Ehr.* = Cymbella cistula *Kirchn.*
cymbiforme *Ehr.* = Cymbella cymbiformis *Ehr.*
cornutum *Ehr.* = Cymbella lanceolata *Kirchn.*
lanceolatum *Ehr.* = Cymbella lanceolata *Kirchn.*
parvum *W. Sm.* = Cymbella cymbiformis *Ehr.*

Colletonema
neglectum *Thw.* = Navicula gracilis *Kütz.*
vulgare *Thw.* = Vanheurckia vulgaris *H. Van. Heurck.*

Coscinodiscus
Smithii *W. Sm.* = Melosira distans *Kütz.*

Cyclotella
punctata *W. Sm.* = Coscinodiscus lacustris *Grun.*
Rotula *Kütz* = Stephanodiscus Astraea *Grun.*

Cymatopleura
apiculata *W. Sm.* = C. Solea *W. Sm.*
parallela *W. Sm.* = C. Regula *Ralfs.*

Cymbella
turgida *Greg.* = Encyonema turgidum *Grun.*
ventricosa *Ag.* = Encyonema ventricosum *Grun.*
zebra *Hass.* = Epithemia Zebra *Kütz.*

Denticula
crassula *Näg.* = D. tenuis *Kütz.*
mutabilis *W. Sm.* = Odontidium mutabile *W. Sm.*
obtusa *Kütz.* = Nitzschia Denticula *Grun.*
ocellata *W. Sm.* = D. elegans *Kütz.*
sinuata *Sm.* = Nitzschia sinuata *Grun.*

Diatoma
flocculosum *Ag.* = D. vulgare *Bory.*
grande *W. Sm.* = D. vulgare *Bory.*
tenue *Kütz.* = D. elongatum *Ag.*

Encyonema
caespitosum *Kütz.* = Cocconema caespitosum *G. S. West.*

II.—Diatomaceae—*continued.*

Epithemia
- granulata *Kütz.* = E. turgida *Kütz.*
- longicornis *Ehr.* = E. Argus *Kütz.*
- rupestris *W. Sm.* = E. gibberula *Kütz.*

Eunotia
- incisa *Greg.* = E. Veneris *Kütz.*

Exilaria
- fasciculata *Grev.* = Synedra pulchella *Kütz.*

Fragilaria
- aequalis *Heib.* = F. virescens *Ralfs.*
- hiemalis *Lyngb.* = Diatoma hiemale *Heib.*
- mesolepta *Rabh.* = F. capucina *Desmaz.*
- pectinalis *Lyngb.* = F. capucina *Desmaz.*
- rhabdosoma *Ehr.* = F. capucina *Desmaz.*
- undata *W. Sm.* = F. virescens *Ralfs.*

Frustulia
- fasciata *Ag.* = Synedra Ulna *Ehr.*
- neglecta *De Toni* = Navicula gracilis *Kütz.*
- saxonica *Rabh.* = Navicula rhomboides *Ehr.*
- Ulna *Kütz.* = Syneda Ulna *Ehr.*
- viridis *Kütz.* = Navicula viridis *Kütz.*
- vulgaris *De Toni* = Vanheurckia vulgaris *H. Van Heurck.*

Gomphonema
- Clavus *Bréb.* = G. acuminatum *Ehr.*
- curvatum *Kütz.* = Rhoicosphenia curvata *Grun.*
- hebridense *Greg.* = G. Vibrio *Ehr.*
- minutissimum *Grev.* = G. exiguum *Kütz.*
- minutum *Ag.* = G. dichotomum *Kütz.*
- rostratum *W. Sm.* = G. parvulum *Kütz.*

Grammatophora
- balfouriana *W. Sm.* = Diatomella balfouriana *Grev.*

Himantidium
- arcus *W. Sm.* = Eunotia Arcus *Ehr.*
- bidens *Ehr.* = Eunotia praerupta *Ehr.*
- gracile *Ehr.* = Eunotia gracilis *Rabh.*
- majus *W. Sm.* = Eunotia major *Rabh.*
- pectinale *Kütz.* = Eunotia pectinalis *Rabh.*
- Soleirolii *Kütz.* = Eunotia Soleirolii *Rabh.*
- undulatum *W. Sm.* = Eunotia pectinalis *Rabh.*

Navicula
- anglica *Ralfs.* = N. Placentula *Kütz.*

II.—Diatomaceae—*continued.*

Navicula
- arenaria *Donk.* = N. lanceolata *Kütz.*
- crassinervia *Bréb.* = Vanheurckia rhomboides *Bréb.*
- dirhynchus *Ehr.* = rhynchocephala *Kütz.*
- dubia *Ehr.* = N. Iridis *Ehr.*
- gracilis *Ehr.* = N. viridula *Kütz.*
- gracillima *Greg.* = N. mesolepta *Ehr.*
- Hebes *Ralfs.* = N. obtusa *W. Sm.*
- Heufleri *Grun.* = N. cincta *Kütz.*
- humilis *Donk.* = N. hungarica *Grun.*
- isocephala *Ehr.* = N. mesolepta *Ehr.*
- Kotschyi *Grun.* = N. Kotschyana *Grun.*
- lacustris *Greg.* = Stauroneis scandinavica *Lagerst.*
- minor *Greg.* = Synedra Vaucheriae *Kütz.*
- nodosa *Ehr.* = N. mesolepta *Ehr.*
- oblongella *Näg.* = N. elliptica *Kütz.*
- ovalis *W. Sm.* = N. elliptica *Kütz.*
- pachyptera *Ehr.* = N. lata *Bréb.*
- patula *W. Sm.* = N. latiuscula *Kütz.*
- subsalina *Ehr.* = N. Amphisbaena *Bory.*
- tumens *W. Sm.* = N. rostrata *Ehr.*
- tumida *W. Sm.* = N. Placentula *Kütz.*
- veneta *Kütz.* = N. cryptocephala *Kütz.*

Nitzschia
- tenuis *W. Sm.* = N. linearis *W. Sm.*

Nitzschiella
- acicularis *Rabh.* = Nitzschia acicularis *W. Sm.*

Odontidium
- anomalum *W. Sm.* = Diatoma anceps *Grun.*
- hiemale *Lyngb.* = Diatoma hiemale *Hieb.*
- inflatum *W. Sm.* = Denticula tenuis *Kütz.*
- mesodon *Ehr.* = Diatoma hiemale *Heib.*
- parasiticum *W. Sm.* = Fragilaria construens *Grun.*
- sinuatum *W. Sm.* = Nitzschia sinuata *Grun.*
- Tabellaria *W. Sm.* = Fragilaria construens *Grun.*

Orthosira
- arenaria *D. Moore* = Melosira arenaria *Moore.*
- Dickiei *Thw.* = Melosira Dickiei *Kütz.*
- orichalcea *W. Sm.* = Melosira crenulata *Kütz.*
- punctata *W. Sm.* = Melosira granulata *Ralfs.*
- Roeseana *Rabh.* = Melosira Roeseana *Rabh.*

II.—Diatomaceae—*continued.*

Pinnularia
acuminata *W. Sm.* = Navicula acuminata *W. Sm.*
acuta *W. Sm.* = Navicula radiosa *Kütz.*
alpina *W. Sm.* = Navicula alpina *Ralfs.*
borealis *Ehr.* = Navicula borealis *Kütz.*
Brebissonii *Rabh.* = Navicula Brebissonii *Kütz.*
cardinalis *Ehr.* = Navicula cardinalis *Ehr.*
divergens *W. Sm.* = Navicula divergens *Ralfs.*
gibba *Ehr.* = Navicula gibba *Kütz.*
hemiptera *Rabh.* = Navicula hemiptera *Kütz.*
interrupta *W. Sm.* = Navicula mesolepta *Ehr.*
latestriata *Greg.* = Navicula borealis *Kütz.*
major *Rabh.* = Navicula major *Kütz.*
mesolepta *W. Sm.* = Navicula mesolepta *Ehr.*
nobilis *Ehr.* = Navicula nobilis *Kütz.*
nodosa *W. Sm.* = Navicula Legumen *Ehr.*
oblonga *Rabh.* = Navicula oblonga *Kütz.*
Rabenhorstii *Ralfs.* = Navicula Rabenhorstii *Ralfs.*
radiosa *Rabh.* = Navicula radiosa *Kutz.*
stauroneiformis *W. Sm.* = Navicula Brebissonii *Kütz.*
Tabellaria *Ehr.* = Navicula Tabellaria *Kütz.*
viridis *W. Sm.* = Navicula viridis *Kütz.*

Pleurosigma
attenuatum *W. Sm.* = Gyrosigma attenuatum *Rabh.*
Spencerii *W. Sm.* = Gyrosigma Spencerii *O. K.*

Pleurosigma
Legumen *Rabh.* = Stauroneis Legumen *Ehr.*

Raphoneis
Harrisonii *W. Sm.* = Odontidium Harrisonii *W. Sm.*

Stauroneis
amphicephala *Kütz.* = S. anceps *Ehr.*
linearis *Ehr.* = S. anceps *Ehr.*
punctata *Kütz.* = Navicula Tuscula *Ehr.*

Surirella
angusta *Kutz.* = S. ovalis *Bréb.*
Brightwellii *W. Sm.* = S. ovalis *Bréb.*
Craticula *Ehr.* = Navicula sp.
crumena *Bréb.* = S. ovalis *Bréb.*
nobilis *W. Sm.* = S. robusta *Ehr.*
ovata *Kutz.* = S. ovalis *Bréb.*
panduriformis *W. Sm.* = S. ovalis *Bréb.*

II.—Diatomaceae—*continued.*

Surirella

pinnata *W. Sm.* = S. ovalis *Bréb.*
salina *W. Sm.* = S. ovalis *Bréb.*

Synedra

acuta *Kütz.* = S. Ulna *Ehr.*
debilis *Kütz.* = Nitzschia Palea *W. Sm.*
delicatissima *W. Sm.* = S. Acus *Kütz.*
longissima *W. Sm.* = S. Ulna *Ehr.*
lunaris *Ehr.* = Eunotia lunaris *Grun.*
obtusa *W. Sm.* = S. Ulna *Ehr.*
salina *W. Sm.* = S. Ulna *Ehr.*
splendens *Kütz.* = S. Ulna *Ehr.*

Tryblionella

angustata *W. Sm.* = Nitzschia angustata *Grun.*
debilis *Arn.* = Nitzschia debilis *Grun.*
gracilis *W. Sm.* = Nitzschia Tryblionella *Hantzsch.*
Hantzschiana *Grun.* = Nitzschia Tryblionella *Hantzsch.*
laevidensis *W. Sm.* = Nitzschia Tryblionella *Hantzsch.*
victoriae *Grun.* = Nitzschia Tryblionella *Hantzsch.*

III.—**Cyanophyceae**.

Anabaena

impalpebralis *Bory.* = Sphaerozyga flexuosa *Ag.*
intricata *Kütz.* = Nostoc Linckia *Born.*
licheniformis *Bory.* = Cylindrospermum licheniforme *Kütz.*
spiralis *Thompson* = A. circinalis *Rabh.*

Anacystis

marginata *Menegh.* = Microcystis marginata *Kutz.*

Aphanizomenon

recurvum *Morren* = A. Flos-aquae *Ralfs.*

Aphanocapsa

parietina *Näg.* = A. virescens *Rabh.*

Aphanothece

nidulans *Richter.* = A. clathrata *W. & G. S. West.*

Arthrosiphon

alatus *Grev.* = Scytonema alatum *Borzi.*

Byssus

purpurea *Lamarck.* = Porphyridium cruentum *Näg.*

Calothrix

Dillwynii *Cooke* = Desmonema Wrangelii *Born. et Flah.*
distorta *Ag.* = Tolypothrix distorta *Kütz.*

III.—Cyanophyceae—*continued.*

Calothrix
- interrupta *Carm.* = a Lichen.
- mirabilis *Kütz.* = Tolypothrix lanata *Wartm.*
- rhizomatoidea *Reinsch* = Hapalosiphon fontinalis *Born.*

Chroococcus
- minor *Näg.* = C. minimus *Lemm.*

Chthonoblastus
- lyngbyaceus *Thur.* = Hydrocoleus lyngbyaceus *Kütz.*
- repens *Kütz.* = Microcoleus vaginatus *Gom.*

Clathrocystis
- aeruginosa *Henfrey* = Microcystis aeruginosa *G. S. West.*

Coccochloris
- mooreana *Harv.* = Aphanothece prasina *A Br.*

Conferva
- Myochrous *Dillw.* = Scytonema Myochrous *Ag.*
- vaginata *Dillw.* = Microcoleus vaginatus *Gom.*

Cylindrospermum
- flexuosum *Rabh.* = Anabaena oscillarioides *Bory.*
- macrospermum *Kütz.* = C. stagnale *Born et Flah.*
- majus *Kütz.* = C. stagnale *Born. et Flah.*

Didymohelix
- ferruginea *Griffith* = Lyngbya ochracea *Thur.*

Gloeothece
- devia *Näg.* = G. rupestris *Born.*

Gloeotrichia
- Pisum *Thur.* = G. echinulata *P. Richter.*

Haematococcus
- lividus *Hass.* = Gloeocapsa livida *Kütz.*
- rupestris *Hass.* = Gloeocapsa polydermatica *Kütz.*

Hapalosiphon
- Braunii *Näg.* = H. fontinalis *Born.*

Hassallia
- ocellata *Hass.* = Stigonema ocellatum *Thur.*

Hypheothrix
- montana *Kütz.* = A. Bacterium.

Inactis
- Kützingii *Rabh.* = I. vaginata *Näg.*

Leptothrix
- ochracea *Kütz.* = Lyngbya ochracea *Thur.*

III.—CYANOPHYCEAE—*continued.*

Limnactis
- minutula *Kütz.* = Rivularia minutula *Born. et Flah.*
- Schnidimanni *A. Br.* = Rivularia minutula *Born. et Flah.*

Mastigothrix
- aeruginea *Kütz.* = Calothrix fusca *Born. et Flah.*

Microcoleus
- repens *Harv.* = M. vaginatus *Gom.*

Monormia
- intricata *Berk.* = Nostoc Linckia *Born.*

Nostoc
- foliaceum *Ag.* = N. commune *Vauch.*
- lichenoides *Ag.* = N. sphaericum *Vauch.*
- rupestre *Kütz.* = N. microscopicum *Carm.*
- variegatum *Moore.* = N. carneum *Ag.*

Oscillatoria
- aerugescens *Hass.* = O. tenuis *Ag.*
- aerugineo-coerulea *Kütz.* = Lyngbya aerugineo-coerulea *Gom.*
- anguina *Kütz.* = O. chalybea *Gom.*
- antliaria *Jurgens.* = Phormidium autumnale *Gom.*
- autumnalis *Ag.* = Phormidium autumnale *Gom.*
- Corium *Ag.* = Phormidium Corium *Gom.*
- decorticans *Grev.* = Phormidium autumnale *Gom.*
- Friesii *Ag.* = Schizothrix Friesii *Gom.*
- gracillima *Kütz.* = O. splendida *Grev.*
- Grateloupii *Bory* = O. princeps *Vauch.*
- leptotricha *Kütz.* = O. splendida *Grev.*
- natans *Kütz.* = O. tenuis *Ag.*
- ochracea *Grev.* = Lyngbya ochracea *Thur.*
- spadicea *Carm.* = Phormidium subfuscum *Kütz.*
- subfusca *Vauch.* = Phormidium subfuscum *Kütz.*
- tenerrima *Kütz.* = O. amphibia *Ag.*

Palmella
- cruenta *Ag.* = Porphyridium cruentum *Näg.*
- hyalina *Lyngb.* = Aphanocapsa hyalina *Hansg.*
- montana *Ag.* = Gloecapsa Magma *Kütz.*
- mooreana *Harv.* = Aphanothece prasina *A. Br.*

Petalonema
- alatum *Berk.* = Scytonema alatum *Borzi.*

Phormidium
- inundatum *Kütz.* = P. autumnale *Gom.*
- membranaceum *Kütz.* = P. subfuscum *Kütz.*

III.—Cyanophyceae—*continued.*

Phormidium

rupestre *Kütz.* = P. uncinatum *Gom.*

spadiceum *Kütz.* = P. subfuscum *Kütz.*

vulgare *Kütz.* = P. autumnale *Gom.*

Polycoccus

punctiformis *Kütz.* = Nostoc punctiforme *Har.*

Polycystis

aeruginosa *Kütz.* = Microcystis aeruginosa *G. S. West.*

elongata *W. & G. S. West* = Microcystis elongata *W. & G. S. West.*

incerta *Lemm.* = Microcystis incerta *Lemm.*

prasina *Wittr.* = Microcystis prasina *Lemm.*

Raphidia

angulosa *Hass.* = Gloeotrichia natans *Rabh.*

Rivularia

angulosa *Ag.* = Gloeotrichia natans *Rabh.*

calcarea *Sm.* = R. Haematites *Ag.*

durissima *Kütz.* = Gloeotrichia echinulata *P. Richter.*

echinata *Cooke* = Gloeotrichia echinulata *P. Richter.*

echinulata *Born. et Flah.* = Gloeotrichia natans *Rabh.*

minor *Kutz.* = Gloeotrichia natans *Rabh.*

natans *Welw.* = Gloeotrichia natans *Rabh.*

Pisum *Ag.* = Gloeotrichia echinulata *P. Richter.*

Schizosiphon

decoloratus *Näg.* = Calothrix parietina *Thur.*

Schizothrix

delicatissima *W. & G. S. West* = Hypheothrix delicatissima *Forti.*

funalis *W. & G. S. West* = Inactis funalis *Forti.*

Scytonema

ambiguum *Kütz.* = Fischerella ambigua *Gom.*

calotrichoides *Kütz.* = S. mirabile *Thur.*

clavatum *Kütz* = S. crustaceum *Ag.*

contextum *Carm.* = S. mirabile *Born.*

dictyonema *Ag.* = A Lichen.

fasciculatum *Kütz.* = S. ocellatum *Lyngb.*

gracillimum *Kütz.* = S. mirabile *Born.*

Hibernicum *Hass.* = S. Myochrous *Ag.*

Julianum *Menegh.* = S. Hoffmanni *Ag.*

minutum *Ag.* = Stigonema minutum *Hass.*

tomentosum *Kütz.* = S. Myochrous *Ag.*

Sirosiphon

alpinus *Kutz.* = Stigonema panniforme *Kirchn.*

III.—CYANOPHYCEAE—*continued.*

Sirosphon

compactus *Ag.* = Stigonema hormoides *Born. et Flah.*
coralloides *Kütz.* = Stigonema informe *Kütz.*
hormoides *Kütz.* = Stigonema hormoides *Born. et Flah.*
ocellatus *Dillw.* = Stigonema ocellatum *Thur.*
pulvinatus *Bréb.* = Stigonema sp.

Sorospora

grumosa *Hass.* = Gloeocapsa paroliniana *Bréb.*

Sphaerozyga

Hassallii *Kütz.* = Anabaena circinalis *Rabh.*
polysperma *Kütz.* = Anabaena variabilis *Kütz.*
Ralfsii *Thw.* = Anabaena oscillarioides *Bory.*
variabilis *Kütz.* = Anabaena variabilis *Kütz.*

Spirillum

minutissimum *Hass.* = Spirulina major *Kütz.*
Thompsoni *Hass.* = Anabaena circinalis *Rabh.*

Spirulina

Jenneri *Kütz.* = Arthrospira Jenneri *Stiz.*
oscillarioides *Turp.* = S. major *Kütz.*
Thuretii *Crouan.* = S. subsalsa *Oersted.*

Stigonema

atrovirens *Ag.* = A Lichen.
interruptum *Hass.* = A Lichen.
mammiferum *Kütz.* = S. mammillosum *Ag.*

Symploca

Ralfsiana *Kütz.* = Schizothrix Friesii *Gom.*

Symplocastrum

Friesii *Kirchn.* = Schizothrix Friesii *Gom.*

Synechococcus

crassus *Arch.* = S. major *Schroet.*
elongatus *Näg.* = S. aeruginosus *Näg.*
parvulus *Näg.* = S. aeruginosus *Näg.*

Tolypothrix

aegagropila *Kütz.* = T. lanata *Wartm.*
Dillwynii *Hass.* = Desmonema Wrangelii *Born. et Flah.*
punctata *Hass.* = T. lanata *Wartm.*
pygmaea *Kütz.* = T. tenuis *Kütz.*

Tremella

Nostoc *Linn.* = Nostoc commune *Vaucher.*

Trichormus

Flos-aquae *Ralfs.* = Anabaena Flos-aquae *Bréb.*

III.—Cyanophyceae—*continued.*

Trichormus
- incurvus *Allman* = Anabaena Flos-aquae *Bréb.*
- spiralis *Ralfs.* = Anabaena circinalis *Rabh.*

Zonotrichia
- alpina *Kütz.* = Rivularia Haematites *Ag.*
- rivularis *Näg.* = Rivularia Haematites *Ag.*

IV.—Desmidiaceae.

Anisopleura
- constricta *Arch.* = Cosmocladium constrictum *Josh.*

Arthrodesmus
- longicornis *Roy.* = Staurastrum jaculiferum *West.*
- Ralfsii *West.* = A. Incus *Hass.*

Bambusina
- Borreri *Ralfs.* = Gymnozyga moniliformis *Ehr.*

Closterium
- directum *Arch.* = C. Ulna *Focke.*
- linea *Perty.* = C. acutum *Bréb.*
- obtusum *Bréb.* = Roya obtusa *W. & G. S. West.*

Coccochloris
- protuberans *Spreng.* = Mesotaenium macrococcum *Roy. & Biss.*

Conferva
- dissiliens *Dillw.* = Hyalotheca dissiliens *Bréb.*
- mucosa *Mert.* = Hyalotheca mucosa *Ehr.*

Cosmarium
- angustatum *Nord.* = C. pokornyanum *W. & G. S. West.*
- ansatum *Kutz.* = Euastrum ansatum *Ralfs.*
- bipapillatum *West.* = C. Boeckii *Wille.*
- concinnum *Reinsch.* = C. angulosum *Bréb.*
- confusum *Cooke.* = C. margaritiferum *Menegh.*
- crenatum *Ralfs.* = C. undulatum *Corda.*
- crenulatum *Näg.* = C. Meneghinii *Bréb.*
- curtum *Ralfs.* = Penium curtum *Bréb.*
- cylindricum *Ralfs.* = C. Ralfsii *Bréb.*
- dissimile *Nordst.* = Euastrum sublobatum *Bréb.*
- elegans *Nordst.* = C. annulatum *De Bary.*
- Elfvingii *Racib.* = C. rectangulare *Grun.*
- emarginulum *Perty.* = C. Hammeri *Reinsch.*
- gemmiferum *Bréb.* = C. Botrytis *Menegh.*
- gotlandicum *Wittr.* = C. rectangulare *Grun.*
- Klebsii *Gutw.* = C. subtumidum *Nordst.*

IV.—DESMIDIACEAE—*continued.*

Cosmarium
malinvernianum *Schmidle.* = C. margaritiferum *Menegh.*
Nuttallii *West.* = C. subundulatum *Wille.*
odontopleurum *Arch.* = C. repandum *Nordst.*
Scenedesmus *Delp.* = C. depressum *Lund.*
schliephackeanum *Grun.* = C. pygmaeum *Arch.*
sendtnerianum *Reinsch.* = Euastrum sendtnerianum *Reinsch.*
sinuosum *Lund.* = C. decedens *Racib.*
sublobatum *Arch.* = Euastrum sublobatum *Bréb.*
subpunctulatum *Nordst.* = C. punctulatum *Bréb.*
Subreinschii *Schmidle.* = Euastrum montanum *W. & G. S. West.*
succisum *West.* = C. tinctum *Ralfs.*

Desmidium
Borreri *Ralfs.* = Gymnozyga moniliformis *Ehr.*
mucosum *Bréb.* = Hyalotheca dissiliens *Bréb.*

Didymocladon
furcigerus *Bréb.* = Staurastrum furcigerum *Bréb.*
longispinum *Bail.* = Staurastrum longispinum *Arch.*

Didymoprium
Borreri *Ralfs.* = Gymnozyga moniliformis *Ehr.*
Grevillei *Kütz.* = Desmidium cylindricum *Grev.*

Docidium
asperum *Bréb.* = Gonatozygon asperum *Cleve.*
clavatum *Kütz.* = Pleurotaenium Trabecula *Näg.*
coronatum *Bréb.* = Pleurotaenium coronatum *Rabh.*
dilatatum *Lund.* = D. undulatum *Bail.*
Ehrenbergii *Ralfs.* = Pleurotaenium Trabecula *Näg.*
minutum *Ralfs.* = Penium minutum *Cleve.*
nobile *Lund.* = D. undulatum *Bail.*
nodosum *Bail.* = Pleurotaenium nodosum *Lund.*
nodulosum *Bréb.* = Pleurotaenium coronatum *Rabh.*
truncatum *Bréb.* = Pleurotaenium truncatum *Näg.*

Euastrum
anceps *Lund.* = Cosmarium anceps *Lund.*
angustatum *Wittr.* = E. binale *Ehr.*
armstrongianum *Arch.* = E. pingue *Elfv.*
circulare *Hass.* = E. ansatum *Ralfs.*
declive *Reinsch.* = E. elegans *Kütz.*
lobulatum *Bréb.* = E. binale *Ralfs.*
pyramidatum *West.* = E. crispulum *W. & G. S. West.*
Rota *Ehr.* = Micrasterias truncata *Bréb.*

IV.—Desmidiaceae—*continued.*

Euastrum
- scitum *West.* = Cosmarium nasutum *Nordst.*
- spinosum *Ralfs.* = E. elegans *Kütz.*

Gloeoprium
- dissiliens *Berk.* = Hyalotheca dissiliens *Bréb.*
- mucosum *Bèrk.* = Hyalotheca mucosa *Ehr.*

Gonatozygon
- Brebissonii *De Bary.* = G. asperum *Cleve.*
- laeve *Hilse.* = G. asperum *Cleve.*
- minutum *West.* = G. asperum *Cleve.*
- Ralfsii *De Bary.* = G. monotaenium *De Bary.*

Leptocystinema
- asperum *Arch.* = Gonatozygon asperum *Cleve.*
- Kinahani *Arch.* = Gonatozygon Kinahani *Rabh.*
- Portii *Arch.* = Gonatozygon asperum *Cleve.*

Mesotaenium
- Braunii *De Bary.* = M. macrococcum *Roy. & Biss.*
- micrococcum *Kirchn.* = M. macrococcum *Roy. & Biss.*

Micrasterias
- angulosa *Hantzsch.* = M. denticulata *Ralfs.*
- brachyptera *Lund.* = M. apiculata *Menegh.*
- fimbriata *Ralfs.* = M. apiculata *Menegh.*
- furcata *Ag.* = M. rotata *Ralfs.*
- mucronata *Rabh.* = M. oscitans *Ralfs.*
- radiosa *Ralfs.* = M. Sol. *Kütz.*

Onychonema
- filiforme *Roy. & Biss.* = O. nordstedtiana *Turn.*

Palmella
- protuberans *Ag.* = Mesotaenium macrococum *Roy. & Biss.*

Penium
- Berginii *Arch.* = P. Navicula *Bréb.*
- Brebissonii *Menegh.* = Cylindrocystis Brebissonii *Menegh.*
- closterioides *Ralfs.* = P. Libellula *Nordst.*
- Digitus *Bréb.* = Netrium Digitus *Itzigs. & Rothe.*
- interruptum *Bréb.* = Netrium interruptum *Lütkem.*
- lamellosum *Bréb.* = Netrium Digitus *Itzigs. & Rothe.*
- Naegelii *Bréb.* = Netrium Naegelii *W. & G. S. West.*
- oblongum *De Bary.* = Netrium oblongum *Lutkem.*
- rufopellitum *Roy.* = P. rufescens *Cleve.*

Pleurotaenium
- clavatum *De Bary.* = P. Trabecula *Näg.*

IV.—DESMIDIACEAE—*continued.*

Pleurotaenium
minutum *Delp.* = Penium minutum *Cleve.*
nobile *Richter.* = Docidium undulatum *Bail.*
nodulosum *De Bary.* = P. coronatum *Rabh.*
rectum *Delp.* = P. Trabecula *Näg.*
Sceptrum *W. & G. S. West.* = P. tridentulum *West.*

Sphaerozosma
filiforme *Ehr.* = Onychonema nordstedtiana *Turn.*
secedens *De Bary.* = Spondylosium secedens *Arch.*

Spirotaenia
endospira *Arch.* = S. bryophila *Rabh.*
muscicola *De Bary.* = S. bryophila *Rabh.*

Spondylosium
pulchellum *Arch.* = Sphaerozosma pulchellum *Rabh.*

Staurastrum
brachycerum *Bréb.* = S. polymorphum *Bréb.*
convergens *Ehr.* = Arthrodesmus convergens *Ehr.*
depressum *Näg.* = S. muticum *Bréb.*
eustephanum *Ralfs.* = S. furcigerum *Bréb.*
Incus *Bréb.* = Arthrodesmus Incus *Hass.*
octocorne *Ehr.* = Arthrodesmus octocornis *Ehr.*
Pringsheimii *Reinsch.* = S. polytrichum *Perty.*
pseudofurcigerum *Reinsch.* = S. furcatum *Bréb.*
Sancti-Sebaldi *Reinsch.* = S. Sebaldi *Reinsch.*
stellatum *Reinsch.* = S. sexangulare *Rabh.*
subulatum *Kütz.* = Arthrodesmus subulatus *Kütz.*
tenuissimum *Arch.* = Arthrodesmus tenuissimus *Arch.*
terebrans *Nordst.* = S. elongatum *Barker.*
trachynotum *West.* = S. aculeatum *Menegh.*
tricorne *Menegh.* = S. hexacerum *Wittr.*

Tetrachastrum
mucronatum *Arch.* = Micrasterias oscitans *Ralfs.*
oscitans *Dixon* = Micrasterias oscitans *Ralfs.*
pinnatifidum *Dixon* = Micrasterias oscitans *Ralfs.*

Xanthidium
bisenarium *Ehr.* = X. cristatum *Bréb.*
furcatum *Ehr.* = X. armatum *Bréb.*
octocorne *Ehr.* = Arthrodesmus octocornis *Ehr.*

V.—Other Conjugatae.

Conferva
  ericetorum *Roth.* = Zygnema ericetorum *Hansg.*
  genuflexa *Dillw.* = Mougeotia genuflexa *Ag.*
  purpurascens *Carm.* = Zygnema ericetorum *Hansg.*

Mesocarpus
  nummuloides *Hass.* = Mougeotia nummuloides *Hass.*
  parvulus *Hass.* = Mougeotia parvula *Hass.*
  robustus *De Bary.* = Mougeotia robusta *Wittr.*
  scalaris *Hass.* = Mougeotia scalaris *Hass.*

Sirogonium
  sticticum *Kutz.* = Choaspis stictica *O. Kuntze.*

Spirogyra
  orthospira *Näg.* = S. majuscula *Kütz.*
  princeps *Vauch.* = S. nitida *Link.*

Staurocarpus
  coerulescens *Hass.* = Mougeotia capucina *Ag.*

Staurospermum
  gracillimum *Hass.* = Mougeotia gracillima *Wittr.*
  quadratum *Hass.* = Mougeotia quadrata *Hass.*
  viride *Kutz.* = Mougeotia viridis *Wittr.*

Tyndaridea
  cruciata *Harv.* = Zygnema cruciatum *Ag.*
  pectinata *Harv.* = Zygnema pectinatum *Ag.*

Zygnema
  deciminum *Ag.* = Spirogyra decimina *Kutz.*
  nitidum *Ag.* = Spirogyra nitida *Link.*
  quininum *Ag.* = Spirogyra porticalis *Cleve.*

Zygogonium
  didymum *Rabh.* = Zygnema ericetorum *Hansg.*
  ericetorum *Kutz.* = Zygnema ericetorum *Hansg.*

VI.—Chlorophyceae.

Acanthococcus
  aciculifer *Lagerh.* = Trochiscia aciculifera *Hansg.*

Aphanochaete
  globosa *Wolle* = Chaetosphaeridium globosum *Klebahn.*
  repens *A. Br.* = Herposteiron confervicola *Näg.*

Bulbochaete
  pringsheimiana *Arch.* = B. insignis *Pringsh.*

VI.—CHLOROPHYCEAE—*continued.*

Chaetophora
endiviaefolia *Ag.* = C. Cornu-Damae *Ag.*

Chlamydococcus
pluvialis *A. Br.* = Sphaerella lacustris *Wittr.*

Chlorococcum
botryoides *Kütz.* = Protococcus botryoides *Kirchn.*
gigas *Grun.* = Gloeocystis gigas *Lagerh.*
humicola *Rabh.* = Pleurococcus vulgaris *Menegh.*
humicolum *Näg.* = Pleurococcus vulgaris *Menegh.*

Chroococcus
macrococcus *Rabh.* = Urococcus insignis *Kütz.*
rufescens *Näg.* = Pleurococcus rufescens *Bréb.*

Chroolepus
Arnottii *Harv.* = A Fungus.
aureus *Kütz.* = Trentepohlia aurea *Mart.*
ebeneum *Ag.* = A Fungus or Lichen.
Jolithus *Ag.* = Trentepohlia Jolithus *Wallr.*
lichenicolus *Ag.* = Trentepohlia lichenicola *Ag.*
umbrinum *Kütz.* = Trentepohlia umbrina *Born.*

Cladophora
aegagropila *Ces.* = C. Sauteri *Kütz.*

Closterium
subtile *Bréb.* = Ankistrodesmus falcatus *Ralfs.*

Conferva
abbreviata *Wille.* = Microspora abbreviata *Lagerh.*
aegagropila *Linn.* = Cladophora Linnaei *Kütz.*
aurea *Dillw.* = Trentepohlia aurea *Mart.*
bombycina *Ag.* = Tribonema bombycinum *Derb. et Sol.*
Brownii *Dillw.* = Cladophora Brownii *Harv.*
capillaris *Linn.* = Oedogonium capillare *Kütz.*
cryptarum *Bory.* = A Moss Protonema.
flavescens *Roth.* = Cladophora penicillata *Kütz.*
floccosa *Ag.* = Microspora floccosa *Thur.*
fontinalis *Berk.* = Rhizoclonium hieroglyphicum *Kütz*
glomerata *Linn.* = Cladophora glomerata *Kütz.*
lichenicola *Dillw.* = Trentepohlia lichenicola *Ag.*
nana *Dillw.* = Myxonema nanum (*Dillw.*).
ochracea *Kütz.* = Microspora abbreviata *Lagerh.*
pachyderma *Wille.* = Microspora pachyderma *Lagerh.*
stagnorum *Kütz.* = Ulothrix subtilis *Kütz.*
zonata *Web. et Mohr.* = Ulothrix zonata *Kütz.*

VI.—Chlorophyceae—*continued.*

Cosmarium
platyisthmum *Arch.* = Tetraëdron platyisthmum *G. S. West.*
Draparnaldia
tenuis *Ag.* = Myxonema tenue *Rabh.*
Gloeococcus
mucosus *A. Br.* = Sphaerocystis Schroeteri *Chodat.*
Gloeocystis
ampla *Kütz.* = G. gigas *Lagerh.*
regularis *W. & G. S. West* = Chlorobotrys regularis *Bohlin.*
Hariotina
reticulata *Dang.* = Coelastrum reticulatum *Senn.*
Herposteiron
globosum *Nordst.* = Chaetosphaeridium globosum *Klebahn.*
repens *Wittr.* = H. confervicola *Näg.*
Hormiscia
bicolor *Cooke* = Ulothrix zonata *Cooke.*
moniliformis *Rabh.* = Ulothrix moniliformis *Kütz.*
subtilis *Kütz.* = Ulothrix subtilis *Kütz.*
tenuis *De Toni* = Ulothrix tenuis *Kütz.*
zonata *Aresch.* = Ulothrix zonata *Kütz.*
Hormospora
transversalis *Bréb.* = Schizogonium thermale *Kütz.*
Hydrianum
heteromorphum *Reinsch.* = Characium heteromorphum *Reinsch.*
Ineffigiata
neglecta *W. & G. S. West* = Botryococcus Braunii *Kütz.*
Limnodictyon
roemerianum *Kütz.* = Gloeocystis infusionum *W. & G. S. West.*
Lyngbya
muralis *Ag.* = Prasiola crispa *Menegh.*
Microspora
vulgaris *Rabh.* = M. floccosa *Thur.*
Nordstedtia
globosa *Borzi* = Chaetosphaeridium globosum *Klebahn.*
Oedogonium
apophysatum *A. Br.* = O. borisianum *Wittr.*
echinospermum *Pringsh.* = O. cleveanum *Wittr.*
gemelliparum *Pringsh.* = O. Landsboroughii *Kütz.*
rostellatum *Pringsh.* = O. crispum *Wittr.*
setigerum *Vaup.* = O. borisianum *Wittr.*

VI.—CHLOROPHYCEAE—*continued.*

Oocystis
- crassa *Wittr.* = O. Marssonii *Lemm.*
- setigera *Arch.* = Chodatella amphitricha *Chod.*

Palmella
- botryoides *Kütz.* = Gloeocystis botryoides *Näg.*

Pediastrum
- angulosum *Ehr.* = P. Tetras *Ralfs.*
- Ehrenbergii *A. Br.* = P. Tetras *Ralfs.*
- ellipticum *Ralfs.* = P. constrictum *Hass.*
- granulatum *Kütz.* = P. boryanum *Menegh.*
- heptactis *Ehr.* = P. Tetras *Ralfs.*
- pertusum *Kütz.* = P. duplex *Meyen.*
- rotula *A. Br.* = P. biradiatum *Meyen.*

Polyedrium
- caudatum *Lagerh.* = Tetraëdron caudatum *Hansg.*
- enorme *De Bary* = Tetraëdron enorme *Hansg.*
- gigas *Wittr.* = Tetraëdron gigas *Hansg.*
- lobulatum *Näg.* = Tetraëdron lobulatum *Hansg.*
- longispinum *Rabh.* = Cerasterias longispina *Reinsch.*
- minimum *A. Br.* = Tetraëdron minimum *Hansg.*
- tetraëdricum *Näg.* = Tetraëdron regulare *Kütz.*
- tetragonum *Näg.* = Tetraëdron tetragonum *Hansg.*
- trigonum *Näg.* = Tetraëdron trigonum *Hansg.*

Prolifera
- rivularis *Vauch.* = Cladophora insignis *Kütz.*

Protococcus
- angulosus *Corda* = Pleurococcus angulosus *Menegh.*
- coccoma *Kütz.* = Botrydium granulatum *Grev.*
- infusionum *Kirchn.* = Gloeocystis infusionum *W. & G. S. West.*
- minor *Kütz.* = Pleurococcus vulgaris *Menegh.*
- nivalis *Ag.* = Sphaerella lacustris *Wittr.*
- tectorum *Kütz.* = Pleurococcus tectorum *Trevis.*
- viridis *Ag.* = Pleurococcus vulgaris *Menegh.*
- vulgaris *Menegh.* = Pleurococcus vulgaris *Menegh.*

Rhaphidium
- aciculare *A. Br.* = Ankistrodesmus falcatus *Ralfs.*
- contortum *Thur.* = Ankistrodesmus falcatus *Ralfs.*
- convolutum *Rabh.* = Ankistrodesmus convolutus *G. S. West.*
- falcatum *Corda* = Ankistrodesmus falcatus *Ralfs.*
- fusiforme *Corda* = Ankistrodesmus falcatus *Ralfs.*
- longissimum *Schroder* = Closteriopsis longissima *Lemm.*
- polymorphum *Fresen.* = Ankistrodesmus falcatus *Ralfs.*

VI.—Chlorophyceae—*continued.*

Richteriella
  quadriseta *Lemm.* = R. botryoides *Lemm.*
Scenedesmus
  acutus *Meyen.* = S. obliquus *Kütz.*
  alternans *Reinsch.* = S. bijugatus *Kütz.*
  dimorphus *Kutz.* = S. obliquus *Kütz.*
  obtusus *Meyen.* = S. bijugatus *Kütz.*
Schizogonium
  murale *Kütz.* = Prasiola parietina *Wille.*
Sciadium
  Arbuscula *A. Br.* = Ophiocytium Arbuscula *Rabh.*
  cochleare *A. Br.* = Ophiocytium cochleare *A. Br.*
Sphaeroplea
  crispa *Berk.* = Ulothrix zonata *Kütz.*
Staurastrum
  enorme *Ralfs.* = Tetraëdron enorme *Hansg.*
Staurogenia
  heteracantha *Nordst.* = Crucigenia heteracantha (*Nordst.*).
  rectangularis *A. Br.* = Crucigenia rectangularis *W. & G. S. West.*
Stigeoclonium
  amoenum *Kutz.* = Myxonema amoena *Hazen.*
  fastigiatum *Kütz.* = Myxonema fastigiatum (*Kütz.*).
  protensum *Kutz.* = Myxonema protensum *Dillw.*
  subsecundum *Kütz.* = Myxonema subsecundum *Hazen.*
  tenue *Rabh.* = Myxonema tenue *Rabh.*
Tetraëdron
  longispinum (*Rabh.*) = Cerasterias longispina *Reinsch.*
Trentepohlia
  pulchella *Ag.* = Myxonema nanum (*Dillw.*).
Tribonema
  abbreviatum (*Wille.*) = Microspora abbreviata *Rabh.*
  pachydermum (*Wille.*) = Microspora pachyderma *Lagerh.*
  Raciborskii (*Gutw.*) = Microspora amoena *Ag.*
Ulothrix
  bicolor *Ralfs.* = U. zonata *Kütz.*
  compacta *Kutz.* = U. subtilis *Kütz.*
  radicans *Kutz.* = Prasiola crispa *Menegh.*
  stagnorum *Kutz.* = U. subtilis *Kütz.*
  variabilis *Kutz.* = U. subtilis *Kütz.*
Ulva
  bullosa *Roth.* = Tetraspora bullosa *Ag.*
  calophylla *Spreng.* = Prasiola calophylla *Menegh.*

VI.—Chlorophyceae—*continued.*

Ulva
crispa *Lightf.* = Prasiola crispa *Menegh.*
furfuracea *Horn.* = Prasiola furfuracea *Menegh.*
incrassata *Huds.* = Chaetophora Cornu-Damae *Ag.*
Vaucheria
caespitosa *Ag.* = V. geminata *D. C.*
racemosa *Walz.* = V. geminata *D. C.*
sericea *Lyngb.* = V. ornithocephala *Ag.*
Volvox
globator *Ehr.* = V. aureus *Ehr.*

VII.—Rhodophyceae.

Batrachospermum
atrum *Roth.* = B. Dillenii *Bory.*
Conferva
atra *Dillw.* = Batrachospermum Dillenii *Bory.*
Lemanea
fluviatilis *Bory.* = Sacheria fluviatilis *Sirod.*

B. MARINE SPECIES.

I.—Diatomaceae.

Actinocyclus
undulatus *Bail.* = Actinoptychus undulatus *Ralfs.*
Actinoptychus
senarius *Ehr.* = A. undulatus *Ralfs.*
Amphipleura
sigmoidea *W. Sm.* = Nitzschia Sigma *W. Sm.*
Amphiprora
constricta *Ehr.* = Navicula simulans *Donk.*
didyma *W. Sm.* = Donkinia sp.
elegans *W. Sm.* = Plagiotropis elegans *Grun.*
pusilla *Greg.* = A. lepidoptera *Greg.*
vitrea *W. Sm.* = Plagiotropis vitrea *Grun.*
Amphitetras
antediluviana *Ehr.* = Biddulphia antediluviana *H. V. H.*
Amphora
dubia *Greg.* = A. arenaría *Donk.*
granulata *Greg.* = A. lineata *Greg.*
lyrata *Greg.* = A. angularis *Greg.*
nana *Greg.* = A. elliptica *Kütz.*
proboscidea *Greg.* = A. commutata *Grun.*

I.—Diatomaceae—*continued.*

Amphora
  quadrata *Greg.* = A. Gregoryi *Pritch.*
  sulcata *Roper* = A. crassa *Greg.*
  ventricosa *Greg.* = A. turgida *Greg.*

Bacillaria
  paradoxa *Grun.* = Nitzschia paradoxa *Gmel.*

Biddulphia
  mobiliensis *Bail.* = B. Baileyii *W. Sm.*
  radiata *W. Sm.* = B. Smithii *H. Van. Heurck.*

Campylodiscus
  cribrosus *W. Sm.* = C. Echeneis *Ehr.*
  parvulus *W. Sm.* = C. Thuretii *Breb.*
  simulans *Greg.* = C. Thuretii *Breb.*

Cocconeis
  binotata *Grun.* = Orthoneis binotata *Grun.*
  coronata *Brightw.* = Orthoneis coronata *Grun.*
  excentrica *Donk.* = Anorthoneis excentrica *Grun.*
  fimbriata *Brightw.* = Orthoneis fimbriata *Grun.*
  pinnata *Greg.* = C. brundusiaca *Rabh.*
  punctatissima *Grev.* = Orthoneis punctatissíma *Lagerst.*

Colletonema
  eximium *Kütz.* = Pleurosigma eximium *Grun.*

Coscinodiscus
  Ehrenbergii *O'Meara* = C. lineatus *Ehr.*
  omphalanthus *Ehr.* = C. Asteromphalus *Ehr.*
  radiolatus *Ehr.* = C. fimbriatus *Ehr.*

Creswellia
  turris *Grev.* = Stephanopyxis turris *Ralfs.*

Cyclotella
  dallasiana *W. Sm.* = C. striata *Grun.*
  scotica *Kütz.* = Hyalodiscus scoticus *Grun.*

Denticula
  nana *Greg.* = Dimeregramma nanum *Ralfs.*

Diadesmis
  Williamsonii *W. Sm.* = Glyphodesmis Williamsonii *Grun.*

Diatoma
  auritum *Lyngb.* = Biddulphia aurita *Breb.*
  fasciculatum *Ag.* = Synedra affinis *Kütz.*
  hyalinum *Kütz.* = Fragilaria hyalina *Grun.*
  marinum *Lyngb.* = Grammatophora marina *Kutz.*
  obliquatum *Lyngb.* = Isthmia sp.

I.—DIATOMACEAE—*continued.*

Diatoma
striatulum *Ag.* = Rhabdonema arcuatum *Kütz.*
truncatum *Grev.* = Synedra affinis *Kütz.*

Dickieia
pinnata *Ralfs.* = Schizonema mesogloeoides *Kütz.*
ulvoides *Berk.* = Navicula ulvacea *H. Van Heurck.*

Dimeregramma
distans *Greg.* = Glyphodesmis distans *Grun.*
nanum *Greg.* = D. minus *Ralfs.*

Donkinia
compacta *Ralfs.* = Rhoicosigma compactum *Grun.*

Epithemia
constricta *W. Sm.* = E. Musculus *Kütz.*
marina *Donk.* = Hantzschia marina *Grun.*

Eupleuria
pulchella *Arnott.* = Entopyla pulchella *Grun.*

Eupodiscus
sculptus *W. Sm.* = Auliscus sculptus *Ralfs.*

Exilaria
truncata *Grev.* = Synedra affinis *Kütz.*

Fragilaria
aequalis *Heib.* = F. virescens *Ralfs.*
aurea *Carm.* = F. striatula *Lyngb.*
diatomoides *Grev.* = F. striatula *Lyngb.*

Gomphonema
marinum *W. Sm.* = Rhoicosphenia marina *W. Sm.*
paradoxum *Ag.* = Licmophora paradoxa *Ag.*

Grammatophora
macilenta *W. Sm.* = G. oceanica *Ehr.*

Grammonema
Jurgensii *Ag.* = Fragilaria striatula *Lyngb.*

Homoeocladia
filiformis *W. Sm.* = Nitzschia filiformis *W. Sm.*
Martiana *Ag.* = Nitzschia Martiana *H. Van Heurck.*
sigmoidea *W. Sm.* = Nitzschia fasciculata *Grun.*

Lysigonium
nummuloides *W. Sm.* = Melosira nummuloides *Ag.*
Westii *W. Sm.* = Melosira Westii *W. Sm.*
Wrightii *O'Meara* = Melosira Wrightii *O'Meara.*

Melosira
globifera *Harv.* = Podosira Montagnei *Kütz.*

I.—Diatomaceae—*continued.*

Melosira

lineata *Ag.* = Lysigonium moniliforme *Link.*

marina *Jan. et Rabh.* = M. sulcata *Kütz.*

subflexilis *Kütz.* = Lysigonium moniliforme *Link.*

Navicula

angulosa *Greg.* = N. palpebralis *Bréb.*

apis *Ehr.* = N. didyma *Ehr.*

arraniensis *O'Meara.* = N. nitescens *Ralfs.*

bicuneata *Grun.* = N. maxima *Greg.*

clavata *Greg.* = N. Hennedyi *W. Sm.*

convexa *W. Sm.* = Scoliopleura latestriata *Grun.*

cyprinus *Ehr.* = N. digito-radiata *Ralfs.*

donkiniana *O'Meara.* = N. musca *Greg.*

Jennerii *W. Sm.* = Scoliopleura tumida *Rabh.*

meniscus *Schum.* = N. peregrina *Kütz.*

minutula *W. Sm.* = N. pygmaea *Kütz.*

punctulata *W. Sm.* = N. marina *Ralfs.*

rostellifera *Greg.* = N. cancellata *Donk.*

Schmidtii *O'Meara.* = N. Eugenia *A. Schm.*

scutellum *O'Meara.* = N. Smithii *Bréb.*

Westii *W. Sm.* = Scoliopleura Westii *Grun.*

Nitzschia

birostrata *W. Sm.* = N. longissima *Ralfs.*

closterium *W. Sm.* = N. curvirostris *Cleve.*

hyalina *Greg.* = N. spathulata *Bréb.*

virgata *Roper.* = Hantzschia virgata *Grun.*

Odontella

aurita *Ag.* = Biddulphia aurita *Bréb.*

Odontodiscus

anglicus *Donk.* = Thalassiosira Nordenskioldii *Cleve.*

excentricus *Ehr.* = Coscinodiscus excentricus *Ehr.*

Omphalopelta

areolata *Ehr.* = Actinoptychus undulatus *Ralfs.*

Orthosira

angulata *Greg.* = Coscinodiscus decipiens *Grun.*

marina *W. Sm.* = Melosira sulcata *Kütz.*

sulcata *Ehr.* = Melosira sulcata *Kütz.*

Paralia

sulcata *Cleve.* = Melosira sulcata *Kütz.*

Pinnularia

distans *W. Sm.* = Navicula distans *Kalfs.*

I.—DIATOMACEAE—*continued.*

Pinnularia
- divaricata *O'Meara.* = Navicula latissima *Greg.*
- marginata *O'Meara.* = Navicula marginata *O'Meara.*
- peregrina *Ehr.* = Navicula peregrina *Kütz.*
- scutellum *O'Meara.* = Navicula Smithii *Bréb.*
- Vickersii *O'Meara* = Navicula Vickersii *O'Meara.*

Pleurosigma
- aestuarii *W. Sm.* = P. angulatum *W. Sm.*
- delicatulum *W. Sm.* = P. angulatum *W. Sm.*
- giganteum *Grun.* = P. validum *Shadb.*
- mirabile *O'Meara.* = P. pulchrum *Grun.*
- quadratum *W. Sm.* = P. angulatum *W. Sm.*
- strigosum *W. Sm.* = P. angulatum *W. Sm.*
- transversale *W. Sm.* = P. naviculaceum *Bréb.*

Podosira
- maculata *W. Sm.* = Hyalodiscus stelliger *Bail.*

Podosphenia
- Ehrenbergii *Kütz.* = Licmophora Ehrenbergii *Grun.*
- Juergensii *Kütz.* = Licmophora Juergensii *Ag.*
- Lyngbyei *Kütz.* = Licmophora Lyngbyei *Grun.*

Ralfsia
- hyalina *Kütz.* = Fragilaria hyalina *Grun.*
- minima *Ralfs.* = Fragilaria hyalina *Grun.*
- Tabellaria *O'Meara* = Fragilaria Tabellaria *O'Meara.*

Raphoneis
- Jonesii *O'Meara* = Cocconeis Scutellum *Ehr.*
- Moorei *O'Meara* = Cocconeis Scutellum *Ehr.*
- suborbicularis *O'Meara* = Campyloneis Grevillei *Grun. et Eul.*

Rhipidophora
- elongata *Kütz.* = Licmophora gracilis *Grun.*
- paradoxa *Kütz.* = Licmophora paradoxa *Ag.*

Schizonema
- crucigerum *W. Sm.* = Navicula crucigera *W. Sm.*
- Dillwynii *Ag.* = Berkeleya rutilans *Grun.*
- gracillimum *W. Sm.* = Berkeleya parasitica *Grun.*
- Grevillei *Ag.* = Navicula Grevillei *Ag.*
- obtusum *Grev.* = Berkeleya obtusa *Grun.*
- parasiticum *Harv.* = Berkeleya parasitica *Grun.*
- quadripunctatum *Ag.* = Berkeleya rutilans *Grun.*
- ramosissimum *Ag.* = Navicula ramosissima *Ag.*
- virescens *Harv.* = Berkeleya rutilans *Grun.*

I.—Diatomaceae—*continued.*

Scoliopleura
- convexa *W. Sm.* = S. latestriata *Grun.*
- Jennerii *W. Sm.* = S. tumida *Rabh.*

Stauroneis
- amphioxus *Greg.* = Stauroneis Gregoryi *Ralfs.*
- crucicula *W. Sm.* = Navicula crucicula *Donk.*
- pulchella *W. Sm.* = Navicula aspera *Ehr.*

Striatella
- arcuata *Ag.* = Rhabdonema arcuatum *Kütz.*

Surirella
- constricta *W. Sm.* = S. Smithii *Ralfs.*
- craticula *Ehr.* = Navicula sp.

Synedra
- Frauenfeldii *Grun.* = Thalassiothrix Frauenfeldii *Grun.*
- gracilis *Kütz.* = S. affinis *Kütz.*
- tabulata *Ag.* = S. affinis *Kütz.*

Tessella
- catena *Ehr.* = Rhabdonema arcuatum *Kütz.*
- interrupta *Ehr.* = Striatella interrupta *Heib.*

Thalassiothrix
- curvata *Castr.* = Synedra nitzschioides *Grun.*

Triceratium
- alternans *Bail.* = Biddulphia alternans *H. Van Heurck.*
- favus *Ehr.* = Biddulphia favus *H. Van Heurck.*

Tryblionella
- acuminata *W. Sm.* = Nitzschia acuminata *Grun.*
- apiculata *Greg.* = Nitzschia apiculata *Grun.*
- constricta *Greg.* = Nitzschia constricta *Grun.*
- marginata *W. Sm.* = Nitzschia navicularis *Grun.*
- Neptuni *Schum.* = Nitzschia punctata *Grun.*
- punctata *W. Sm.* = Nitzschia punctata *Grun.*
- scutellum *W. Sm.* = Nitzschia circumsuta *Grun.*

II.—Cyanophyceae.

Calothrix
- caespitula *Harv.* = Hydrocoleus comoides *Gom.*
- hydnoides *Harv.* = C. pulvinata *Ag.*
- luteola *Grev.* = Lyngbya luteola *Crouan.*
- pannosa *Ag.* = Lyngbya aestuarii *Liebm.*
- semiplena *Harv.* = Symploca hydnoides *Kütz.*

II.—CYANOPHYCEAE—*continued.*

Conferva

confervicola *Roth.* = Calothrix confervicola *Ag.*

majuscula *Dillw.* = Lyngbya majuscula *Harv.*

Hyella

nitida *Batt.* = H. caespitosa *Born. et Flah.*

Lyngbya

ferruginea *Ag.* = L. aestuarii *Liebm.*

Microcoleus

lyngbyaceus *Thur.* = Hydrocoleus lyngbyaceus *Kütz.*

Oscillatoria

chthonoplastes *Hoffm.* = Microcoleus chthonoplastes *Thur.*

Rivularia

Biasolettiana *Menegh.* = R. coadunata *Fosl.*

plana *Harv.* = Isactis plana *Harv.*

plicata *Carm.* = R. nitida *Ag.*

Sphaerozyga

Carmichaeli *Harv.* = Anabaena torulosa *Lagerh.*

Thwaitesii *Harv.* = Anabaena variabilis *Kütz.*

Tremella

hemispherica *Linn.* = Rivularia atra *Roth.*

III.—Chlorophyceae.

Bangia

laetevirens *Harv.* = Urospora isogona *Batt.*

Cladophora

diffusa *Harv.* = C. Hutchinsiae *Harv.*

nuda *Harv.* = C. rupestris *Kütz.*

Conferva

aerea *Dillw.* = Chaetomorpha aerea *Kütz.*

albida *Huds.* = Cladophora albida *Kütz.*

arcta *Dillw.* = Cladophora arcta *Kütz.*

arenosa *Carm.* = Rhizoclonium arenosum *Kütz.*

bangioides *Harv.* = Urospora bangioides *Holm. & Batt.*

bullosa *Wade.* = Cladophora fracta *Kütz.*

crassa *Ag.* = Chaetomorpha crassa *Kütz.*

diffusa *Roth.* = Cladophora Hutchinsiae *Kütz.*

fracta *Fl. Dan.* = Cladophora fracta *Kütz.*

glaucescens *Griff.* = Cladophora glaucescens *Harv.*

gracilis *Griff.* = Cladophora gracilis *Kütz.*

Hutchinsiae *Dillw.* = Cladophora Hutchinsiae *Kütz.*

implexa *Dillw.* = Rhizoclonium implexum *Batt.*

III.—Chlorophyceae—*continued.*

Conferva
- intricata *Grev.* = Chaetomorpha tortuosa *Kütz.*
- Kaneana *McCalla.* = Cladophora rudolphiana *Harv.*
- laetevirens *Dillw.* = Cladophora laetevirens *Kütz.*
- lanosa *Roth.* = Cladophora lanosa *Kütz.*
- Linum *Harv.* = Cladophora crassa *Kütz.*
- Melagonium *Web. et Mohr.* = Chaetomorpha Melagonium *Kütz.*
- nuda *Harv.* = Cladophora rupestris *Kütz.*
- pellucida *Huds.* = Cladophora pellucida *Kütz.*
- rectangularis *Griff.* = Cladophora rectangularis *Harv.*
- refracta *Wyatt.* = Cladophora albida *Kütz.*
- riparia *Roth.* = Rhizoclonium riparium *Harv.*
- rupestris *Linn.* = Cladophora rupestris *Kütz.*
- sericea *Lyngb.* = Cladophora sericea *Kütz.*
- tortuosa *Dillw.* = Chaetomorpha tortuosa *Kutz.*

Enteromorpha
- erecta *Harv.* = E. paradoxa *Kütz.*
- Hopkirkii *McCalla* = E. paradoxa *Kütz.*
- percursa *Harv.* = Percursaria percursa *Rosenv.*

Epicladia
- Flustrae *Reinke* = Endoderma Flustrae *Batt.*

Lyngbya
- Carmichaelii *Harv.* = Urospora isogona *Batt.*
- speciosa *Carm.* = Urospora isogona *Batt.*

Monostroma
- Blyttii *Wittr.* = M. fuscum *Wittr.*
- lactuca *J. Ag.* = M. Grevillei *Wittr.*

Tremella
- adnata *Huds.* = Gloeocystis adnata *Schm.*

Ulothrix
- flacca *Thur.* = Urospora isogona *Batt.*
- speciosa *Kütz.* = Urospora isogona *Batt.*

Ulva
- bullosa *Kütz.* = Monostroma bullosum *Wittr.*
- clathrata *Ag.* = Enteromorpha clathrata *J. Ag.*
- compressa *Linn.* = Enteromorpha compressa *Grev.*
- Grevillei *Le Jol.* = Monostroma Grevillei *Wittr.*
- intestinalis *Linn.* = Enteromorpha intestinalis *Link.*
- latissima *J. Ag.* = U. Lactuca *Linn.*
- Linza *Linn.* = Enteromorpha Linza *J. Ag.*
- plumosa *Huds.* = Bryopsis plumosa *Ag.*

III.—CHLOROPHYCEAE—*continued.*

Urospora
  penicilliformis *Aresch.* = U. isogona *Batt.*

Vaucheria
  marina *Lyngb.* = Derbesia marina *Kjellm.*
  velutina *Ag.* = V. Thuretii *Woron.*

IV.—Phaeophyceae.

Aglaozonia
  parvula *Grev.* = Cutleria multifida *Grev.*
  reptans *Crn.* = Cutleria multifida *Grev.*

Ascocyclus
  Leclancherii *Magn.* = Chilionema Nathaliae *Sauv.*

Asperococcus
  echinatus *Grev.* = A. fistulosus *Hook.*
  pusillus *Hook.* = Litosiphon pusillus *Harv.*
  Turneri *Lamour.* = A. bullosus *Lamour.*

Bangia
  Laminariae *Lyngb.* = Litosiphon Laminariae *Harv.*

Carpomitra
  Cabrerae *Kütz.* = C. costata *Batt.*

Chorda
  lomentaria *Lyngb.* = Scytosiphon lomentarius *J. Ag.*

Cladostephus
  plumosus *Holmes.* = Chaetopteris plumosa *Kütz.*

Conferva
  curta *Dillw.* = Elachistea flaccida *Aresch.*
  flaccida *Dillw.* = Elachistea flaccida *Aresch.*
  fucicola *Velley* = Elachistea fucicola *Fries.*
  fusca *Huds.* = Sphacelaria cirrhosa *Ag.*
  littoralis *Linn.* = Pylaiella littoralis *Kjellm.*
  Mertensii *Dillw.* = Tilopteris Mertensii *Kütz.*
  paradoxa *Roth.* = Spermatochnus paradoxus *Kütz.*
  pennata *Eng. Bot.* = Chaetopteris plumosa *Kütz.*
  radicans *Dillw.* = Sphacelaria radicans *Ag.*
  scoparia *Linn.* = Stypocaulon scoparium *Kütz.*
  scutulata *Sm.* = Elachistea scutulata *Duby.*
  tomentosa *Huds.* = Ectocarpus tomentosus *Lyngb.*
  verticillata *Lightf.* = Cladostephus verticillatus *Ag.*

Corynephora
  marina *Ag.* = Leathesia difformis *Aresch.*

IV.—Phaeophyceae—*continued.*

Cystoseira
  foeniculacea *Grev.* = C. discors *Ag.*

Desmotrichum
  balticum *Kütz.* = Punctaria baltica *Batt.*
  undulatum *Rke.* = Punctaria undulata *J. Ag.*

Dichloria
  viridis *Grev.* = Desmarestia viridis *Lamour.*

Dictyopteris
  polypodioides *Lamour.* = D. membranacea *Batt.*

Dictyota
  atomaria *Grev.* = Taonia atomaria *J. Ag.*
  implexa *J. Ag.* = D. dichotoma *Lamour.*

Ectocarpus
  brachiatus *Harv.* = Phloeospora brachiata *Born.*
  crinitus *Carm.* = Achinetospora pusilla *Born.*
  firmus *J. Ag.* = Pylaiella littoralis *Kjellm.*
  Griffithsianus *Le Jol.* = Phloeospora brachiata *Born.*
  littoralis *Wyatt* = Pylaiella littoralis *Kjellm.*
  Mertensii *Harv.* = Tilopteris Mertensii *Kütz.*
  pusillus *Griff.* = Achinetospora pusilla *Born.*
  sphaerophorus *Carm.* = Isthmoplea sphaerophora *Kjellm.*

Elachistea
  Areschougii *Crn.* = Myriactis Areschougii *Batt.*

Elaionema
  villosum *Berk.* = Arthrocladia villosa *Duby.*

Fucus
  aculeatus *Linn.* = Desmarestia aculeata *Lamour.*
  balticus *Ag.* = F. vesiculosus *Linn.*
  bifurcatus *With.* = Bifurcaria tuberculata *Stackh.*
  canaliculatus *Linn.* = Pelvetia canaliculata *Dene et Thur.*
  digitatus *Linn.* = Laminaria digitata *Lamour.*
  distichus *Linn.* = F. anceps *Harv. and Ward.*
  Fascia *Müll.* = Phyllitis Fascia *Kütz.*
  Filum *Linn.* = Chorda Filum *Stackh.*
  loreus *Linn.* = Himanthalia lorea *Lyngb.*
  Mackaii *Turn.* = Ascophyllum Mackaii *Holm. & Batt.*
  nodosus *Linn.* = Ascophyllum nodosum *Le Jol.*
  Phyllitis *Stackh.* = Laminaria saccharina *Lamour.*
  polyschides *Lightf.* = Saccorhiza polyschides *Batt.*
  saccharinus *Linn.* = Laminaria saccharina *Lamour.*
  siliquosus *Linn.* = Halidrys siliquosa *Lyngb.*

IV.—PHAEOPHYCEAE—*continued.*

Fucus
teres *Good. & Woodw.* = Alaria esculenta *Grev.*
tuberculatus *Huds.* = Bifurcaria tuberculata *Stackh.*

Giffordia
secunda *Batt.* = Ectocarpus secundus *Kütz.*

Haligenia
bulbosa *Huds.* = Saccorhiza polyschides *Batt.*

Haliseris
polypodioides *Ag.* = Dictyopteris membranacea *Batt.*

Helminthocladia
Griffithsiana *Harv.* = Mesogloia Griffithsiana *Grev.*
vermicularis *Sm.* = Mesogloia vermiculata *Le Jol.*
virescens *Grev.* = Castagnea virescens *Thur.*

Laminaria
bulbosa *Lamour.* = Saccorhiza polyschides *Batt.*
Cloustoni *Le Jol.* = L. hyperborea *Fosl.*
Fascia *Harv.* = Phyllitis Fascia *Kütz.*
flexicaulis *Le Jol.* = L. digitata *Lamour.*
Phyllitis *Lamour.* = L. saccharina *Lamour.*

Leathesia
Berkeleyi *Harv.* = Petrospongium Berkeleyi *Näg.*
tuberformis *S. F. Gray.* = L. difformis *Aresch.*

Mesogloia
vermicularis *Ag.* = M. vermiculata *Le Jol.*
virescens *Carm.* = Castagnea virescens *Thur.*

Myrionema
Leclancherii *Harv.* = Chilionema Nathaliae *Sauv.*
punctiforme *Harv.* = M. strangulans *Grev.*

Padina
deusta *Grev.* = Ralfsia verrucosa *J. Ag.*
parvula *Grev.* = Cutleria multifida *Grev.*

Phloeospora
subarticulata *Aresch.* = Stictyosiphon subarticulatus *Rke.*

Pogotrichum
filiforme *Rke.* = Litosiphon filiformis *Batt.*
hibernicum *T. Johns.* = Litosiphon hibernicus *Batt.*

Pycnophycus
tuberculatus *Kütz.* = Bifurcaria tuberculata *Stackh.*

Ralfsia
deusta *Berk.* = R. verrucosa *J. Ag.*

IV.—Phaeophyceae—*continued.*

Saccorhiza
  bulbosa *De La Pyl.* = S. polyschides *Batt.*

Sphacelaria
  filicina *Ag.* = Halopteris filicina *Kütz.*
  plumosa *Lyngb.* = Chaetopteris plumosa *Kütz.*
  scoparia *Ag.* = Stypocaulon scoparium *Kütz.*
  sertularia *Bonnem.* = Halopteris filicina *Kütz.*
  velutina *Grev.* = Ectocarpus velutinus *Kütz.*

Sporochnus
  Cabrerae *Ag.* = Carpomitra costata *Batt.*
  rhizodes *Ag.* = Stilophora rhizodes *J. Ag.*
  villosus *Ag.* = Arthrocladia villosa *Duby.*

Stilophora
  Lyngbyei *J. Ag.* = Spermatochnus paradoxus *Kütz.*

Streblonema
  Areschougii *Batt.* = Myriactis Areschougii *Batt.*
  luteolum *De Toni* = Ectocarpus luteolus *Sauv.*
  minimum *Sauv.* = Ectocarpus minimus *Näg.*
  reptans *Farl.* = Ectocarpus repens *Rke.*
  simplex *Holm. & Batt.* = Ectocarpus simplex *Crn.*
  solitarium *De Toni* = Ectocarpus solitarius *Sauv.*
  velutinum *Thur.* = Ectocarpus velutinus *Kütz.*

Trichocladia
  Griffithsiana *Harv.* = Mesogloia Griffithsiana *Grev.*
  vermicularis *Harv.* = Mesogloia vermiculata *Le Jol.*
  virescens *Harv.* = Castagnea virescens *Thur.*

Ulva
  dichotoma *Huds.* = Dictyota dichotoma *Lamour.*
  fistulosa *Huds.* = Asperococcus fistulosus *Hook.*
  Pavonia *Linn.* = Padina Pavonia *Gaillon.*

Zonaria
  parvula *Grev.* = Cutleria multifida *Grev.*

V.—Rhodophyceae.

Acrochaetium
  chylocladiae *Batt.* = Chantransia chylocladiae (*Batt.*).
  corymbiferum *Batt.* = Chantransia corymbifera *Thur.*
  Daviesii *Näg.* = Chantransia Daviesii *Thur.*
  endozoicum *Batt.* = Chantransia endozoica *Darbish.*
  secundatum *Näg.* = Chantransia secundata *Thur.*
  sparsum *Batt.* = Chantransia sparsa (*Carm.*).
  virgatulum *J. Ag.* = Chantransia virgatula *Thur.*

V.—Rhodophyceae—*continued.*

Bangia
ciliaris *Carm.* = Erythrotrichia ciliaris *Batt.*
elegans *Chauv.* = Goniotrichum elegans *Le Jol.*

Calliblepharis
jubata *Good. & Woodw.* = C. lanceolata *Batt.*

Callithamnion
Borreri *Harv.* = Pleonosporium Borreri *Näg.*
brachiatum *Harv.* = C. tetragonum *Ag.*
byssoideum *Buffh.* = Seirospora interrupta *Schm.*
cruciatum *Ag.* = Antithamnion cruciatum *Näg.*
Daviesii *Harv.* = Chantransia Daviesii *Thur.*
floridulum *Ag.* = Rhodochorton floridulum *Näg.*
gracillimum *Ag.* = Compsothamnion gracillimum *Schm.*
Grevillei *Harv.* = C. polyspermum *Ag.*
lanosum *Harv.* = C. Hookeri *Ag.*
pedicellatum *Ag.* = Monospora pedicellata *Sol.*
Pluma *Ag.* = Ptilothamnion Pluma *Thur.*
Plumula *Lyngb.* = Antithamnion Plumula *Thur.*
pumilum *Harv.* = Antithamnion cruciatum *Näg.*
purpureum *Harv.* = Rhodochorton purpureum *Rosenv.*
repens *Lyngb.* = Spermothamnion Turneri *Aresch.*
Rothii *Lyngb.* = Rhodochorton Rothii *Näg.*
secundatum *Ag.* = Chantransia secundata *Thur.*
seirospermum *Griff.* = Seirospora Griffithsiana *Harv.*
sparsum *Carm.* = Chantransia sparsa (*Carm.*).
spongiosum *Harv.* = C. granulatum *Ag.*
thuyoideum *Harv.* = Compsothamnion thuyoides *Schm.*
Turneri *Ag.* = Spermothamnion Turneri *Aresch.*
versicolor *Ag.* = C. corymbosum *Lyngb.*
virgatulum *Harv.* = Chantransia virgatula *Thur.*

Catenella
Opuntia *Grev.* = C. repens *Batt.*

Ceramium
agardhianum *Griff.* = C. Deslongchampii *Chauv.*
nodosum *Harv.* = C. tenuissimum *J. Ag.*

Chaetophora
pellita *Lyngb.* = Cruoria pellita *Fries.*

Chaetospora
Wigghii *Ag.* = Naccaria Wigghii *Endl.*

Chondrus
Brodiaei *Grev.* = Phyllophora Brodiaei *J. Ag.*

V.—Rhodophyceae—*continued.*

Chondrus
mammillosus *Grev.* = Gigartina stellata *Batt.*
membranifolius *Grev.* = Phyllophora membranifolia *J. Ag.*
norvegicus *Lamour.* = Gymnogongrus norvegicus *J. Ag.*

Chrysymenia
clavellosa *Harv.* = Lomentaria clavellosa *Gaill.*

Chylocladia
articulata *Grev.* = Lomentaria articulata *Lyngb.*
clavellosa *Hook.* = Lomentaria clavellosa *Gaill.*
ovalis *Hook.* = C. ovata *Batt.*
parvula *Hook.* = Champia parvula *Harv.*

Conferva
ciliata *Ellis* = Ceramium ciliatum *Ducluz.*
coccinea *Huds.* = Heterosiphonia plumosa *Batt.*
Daviesii *Dillw.* = Chantransia Daviesii *Thur.*
diaphana *Lightf.* = Ceramium diaphanum *Roth.*
elongata *Huds.* = Polysiphonia elongata *Grev.*
fibrillosa *Dillw.* = Polysiphonia fibrillosa *Grev.*
floridula *Dillw.* = Rhodochorton floridulum *Näg.*
interrupta *Dillw.* = Seirospora interrupta *Schm.*
lanuginosa *Dillw.* = Callithamnion lanuginosum *Lyngb.*
multifida *Dillw.* = Sphondylothamnion multifidum *Näg.*
nodulosa *Lightf.* = Ceramium rubrum *Ag.*
parasitica *Huds.* = Pterosiphonia parasitica *Falkenb.*
patens *Dillw.* = Polysiphonia urceolata *Grev.*
pluma *Dillw.* = Ptilothamnion pluma *Thur.*
plumosa *Ellis* = Heterosiphonia plumosa *Batt.*
polymorpha *Fl. Dan.* = Polysiphonia fastigiata *Grev.*
purpurascens *Huds.* = Callithamnion Brodiaei *Harv.*
Rothii *Dillw.* = Rhodochorton Rothii *Näg.*
rubra *Huds.* = Ceramium rubrum *Ag.*
setacea *Huds.* = Griffithsia flosculosa *Batt.*
stricta *Dillw.* = Polysiphonia urceolata *Grev.*
tenella *Dillw.* = Spermothamnion Turneri *Aresch.*
tetrica *Dillw.* = Callithamnion tetricum *Ag.*

Corallina
mediterranea *Aresch.* = C. elongata *Johnst.*

Cystoclonium
purpurascens *Kütz.* = C. purpureum *Batt.*

Dasya
coccinea *Huds.* = Heterosiphonia plumosa *Batt.*

V.—RHODOPHYCEAE—*continued.*

Dasya
Hutchinsiae *Harv.* = D. arbuscula *Ag.*

Delesseria
sinuosa *Lamour.* = D. rubens (*Huds.*).

Diploderma
amplissimum *Kjellm.* = Porphyra miniata *Ag.*

Dudresnaya
coccinea *Crn.* = D. verticillata *Le Jol.*
divaricata *Harv.* = Helminthora divaricata *J. Ag.*

Dumontia
filiformis *Lyngb.* = D. incrassata *Lamour.*

Fastigiaria
furcellata *Linn.* = Furcellaria fastigiata *Lamour.*

Fucus
alatus *Gmel.* = Delesseria alata *Lamour.*
albidus *Esper.* = Gracilaria compressa *Grev.*
amphibius *Huds.* = Bostrychia scorpioides *Mont.*
articulatus *Lightf.* = Lomentaria articulata *Lyngb.*
ciliatus *Huds.* = Calliblepharis ciliata *Kütz.*
coccineus *Huds.* = Plocamium coccineum *Lyngb.*
confervoides *Linn.* = Gracilaria confervoides *Grev.*
corneus *Huds.* = Gelidium corneum *Lamour.*
crispus *Linn.* = Chondrus crispus *Lyngb.*
dasyphyllus *Woodw.* = Chondria dasyphylla *Ag.*
dentatus *Linn.* = Odonthalia dentata *Lyngb.*
edulis *Stackh.* = Dilsea edulis *Stackh.*
fastigiatus *Huds.* = Furcellaria fastigiata *Lamour.*
Hypoglossum *Woodw.* = Delesseria Hypoglossum *Lamour.*
kaliformis *Good. & Woodw.* = Chylocladia kaliformis *Hook.*
laceratus *Gmel.* = Nitophyllum ramosum *Batt.*
laciniatus *Huds.* = Callophyllis laciniata *Kütz.*
lumbricalis *Gmel.* = Furcellaria fastigiata *Lamour.*
mammillosus *Good. & Woodw.* = Gigartina stellata *Batt.*
palmatus *Linn.* = Rhodymenia palmata *Grev.*
pinastroides *Gmel.* = Halopithys incurvus *Batt.*
pinnatifidus *Gmel.* = Laurencia pinnatifida *Lamour.*
plicatus *Huds.* = Ahnfeltia plicata *Fries.*
plumosus *Linn.* = Ptilota plumosa *Ag.*
purpurascens *Huds.* = Cystoclonium purpureum *Batt.*
repens *Lightf.* = Catenella repens *Batt.*
rubens *Huds.* = Delesseria rubens (*Huds.*).

V.—Rhodophyceae—*continued.*

Fucus

sanguineus *Linn.* = Delesseria sanguinea *Lamour.*
sedoides *Good. & Woodw.* = Chylocladia ovata *Batt.*
subfuscus *Woodw.* = Rhodomela subfusca *Ag.*
variabilis *Good. & Woodw.* = Rhodomela subfusca *Ag.*

Gigartina

confervoides *Lamour.* = Gracilaria confervoides *Grev.*
erecta *Hook.* = Cordylecladia erecta *J. Ag.*
Griffithsiae *Grev.* = Gymnogongrus Griffithsiae *Mart.*
mammillosa *J. Ag.* = G. stellata *Batt.*
plicata *Lamour.* = Ahnfeltia plicata *Fries.*
purpurascens *Lamour.* = Cystoclonium purpureum *Batt.*

Ginnania

furcellata *Mont.* = Scinaia furcellata *Bivona.*

Gracilaria

erecta *Grev.* = Cordylecladia erecta *J. Ag.*

Griffithsia

corallina *Ag.* = G. corallinoides *Batt.*
equisetifolia *Ag.* = Halurus equisetifolius *Kütz.*
multifida *Ag.* = Sphondylothamnion multifidum *Näg.*
setacea *Ag.* = G. flosculosa *Batt.*
simplicifilum *Ag.* = Halurus equisetifolius *Kütz.*

Gymnogongrus

plicatus *Kütz.* = Ahnfeltia plicata *Fries.*

Halymenia

furcellata *Ag.* = Scinaia furcellata *Bivona.*
ligulata *Ag.* = Halarachnion ligulatum *Kütz.*

Hapalidium

phyllactidium *Kütz.* = Melobesia confervicola *Fosl.*

Hildenbrandtia

rubra *Harv.* = H. prototypus *Nardo.*

Hydrolapathum

sanguineum *Linn.* = Delesseria sanguinea *Lamour.*

Hypnea

purpurascens *Harv.* = Cystoclonium purpureum *Batt.*

Iridaea

edulis *Harv.* = Dilsea edulis *Stackh.*

Jania

rubens *Ell. et Sol.* = Corallina rubens *Linn.*

V.—Rhodophyceae—*continued.*

Kallymenia
Dubyi *Harv.* = Schizymenia Dubyi *J. Ag.*

Laurencia
dasyphylla *Grev.* = Chondria dasyphylla *Ag.*
tenuissima *Grev.* = Chondria tenuissima *Ag.*

Lithocystis
Allmanni *Harv.* = Melobesia confervicola *Fosl.*

Lithophyllum
calcareum *Fosl.* = L. fasciculatum *Fosl.*

Lithothamnion
agariciforme *Aresch.* = Lithothamnion lichenoides *Heydr.*
circumscriptum *Strömf.* = Clathromorphum circumscriptum *Fosl.*
Crouani = Lithophyllum Crouani *Fosl.*
dentatum *Kütz.* = Lithophyllum dentatum *Fosl.*
fasciculatum *Harv.* = Lithophyllum fasciculatum *Fosl.*
Hauckii *Fosl.* = Goniolithon mammillosum *Fosl.*
incrustans *Fosl.* = Lithophyllum incrustans *Fosl.*
laevigatum *Fosl.* = Phymatolithon laevigatum *Fosl.*
polymorphum *Aresch.* = Phymatolithon polymorphum *Fosl.*

Lomentaria
kaliformis *Gaill.* = Chylocladia kaliformis *Hook.*
reflexa *Chauv.* = Chylocladia reflexa *Harv.*

Melobesia
agariciformis *Harv.* = Lithothamnion lichenoides *Fosl.*
confervoides = M. confervicola *Fosl.*
confinis *Crn.* = Dermatolithon hapalidioides *Fosl.*
corticiformis *Kütz.* = Lithothamnion corticiforme *Fosl.*
fasciculata *Harv.* = Lithophyllum fasciculatum *Fosl.*
Laminariae *Crn.* = Dermatolithon macrocarpum *Fosl.*
lichenoides *Harv.* = Lithothamnion lichenoides *Heydr.*
macrocarpa *Rosan.* = Dermatolithon macrocarpum *Fosl.*
membranacea *Lamour.* = Lithothamnion membranaceum *Fosl.*
pustulata *Lamour.* = Dermatolithon pustulatum *Fosl.*

Mesogloia
coccinea *Ag.* = Dudresnaya verticillata *Le Jol.*
Hudsoni *Ag.* = Helminthocladia Hudsoni *J. Ag.*
multifida *Ag.* = Nemalion multifidum *J. Ag.*
purpurea *Harv.* = Helminthocladia purpurea *J. Ag.*

Nemalion
purpureum *Chauv.* = Helminthocladia purpurea *J. Ag.*

V.—Rhodophyceae—*continued.*

Nitophyllum

laceratum *Grev.* = N. ramosum *Batt.*
ocellatum *Grev.* = N. punctatum *Grev.*
ulvoideum *Hook.* = N. Hilliae *Grev.*

Peyssonnelia

Dubyi *Crn.* = Cruoriella Dubyi *Schm.*

Phycodrys

rubens *Batt.* = Delesseria rubens (*Huds.*).

Phyllophora

rubens *Good. & Woodw.* = P. epiphylla *Batt.*

Phyllotylus

Brodiaei *M'Calla* = Phyllophora Brodiaei *J. Ag.*
membranifolius *Good. & Woodw.* = Phyllophora membranifolia *J. Ag.*

Polysiphonia

affinis *Moore.* = P. nigrescens *Grev.*
atropurpurea *Moore.* = P. nigrescens *Grev.*
atrorubescens *Dillw.* = P. nigra *Batt.*
byssoides *Grev.* = Brongniartella byssoides *Bory.*
cristata *Harv.* = Pterosiphonia complanata *Schm.*
formosa *Suhr.* = P. urceolata *Grev.*
Lyngbyei *Harv.* = P. elongata *Harv.*
parasitica *Huds.* = Pterosiphonia parasitica *Schm.*
patens *Grev.* = P. urceolata *Grev.*
pulvinata *Roth.* = P. macrocarpa *Harv.*
stricta *Grev.* = P. urceolata *Grev.*
thuyoides *Harv.* = Pterosiphonia thuyoides *Schm.*

Porphyra

ciliaris *Crn.* = Erythrotrichia Boryana *Berth.*
vulgaris *Ag.* = P. umbilicalis *Kütz.*

Ptilota

elegans *Bonnem.* = Plumaria elegans *Schm.*
sericea *Harv.* = Plumaria elegans *Schm.*

Rhododermis

Drummondii *Harv.* = Hildenbrandtia prototypus *Nardo.*

Rhodomela

pinastroides *Ag.* = Halopithys incurvus *Batt.*
scorpioides *Ag.* = Bostrychia scorpioides *Mont.*

Rhodomenia = Rhodymenia.

V.—RHODOPHYCEAE—*continued.*

Rhodymenia
bifida *Grev.* = Rhodophyllis bifida *Kütz.*
ciliata *Grev.* = Calliblepharis ciliata *Kütz.*
jubata *Grev.* = Calliblepharis lanceolata *Batt.*
laciniata *Grev.* = Callophyllis laciniata *Kütz.*
reniformis *Hook.* = Kallymenia reniformis *J. Ag.*
sobolifera *Grev.* = R. palmata *Grev.*

Rytiphloea
complanata *Harv.* = Pterosiphonia complanata *Schm.*
fruticulosa *Harv.* = Polysiphonia fruticulosa *Spreng.*
thuyoides *Harv.* = Pterosiphonia thuyoides *Schm.*

Schizymenia
edulis *Stackh.* = Dilsea edulis *Stackh.*

Thamnidium
floridulum *Dillw.* = Rhodochorton floridulum *Näg.*
Rothii *Lyngb.* = Rhodochorton Rothii *Näg.*

Trentepohlia
Daviesii *Harv.* = Chantransia Daviesii (*Dillw.*).
floridulum *Harv.* = Rhodochorton floridulum *Näg.*
lanuginosa *Harv.* = Callithamnion lanuginosum *Lyngb.*
Rothii *Harv.* = Rhodochorton Rothii *Näg.*
secundata *Harv.* = Chantransia secundata (*Ag.*).
sparsa *Harv.* = Chantransia sparsa (*Carm.*).

Ulva
elminthoides *With.* = Nemalion elminthoides *Batt.*
filiformis *Huds.* = Dumontia incrassata *Lamour.*
palmata *Lyngb.* = Rhodymenia palmata *Grev.*
purpurascens *Huds.* = Dumontia incrassata *Lamour.*
rubens *Huds.* = Helminthora divaricata *J. Ag.*
umbilicalis *Lightf.* = Porphyra umbilicalis *Kütz.*

Wildemannia
amplissima *Kjellm.* = Porphyra amplissima (*Kjellm.*).
miniata *Fosl.* = Porphyra miniata *Ag.*

Wrangelia
multifida *Huds.* = Sphondylothamnion multifidum *Näg.*

ADDITIONAL SPECIES.

The species enclosed in square brackets are not, strictly speaking, additional, as they appeared in the "Synopsis" under a different name.

A.—Freshwater Species.

I.—Flagellatae.

Bicoeca
lacustris *J. Cl.* M.
Cryptomonas
erosa *Ehr.* U.
Diplosigopsis
frequentissima *Lemm.* M C.
Euglena
viridis *Ehr.* U.
Lepocinclis
ovum *Lemm.* U.
Mallomonas
acaroides *Perty.* M C.
caudata *Iwanoff.* M.
producta *Iwanoff.* C.

II.—Diatomaceae.

Navicula
Legumen *Ehr.* U.
Rhopalodia
gibba *O. Mull.* U.

III.—Cyanophyceae.

[Chroococcus
minimus *Lemm.* L U.]
[Gloeotrichia
echinulata *P. Richter.* M L C U.
natans *Rabh.* L U.]
[Schizothrix
Friesii *Gom.* M L.]

Doubtful.

Calothrix
caespitula *Harv.* M.
Polycystis
persicinus *Gutw.* U.

IV.—Desmidiaceae.

Cosmarium
corriense *Biss.* M.
cymatonotophorum *West.* C.
[decedens *Racib.* M C L U.]
didymoprotupsum *W. & G. S. West.* C.
etchachanense *Roy & Biss.* M.
furcatospermum *W. & G. S. West.* U.
nasutum *Nordst.* M.
obcuneatum *West* M.
[repandum *Nordst.* L.]
retusum *Rabh.* C.
sexnotatum *Gutw.* C U.
subturgidum *Schmidle.* C.
Turneri *Roy.* U.
Staurastrum
arachnoides *West.* C.
bifidum *Bréb.* L.

Doubtful.

Cosmarium
minutissimum *Arch.* Ireland.
substriatum *Nordst.* M C.
Staurastrum
armigerum *Bréb.* L.
spinosum *Bréb.* L.

V.—Chlorophyceae.

[Ankistrodesmus
convolutus *G. S. West.* L U.]
[Chodatella
amphitricha *Chod.* C.]
Crucigenia
heteracantha (*Nordst.*) C.
[Microspora
pachyderma *Lagerh.* M C.]

DOUBTFUL.

Allogonium
tergestinum *Kütz.* L.
Chlorococcum
coccoma *Menegh.* L.
Conferva
alternata *Dillw.* M U.
Raciborskii *Gutw.* U.
Spondylomorum
quaternatum *Ehr.* L.

B.—MARINE SPECIES.

I.—Flagellatae.

Dinobryon
pellucidum *Lev.* M L U.

II.—Silicoflagellatae.

Dictyocha
fibula *Ehr.* M L U.
Distephanus
speculum *Haeckel.* M U.

III.—Coccosphaerales.

Coccosphaera
atlantica *Ostenf.* L.

IV.—Peridinieae.

Ceratium
furca *Clap. et Lachm.* M L U.
horridum *Cleve.* M L U.
longipes *Cleve.* M L U.
macroceras *Ehr.* M.
Dinophysis
rotundata *Clap. et Lachm.* L U.
Diplopsalis
lenticula *Bergh.* M L U.
Glenodinium
acuminatum *Ehr.* M L.
Gonyaulax
polygramma *Stein.* M L.
Peridinium
conicum *Gran.* M L U.
decipiens *Jörg.* L.
depressum *Bail.* M L U.
globulus *Stein.* L U.
Peridinium
oceanicum *Jörg.* M L.
ovatum *Schütt.* M L U.
pallidum *Ostenf.* M L U.
pentagonum *Gran.* M L U.
Steini *Jörg.* L.

V.—Diatomaceae.

Amphiprora
complexa *Greg.* L.
Amphora
commutata *Grun.* L.
Gregoryi *Pritch.* L.
Asterionella
glacialis *Castr.* M L U.
Bellerochea
malleus *H. V. H.* L U.
Biddulphia
granulata *Roper.* L.
Cerataulina
Bergonii *Perag.* L U.
Chaetoceras
boreale *Bail.* M L.
constrictum *Gran.* M L U.
contortum *Schütt.* U.
convolutum *Castr.* U.
crinitum *Schütt.* L U.
curvisetum *Cleve.* M L U.
danicum *Cleve.* M L U.
debile *Cleve.* L U.
decipiens *Cleve.* M L U.
densum *Cleve.* M L.
diadema *Gran.* U.

Chaetoceras
- didymum *Cleve.* M L U.
- laciniosum *Schütt.* M L U.
- peruvianum *Brightw.* M.
- Schütti *Cleve.* L U.
- scolopendra *Cleve.* M U.

Corethron
- hystrix *Hensen.* L.

Coscinodiscus
- Grani *Gough.* U.

Coscinosira
- polychorda *Gran.* L U.

Dimeregramma
- nanum *Ralfs.* L.

Ditylum
- Brightwellii *West.* M L U.

Eucampia
- zodiacus *Ehr.* U.

Guinardia
- flaccida *Perag.* M L U.

Lauderia
- borealis *Gran.* M L U.

Leptocylindrus
- danicus *Cleve.* U.

Lithodesmium
- undulatum *Ehr.* L.

Navicula
- membranacea *Cleve.* M L U.

Nitzschia
- [filiformis *W. Sm.* L.]
- [paradoxa *Gmel.* M L U.]
- seriata *Cleve.* M L U.

Rhizosolenia
- alata *Brightw.* M L U.
- delicatula *Cleve.* U.
- semispina *Hensen.* M L U.
- Shrubsolei *Cleve.* M L U.
- Stolterfothii *Perag.* M L U.

Rhoicosphenia
- marina *W. Sm.* L.

Sceletonema
- costatum *Cleve.* M L U.

Schizonema
- mucosum *Kütz.* C L.

Streptotheca
- tamesis *Cleve.* L U.

Thalassiosira
- condensata *Cleve.* M.
- gelatinosa *Hensen.* L.
- gravida *Cleve.* M L U.

[Thalassiothrix
- Frauenfeldii *Grun.* M L U.]

Doubtful.

Amphiprora
- costata *O'Meara.* M.

Isthmia
- obliquata *Ag.* M L U.

Navicula
- Williamsonii *W. Sm.* C.

Pinnularia
- Cyprinus *Ehr.* L U.

VI.—Cyanophyceae.

Hydrocoleus
- [comoides *Gom.* M.]
- lyngbyaceus *Kütz.* L.

VII.—Chlorophyceae.

Hexasterias
- problematica *Cleve.* L U.

Trochiscia
- brachiolata *Lemm.* L.
- Clevei *Lemm.* M L U.
- paucispinosa *Lemm.* L U.

Doubtful.

Conferva
- perreptans *Carm.* M.
- subimmersa *Berk.* L.

Urospora
- penicillatum. U.

VIII.—Phaeophyceae.

Punctaria
baltica *Batt.* C U.

DOUBTFUL.

Streblonema
pseudosolitarium. *Johnson.* Ireland.

IX.—Rhodophyceae.

Gracilaria
compressa *Grev.* L.
Porphyra
amplissima (*Kjellm.*). L U.
laciniata *Ag.* M L U.
Rhodochorton
purpureum *Rosenv.* M U.

CORRECTIONS AND ERRATA.

The different groups are reviewed in the order in which they appear in the "Synopsis," the Freshwater Species being taken first.

FRESHWATER PERIDINIEAE.

The following species should be deleted:—Peridinium alatum *Garbini.*

FRESHWATER DIATOMACEAE.

(*a*) The following species should be deleted:—Achnanthes subsessilis *Kütz.*, Amphora membranacea *W. Sm.*, Campylodiscus Echeneis *Ehr.*, Denticula crassula *Näg.*, Encyonema caespitosum *Kütz.*, Eunotia robusta *Ralfs.*, Navicula peregrina *Kütz.*, Nitzschia constricta *Pritch.*, N. filiformis *W. Sm.*, N. navicularis *Grun.*, N. paradoxa *Grun.*, N. Sigma *W. Sm.*, Pleurosigma attenuatum *W. Sm.*, P. Spencerii *W. Sm.*, P. strigile *W. Sm.*, Surirella Smithii *Ralfs.*, Synedra lunaris *Ehr.*, S. splendens *Kütz.*

(*b*) Cymbella Cistula *Kirchu.* should be C. Cistula *Kirchn.*, C. lanceolata *Kirchu.* should be C. lanceolata *Kirchn.*, Epithemia globifera *Heib.* should be E. globigera *Heib.*, Navicula serians *Bréb.* should be N. serians *Kütz.*, N. spaerophora *Kütz.* should be N. sphaerophora *Kütz.*, Synedra Acus *Kütz.* should be S. Acus *Grun.*, Cyclotella accuminata *W. Sm.* should be C. acuminata *W. Sm.*

FRESHWATER CYANOPHYCEAE.

(*a*) The following species should be deleted:—Anabaena variabilis *Kütz.*, Calothrix Dillwyni *Cooke*, Chroococcus minor *Näg.*, Clathrocystis aeruginosa *Henfrey*, Gloeocapsa crepidinum *Thur.*, G. Paroliniana *Bréb.*, Hapalosiphon Braunii *Näg.*, Hydrocoleus Lyngbyaceus *Kütz.*, Oscillatoria aerugescens *Hass.*, Phormidium inundatum *Kütz.*, P. spadiceum *Kütz.*, Rivularia calcarea *Sm.*, R. echinata *Cooke*, R. echinulata *Born. et Flah.*, R. natans *Welw.*, R. Pisum *Ag.*, Scytonema ambiguum *Born. et Flah.*, S. calotrichoides *Kütz.*, Symplocastrum Friesii *Kirchn.*, Synechococcus elongatus *Näg.*, S. parvulus *Näg.*, Tolypothrix aegagropila, *Kütz.*

(*b*) The following should be grouped as doubtful species:—Anabaena polysperma *Kütz.*, Oscillatoria percursa *Kütz.*, O. subtilissima *Kütz*, O. violacea *Hass.*, Phormidium Boryanum *Kütz.*, P. leptodermum *Kütz.*, Rivularia granulifera *Carm.*, Sphaerozyga flexuosa *Ag.*, S. Mooreana *Ralfs.*, Symploca Flotowiana *Kütz.*

(*c*) Microcystis aeruginosa *G. S. West* should be M. aeruginosa *Kütz.*, Scytonema mirabile *Born.* should be S. mirabile *Thur.*

Desmidiaceae.

(*a*) The following species should be deleted:—Arthrodesmus longicornis *Roy*, A. Ralfsii *West*, Closterium obtusum *Bréb.*, C. subtile *Bréb.* (occurs twice, and both should be deleted), C. toxon *West* (occurs twice, and one of the records should be deleted), Cosmarium angustatum *Nord.*, C. ansatum *Kutz.*, C. bipapillatum *West*, C. confusum *Cooke*, C. crenatum *Ralfs.*, C. curtum *Bréb.*, C. cylindricum *Ralfs.*, C. Elfvingii *Racib.*, C. gemmiferum *Bréb.*, C. Klebsii *Gutw.*, C. Malinvernianum *Schmidle*, C. Nuttallii *West*, C. platyisthmum *Arch.*, C. Scenedesmus *Delp.*, C. sinuosum *Lund.*, C. sublobatum *Arch.*, C. subpunctulatum *Nordst.*, C. Subreinschii *Schmidle*, C. succisum *West*, Cylindrocystis quadratum *Nordst.*, Docidium dilatatum *Lund.*, D. nobile *Lund.*, Euastrum circulare *Hass.*, E. pyramidatum *West*, E. scitum *West*, Gonatozygon Ralfsii *De Bary*, Mesotaenium Braunii *De Bary*, M. micrococcum *Kirchn.*, Micrasterias brachyptera *Lund.*, M. fimbriata *Ralfs.*, M. furcata *Ag.*, M. mucronata *Rabh.*, M. radiosa *Ag.*, Onychonema filiforme *Roy et Biss.*, Oocardium stratum *Naeg.*, Penium lamellosum *Bréb.*, P. rufopellitum *Roy*, Pleurotaenium clavatum *De Bary*, P. minutum *Delponte*, P. nodulosum *De Bary*, P. rectum *Delp.*, Sphaerozosma secedens *De Bary*, Spirotaenia endospira *Arch.*, Staurastrum eustephanum *Ralfs.*, S. pseudofurcigerum *Reinsch.*, S. trachynotum *West*, S. tricorne *Menegh.*, Xanthidium bisenarium *Ehr.*

(*b*) The following should be grouped as doubtful species:—Cosmarium gravatum *Arch.*, C. lasiosporum *Arch.*, C. lobatosporum *Arch.*, C. Wrightianum *Arch.*, Docidium hirsutum *Bail.*

(*c*) Cosmarium humile *Gay* should be C. humile *Nordst.*, C. istmochondrum *Nordst.* should be C. isthmochondrum *Nordst.*, Xanthidium armatum *Rabenh.* should be X. armatum *Bréb.*

Other Conjugatae.

The following species should be deleted.—Mougeotia laevis *Arch.*, Zygnema didymum *Rabh.*

Freshwater Chlorophyceae.

(*a*) The following species should be deleted:—Crucigenia pulchra *W. & G. S. West*, Gloeococcus mucosus *Br.*, Gloeocystis ampla *Rabh.*, G. humicola

(*Rabh.*), G. regularis *W. & G. S. West*, Ineffigiata neglecta *W. & G. S. West*, Microspora vulgaris *Rabh.*, Nordstedtia globosa *Borzi*, Oocystis setigera *Arch.*, Palmella botryoides *Kütz.*, Pediastrum angulosum *Ehr.*, P. pertusum *Kütz.*, Pleurococcus rufescens *Bréb.*, Protococcus infusionum *Kirchn.*, P. viridis *Ag.*, Rhaphidium convolutum *Rabh.*, R. polymorphum *Fresen.*, Scenedesmus acutus *Meyen*, S. alternans *Reinsch*, Sphaerella nivalis *Sommerf.*, Spondylomorum quaternatum *Ehr.*, Tetrastrum heteracanthum *Chod.*, Tribonema abbreviatum (*Rabh.*), T. pachydermum (*Wille*), T. Raciborskii (*Gutw.*), T. stagnorum *Kütz.*, Ulothrix bicolor *Ralfs.*, U. radicans *Kütz.*

(*b*) The following should be regarded as doubtful species:—Conferva polita *Harv.*, Microspora punctalis *Rabh.*

(*c*) Microspora abbreviata *Rabh.* should be M. abbreviata *Lagerh.*

MARINE DIATOMACEAE.

(*a*) The following species should be deleted:—Amphiprora paludosa *W. Sm.*, A. ovalis *Kütz.*, Campylosira cymbelliformis *Grun.*, Coscinodiscus subtilis *Grun.*, Dimeregramma fulvum *Ralfs.*, Fragilaria virescens *Ralfs.*, Hyalodiscus subtilis *Bail.*, Mastogloia Grevillei *W. Sm.*, M. Smithii *Thw.*, Navicula abrupta *Greg.*, N. amphisbaena *Bory*, N. constricta *Grun.*, N. cryptocephala *Kütz.*, N. elliptica *W. Sm.*, N. forcipata *Grev.*, N. lanceolata *Kütz.*, N. rostrata *Ehr.*, Nitzschia affinis *Kütz.*, N. Tryblionella *Hantzsch*, Orthotropis lepidoptera *Cleve*, O. maxima *Greg.*, Plagiogramma Gregorianum *Grev.*, Surirella craticula *Ehr.*, S. ovalis *Bréb.*, Synedra frauenfeldii *Grun.*, S. Ulna *Ehr.*

(*b*) Navicula distans *H. van Heurck* should be N. distans *Ralfs.*, N. ramosissimum *Ag.* should be N. ramosissima *Ag.*, Pleurosigma strigilis *W. Sm.* should be P. strigile *W. Sm.*, Surirella striatula *Turpin* should be S. striatula *Turpin.*

MARINE CYANOPHYCEAE.

The following species should be deleted:—Calothrix aeruginea *Thur.*, Microcoleus Chthonoplastes *Thur.*

MARINE CHLOROPHYCEAE.

The following species should be deleted:—Chaetomorpha Linum *Kütz.*, Ulothrix flacca *Thur.*, U. speciosa *Kütz.*

MARINE RHODOPHYCEAE.

Ceramium Derbesii *Solier* should be regarded as a doubtful species.

DISTRIBUTION.

Ptilota plumosa *Ag.* occurs all round the Irish coasts; Odonthalia dentata *Lyngb.* is confined to Ulster, though it has been found washed up as far south as Co. Dublin.

Dickie's statement referring to the occurrence of Red Algae at a depth of 80 fathoms must evidently refer to drifted specimens. There are no records of the maximum depth at which Algae are found actually growing on the coast of Ireland, but it is extremely improbable that any occur below a depth of 25 fathoms.

REVISED CENSUS OF SPECIES.

A.—Freshwater Species.

	M	C	L	U	Ireland
Flagellatae, .	8	6	0	6	15
Peridinieae, .	4	5	1	5	10
Diatomaceae, .	150	147	206	196	281
Cyanophyceae, .	61	55	98	86	163
Desmidiaceae, .	293	360	282	323	499
Other Conjugatae, .	13	6	26	9	35
Chlorophyceae, .	88	96	146	118	249
Rhodophyceae, .	4	3	10	6	11
Total, .	621	678	769	749	1263

B.—Marine Species.

	M	C	L	U	Ireland
Flagellatae, .	1	0	1	1	1
Silicoflagellatae, .	2	0	1	2	2
Coccosphaerales, .	0	0	1	0	1
Peridinieae, .	16	0	23	15	24
Diatomaceae, .	178	131	275	133	401
Cyanophyceae, .	18	7	29	10	31
Chlorophyceae, .	49	26	55	44	80
Phaeophyceae, .	85	47	74	65	121
Rhodophyceae, .	162	103	163	144	232
Total, .	511	314	622	414	893

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VI.

THE MARINE WORMS (ANNELIDA) OF DUBLIN BAY AND THE ADJOINING DISTRICT.

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The material on which this paper is based has been collected in Dublin Bay and the adjoining coast, roughly corresponding to the county of Dublin. The opportunity has been taken to collect all the previous records of this group falling within the district; and some material collected by the Scientific Staff of the Fisheries Branch of the Department of Agriculture and Technical Instruction is also included. The greater part of the material was collected on dredging trips under the auspices of the Dublin Marine Biological Committee,[1] during the years 1907 and 1908, with the aid of grants from the Fauna and Flora Committee of the Royal Irish Academy. On several occasions a small sailing trawler was used for dredging, usually between Dalkey Island and the Burford Bank. A great deal of dredging was also done from a rowing-boat in Malahide Inlet, Dalkey Sound, &c.; and much the greater part of the material was taken inside the three-mile limit. The greatest depth from which specimens were obtained was Lambay Deep, where several hauls were taken by the Fisheries' cruiser in 40–60 fathoms. There is considerable variety of habitat in the littoral region, from the muddy flats near the mouth of the Liffey to the rocky shores of Howth. Most of the shore-collecting was done at Sandymount and Howth.

In this paper the division Annelida is understood as including the Archiannelida, or primitive segmented worms—the Polychaeta, Oligochaeta Gephyrea, and Hirudinea. The study of these groups in this district has a short and modern history. In the "Guide to the County of Dublin," published for the 1878 meeting of the British Association in Dublin, not a single worm is included in the faunistic lists. In his "Preliminary Report on the Fauna of Dublin Bay,"[2] Professor Haddon stated that he had collected over two dozen species of Annelids in the Bay, and that he was engaged in working them out; but unfortunately nothing more has been published concerning them.

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[1] Irish Naturalist, 1908, vol. xvii., p. 105; vol. xviii., p. 166.

[2] Proc. Roy. Irish Academy (1888), vol. iv., p. 529.

In the last fifteen years a number of scattered records have been published, and these are collected and included in this paper. A list of these records and their place of publication is given under each group.

The total number of species of Annelids found in the district is 115, made up of 2 species of Archiannelida, 94 species of Polychaeta, 14 species of Oligochaeta, 1 Leech, and 4 species of Gephyrea. Of these species 6 are new to the fauna of the British Isles. These are :—*Protodrilus flavocapitatus* (Uljanin); *Grubea pusilla* (Dujardin); *Autolytus megodon*, de St.-Joseph; *Autolytus Edwardsi*, de St.-Joseph; *Spio martinensis*, Mesnil; *Prionospio Steenstrupii*, Malmgren. Altogether 37 species are added to the Irish fauna. These are marked with an asterisk in the following list of all the species found in the district.

LIST OF SPECIES.

ARCHIANNELIDA

Dinophilus taeniatus, *Harmer*.
Protodrilus flavocapitatus (*Uljanin*).*

POLYCHAETA

Nerilla antennata, *O. Schmidt*.*
Exogone gemmifera, *Pagenstecher*.
Sphaerosyllis hystrix, *Claparède*.
Pionosyllis hyalina (*Grube*).
Eusyllis tubifex, *Gosse*.*
Odontosyllis ctenostoma, *Claparède*.*
O. gibba, *Claparède*.
Grubea clavata (*Claparède*).*
G. pusilla (*Dujardin*).*
Syllis armillaris (*Müller*).*
S. gracilis, *Grube*.*
Autolytus pictus (*Ehlers*).
A. prolifer (*Müller*).*
A. Edwardsi, *de St.-Joseph*.*
A. megodon, *de St.-Joseph*.*
A. longeferiens, *de St.-Joseph*.*
A. ehbiensis, *de St.-Joseph*.*
Myrianida pinnigera (*Montagu*).
Castalia punctata (*Müller*).
C. fusca (*Johnston*).
Magalia perarmata *Mar. et Bobr*.*
Aphrodite aculeata, *L.*
Lepidonotus squamatus (*L.*).
L. clava, *Montagu*
Gattyana cirrosa (*Pallas*).
Lagisca floccosa (*Savigny*).
L. Elizabethae, *McIntosh*.*
Harmothoe imbricata (*L.*).
H. setosissima (*Savigny*).*
H. antilopis, *McIntosh*.*
Evarne impar (*Johnston*).
Halosydna gelatinosa (*M. Sars*).
Polynoe scolopendrina, *Savigny*.
Sthenelais boa (*Johnston*).
S. limicola, *Ehlers*.
Phloe minuta (*Fabricius*).
Eulalia viridis (*O. F. Müller*).
E. bilineata (*Johnston*).*
Eumida sanguinea (*Oersted*).
Phyllodoce maculata (*L.*).
P. groenlandica, *Oersted*.
Tomopteris helgolandica, *Greeff*.
Nereis cultrifera, *Grube*.
N. Dumerilii, *Aud. et Edw.*
N. zonata, *Malmgren*.*
N. pelagica, *L.*
Nereilepas fucata, *Savigny*.
Nephthys caeca (*O. F. Müller*).
N. Hombergii, *Lamarck*.
N. hystricis, *McIntosh*.
N. ciliata (*O. F. Müller*).*
Ophryotrocha puerilis, *Clap. et Mecz.*

Glycera alba, *Rathke.*
Goniada maculata, *Oersted.*
Scoloplos Mülleri (*Rathke*).
Naidonereis quadricuspida, *Fabricius.**
Nerine cirratulus (*D. Chiaje*).
Scolecolepis vulgaris (*Johnston*).*
Spio martinensis, *Mesnil.**
Aonides oxycephala (*Sars*).*
Polydora ciliata (*Johnston*).
P. flava, *Claparède.**
Pygospio elegans, *Claparède.**
Prionospio Steenstrupii, *Malmgren.**
Cirratulus cirratus (*Müller*).
C. tentaculatus (*Montagu*).
Dodecaceria concharum, *Oersted.**
Lanice conchilega (*Pallas*).
Nicolea venustula (*Montagu*).*
Thelepus setosus (*Quatr.*).*
T. cincinnatus (*Fabr.*).
Capitella capitata (*Fabr.*).
Ampharete Grubei, *Malmgren.**
Pectinaria belgica (*Pallas*).*
P. auricoma (*Müller*).
Ophelia limacina (*Rathke*).*
Arenicola marina, *L.*
A. ecaudata, *Johnston.*
Scalibregma inflatum, *Rathke.*
Stylaroides plumosus (*Müller*).
S. glaucus (*Malmgren.**
Flabelligera affinis, *M. Sars.*
Sabella pavonina, *Savigny.*
Dasychone bombyx (*Dalyell*).
Fabricia sabella, *Ehrbg.**
Chone infundibuliformis (*Kroyer*).*
Haplobranchus aestuarinus, *Bourne.*
Jasmineira elegans, *de St.-Joseph.*
Pomatoceros triqueter (*L.*).
Hydroides norvegica (*Gunnerus*).*
Spirorbis borealis, *Daudin.*
S. spirillum, *L.*
Sabellaria alveolata (*L.*).
S. spinulosa, *Leuckart.*

OLIGOCHAETA.

Clitellio arenarius (*Müller*).
Tubifex Benedeni (*Udekem*).
T. costatus (*Claparède*).
T. Thompsoni, *Southern.*
Marionina semifusca (*Claparède*).
Lumbricillus litoreus (*Hesse*).
L. verrucosus (*Claparède*).
L. fossorum (*Tauber*).
L. Pagenstecheri (*Ratz.*).
L. niger, *Southern.*
L. Evansi, *Southern.*
Enchytraeus albidus, *Henle.*
E. sabulosus, *Southern.*
E. lobatus *Southern.*

HIRUDINEA

Pontobdella muricata, *L.*

GEPHYREA.

Petalostoma minutum (*Keferstein*).
Phascolosoma vulgare (*Blainville*).
Phascolion strombi (*Mont.*).
Priapulus caudatus, *Lamarck.*

It is interesting to compare this list with that of the similar list recently published for Plymouth,[1] a district where the Annelids have been very well worked. The same five groups of Annelids have a total number of 153 species, including 144 Polychaetes, as against a total of 115 species, including 93 Polychaetes from Dublin Bay. The deficit in the Dublin Bay list is largely accounted for by the almost complete absence of the southern or Lusitanian group, which is very prominent at Plymouth. For instance, in

[1] Journal Mar. Biol. Assoc., N.S., vol. vii., 1904, p. 219.

the family Eunicidae, the British species of which have mostly a southern distribution, there are 14 species recorded from Plymouth, and only one species from Dublin Bay. The Annelid fauna of Dublin Bay differs markedly from that of the west coast of Ireland, which in its turn closely resembles that of Plymouth.

The chief geographical feature of the Annelid fauna of Dublin Bay is its generalized character. Most of the species have a wide distribution, and are to be found in many parts of the British Isles and the adjacent coasts of Europe. One of its most interesting components is a group of species which have a distinctly northern or Arctic distribution. Of these the species *Prionospio Steenstrupii*, Malmgren, may be taken as an example. Its only British habitat so far known is a little north of Balbriggan, where a single specimen was taken. It is a very inconspicuous little animal, and probably occurs on the west coast of Scotland. Elsewhere it is found in Norway, Iceland, Greenland, and Eastern North America. Its distribution is typical of a group of species which is found in the northern part of the Irish Sea, and which seldom extends so far south as Dublin. There is also a small group of species having a distinctly southern distribution. Of these *Lepidonotus clava*, Mont., may be taken as a type. It is found on the west coast of Scotland, the west and north-east coasts of Ireland, the English Channel, Mediterranean, and Canaries. It seems probable, from the distribution of this group round the west and north of Ireland, and frequently on the west of Scotland, that these southern species reached the Irish Sea round the north of Ireland, and not round the south.

This generalized character of the Dublin Bay fauna may be easily accounted for on geological considerations. The east coast of Ireland in comparatively recent times did not exist, as Ireland was joined on to England. As the land gradually sank and the Irish Sea was formed, the marine fauna immigrated into the new area, and in consequence we find the fauna composed chiefly of species which are common in the adjacent seas. Its arrival has probably been so recent that the processes of variation, selection, and extinction have not had sufficient time to differentiate the fauna from that of the neighbouring districts.

In order to put these theories on a sound basis, a much more complete knowledge of the distribution of the littoral and shallow-water fauna of the British Isles is necessary, and especially that of the north and south coasts of Ireland, about which we know practically nothing. Another factor in the solution of this problem would be a knowledge of the prevailing currents in the Irish Sea, by means of which the pelagic larvae of the Annelids would be carried from place to place. Many species have a very restricted local range;

and the conditions which determine this are quite unknown. At present there appears to be some doubt as to whether the main current in the Irish Sea runs north or south. The position of the last land-connexion with Great Britain must have also been an important factor, as the faunas to the north and south of it would arrive by different routes.

No attempt has been made to give the full synonymy of the various species. Instead, a single reference is given to some standard monograph where the species is fully described and figured.

Where a person's name follows a locality, it refers to the investigator who made the record.

After records of species collected by the Scientific Staff of the Irish Fisheries Branch, the station number and other particulars are given in brackets. For fuller information reference must be made to the "List of Stations" published by the Fisheries Branch.

Class **ARCHIANNELIDA.**

Dinophilus taeniatus, Harmer.

1889–90. Harmer, Journ. Mar. Biol. Assoc., N.S., vol. i., p. 119.

Sandycove. 28, iii, '09. In rock-pools amongst sea-weeds.

This species is easily recognized, especially in its young stages. It has five body-segments, each with two rings of cilia, and the ovaries are bilobed. The epidermis is full of clear glands, and the colour is bright red. As usual, the species could only be found in the spring months. It has only been recorded from the British Isles.

General Distribution.—British Isles (Plymouth, Valencia, Galway Bay).

Protodrilus flavocapitatus (Uljanin).

1908. Pierantoni. Fauna u. flora des Golfes von Neapel, vol. xxxi., Protodrilus, p. 167.

This species, which is the first of its genus to be recorded from Ireland, was found in rock-pools at Malahide in February, 1908. The specimens were all immature, and had been preserved and mounted in balsam some months before I tried to determine the species; so I sent them to Professor Pierantoni, who has recently published an elaborate monograph on the group (tom. cit.). He informed me that they belonged to the species *Protodrilus flavocapitatus* (Uljanin), a species only previously found at Sebastopol and Naples. They agree with this species in having rings of cilia segmentally arranged, in having two ventral eyes in the adult stage, and in having two caudal lobes. They were 4–6 mm. long. At the tip of the prostomium there was a conspicuous bunch of cilia. Cilia are scattered all over the body, as well as in segmentally arranged rings. The worms are flesh-coloured. The blood is colourless, and the blind stomach is bright red. The dorsal vessel rises from a sinus or plexus round the anterior end of the intestine, as in the Enchytraeidae.

General Distribution.—Sebastopol; Gulf of Naples.

Order **POLYCHAETA.**

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1849. Ball, R.—Report, British Association. Records the capture of *Bryarea scolopendra* (*Tomopteris helgolandica*, Greeff) in Dublin Bay by Dr. Corrigan. This is the first record of a Polychaete in the Dublin District.

1856. Thompson, W.—The Natural History of Ireland, vol. iv. The following Polychaeta are recorded from this district:—*Cirratulus medusa*, Johnston (= *C. cirratus*, Müller). *Spirorbis granulatus*, L. (sp. ?). *Serpula vermicularis*, Mont. (sp. ? recorded in Capt. Brown's Irish Testacea). *Serpula contortus* (sp. ? Brown's MSS. Illus., Pl. 2, Dublin Coast). "Hairy bait," Dalkey (*Nereilepas fucata*, Savigny).

1883. Bourne, G.—Quart. Journ. Micr. Soc., xxiii., p. 169. Records *Haplobranchus aestuarinus*, n. sp., from the mud at the mouth of the River Liffey.

1884. Mackintosh, H. W.—Report on Irish Zoophytes, &c., Proc. Roy. Irish Academy, vol. iv., p. 57. Records following species from off Bray Head:—*Aphrodite aculeata*. *Polynoe squamata* (= *Lepidonotus squamatus*). *Nephthys margaritacea* (sp. ?). *Terebella medusa* (sp. ?). *Serpula triquetra* (*Pomatoceros triqueter*). *Spirorbis communis*.

1894. Duerden, J. E.—Notes on the Marine Invertebrates of Rush. Irish Naturalist, vol. iii., p. 232. Records *Phyllodoce viridis*, L. (= *Eulalia viridis*).

1896. McIntosh, W. C.—Notes on the Irish Annelids in the Museum of Science and Art, Dublin. No. 1. Sci. Proc. Roy. Dublin Soc., vol. viii. (N.S.), Pt. v., No. 50, p. 399. Records the following species:—*Aphrodite aculeata*, L. *Lepidonotus squamatus*, L. *Nychia cirrosa*, Pall (= *Gattyana cirrosa*). *Lagisca propinqua*, Malm. (= *L. floccosa*). *Harmothoë imbricata*, L. *Evarne impar*, Johnston. *Polynoe scolopendrina*, Sav. *Sthenelais boa*, Johnston.

1907. Wilson, Gregg.—Polychaeta of Lambay. Irish Naturalist, vol. xvi., p. 67. Records the following species:—*Nereis cultrifera*, Gr. *Harmothoe imbricata*, L. *Lepidonotus squamatus*, L. *Sthenelais boa*, Johnston.

1908. McINTOSH, W. C.—Notes from the Gatty Marine Laboratory. No. xxix. Ann. Mag. Nat. Hist. (8), vol. i., p. 383. Records a post-larval stage of *Arenicola ecaudata* from Salthill.

1908. SOUTHERN, R.—Section "Polychaeta" in the "Handbook to the City of Dublin," prepared for the meeting of the British Association in Dublin, 1908, p. 196. Following species recorded:—*Lepidonotus squamatus*, L. *Nychia cirrosa*, Pallas (= *Gattyana cirrosa*). *Harmothoë imbricata* (L.). *Evarne impar* (Johnston). *Lagisca floccosa*, Pallas. *Polynoe scolopendrina* (Sav.). *Sthenelais boa* (Johnston). *Phyllodoce viridis* (L.) = *Eulalia viridis* (L.). *Nereilepas fucata* (Sav.). *Tomopteris helgolandica*, Greeff. *Scoloplos armiger* (Müll.) = *S. Mülleri* (Rathke). *Nerine conioccphala*, Johnst. = *N. cirratulus* (D. Chiaje). *Thelepus cincinnatus* (Fabr.). *Lanice conchilega* (Pallas). *Capitella capitata* (Fabr.). *Pectinaria auricoma* (Müller). *Dasychone bombyx* (Dalyell). *Haplobranchus aestuarinus*, Bourne.

1909. ASHWORTH, J. H.—"Arenicolidae and Scalibregmidae," "Fisheries, Ireland, Sci. Invest., 1908, ii. [1909], records *Arenicola marina* (L.).

1910. McINTOSH, W. C.—Note on Irish Annelids in the National Museum, Dublin. No. II. Irish Naturalist, vol. xix., p. 95. Records the following species from Dublin district:—*Nephthys caeca* (O. F. Müller). *N. hystricis*, McI. *Eulalia viridis*, O. F. Müller. *Eumida sanguinea*, Oersted. *Odontosyllis gibba*, Claparède. *Scoloplos armiger*, O. F. Müller (= *S. Mülleri*).

1908-9. SOUTHERN, R.—Dublin Microscopical Club. Following species, found in the Dublin district, exhibited:—*Dasychone bombyx* (Dal.), Irish Naturalist, xvii., p. 40. *Pectinaria auricoma* (Müll.), ibid., xvii., p. 63; *Exogone gemmifera*, Pag., ibid., xviii., p. 45. *Lanice conchilega* (Pall.), ibid., xviii., p. 252.

1909. COLGAN, N.—Dublin Marine Biological Committee Report for 1908. Irish Naturalist, xviii, p. 167. Records *Pectinaria auricoma* (Müll.).

INCERTAE SEDIS.

Nerilla antennata, O. Schmidt.

1863. Claparède. Beobachtungen, &c., p. 48.

Sandycove shore, 28, iii, '09.

The systematic position of this curious little Polychaete has not yet been satisfactorily determined. It is sometimes placed with the Syllidae, and sometimes a special family, the Nerillidae, is created for it.

General Distribution.—Plymouth; Faroë; Heligoland; Kiel; France.

Family **SYLLIDAE.**

Exogone gemmifera, Pagenstecher.

1908. McIntosh. A Monograph of the British Annelids, vol. ii, Part i, page 151.

Dalkey Sound, 6, vi, 1885. ♀ with 12 pairs of young attached to ventral surface.

10 miles east of Bailey Light (S. 553—16, viii, '07. Trawl, 41–52 fathoms).

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

This species was obtained in large numbers at Malahide. Several females were found having embryos in various stages of development attached to the body, near the parapodia. It was exhibited to the Dublin Microscopical Club, December 9th, 1908.[1] This species has usually been taken between tide-marks; but it evidently lives also in deeper water, as it was found in Lambay Deep in 41–52 fathoms.

General Distribution.—Great Britain (St. Andrews, Lochmaddy, Torquay); France; Algiers; Madeira.

Sphaerosyllis hystrix, Claparède.

1908. McIntosh. Tom. cit., p. 156.

Shennick's Island, Skerries, 22, vii, '07.

Malahide Inlet, 27, vii, '08; also 11, xi, '08. Dredge, 2 fms.

This species occurs plentifully in 2 fathoms at Malahide. A young individual, with only 10 seta-bearing segments, was found in July. In November I found a male bud with 17 segments but without swimming bristles. Only a single pair of large ventrally placed eyes were present, and palps and anal cirri were absent. In the same haul of the dredge another budding form was found, with sperm-sacs beginning at the fifth setigerous segment.

General Distribution.—British Isles; France; North Sea; Mediterranean; Atlantic.

Grubea clavata (Clap.).

1886. de Saint-Joseph. Annales des Sc. Nat. Zool. (7), tom. i, p. 200.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

This species was abundant at Malahide. Behind the head, and on a level with the tentacular cirri, are a pair of conspicuous ciliated grooves, which do

[1] Irish Naturalist, 1909, vol. xviii., p. 45.

not seem to have been observed by previous investigators. The skin has dorsally a large number of small shining glands.

General Distribution.—South of England (Torquay); France; Atlantic; Mediterranean; Madeira.

Grubea pusilla (Dujardin).

1886. de Saint-Joseph. Tom. cit., p. 203.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

This species was taken with the previous one. It has not been recorded hitherto from the British Isles. It is characterized by the truncated dorsal cirri, which are swollen in the middle.

General Distribution.—France; Mediterranean; Madeira.

Eusyllis tubifex, Gosse.

1908. McIntosh. Tom. cit., p. 173.

Dredged off the Bailey Light, 7, ix, '07.

Malahide Inlet, 17, vi, '08; also 11, xi, '08. Dredge, 2 fms.

This species emits a brilliant green phosphorescence when irritated.

McIntosh separates this species from *E. Blomstrandi*, Mgn.; but I am unable to detect any differences, either in the published descriptions and figures or in specimens of the two species named by him. Moreover, although *E. tubifex* has been found on the English side of the Channel, all the records on the north coast of France have been referred to *E. Blomstrandi.*

General Distribution.—Great Britain; Madeira; Canada.

Odontosyllis gibba, Claparède.

1908. McIntosh. Tom. cit., p. 183.

Kingstown Harbour (McIntosh, tom. cit.).

Dalkey Sound, April, 1907. Dredge, 6–8 fms.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

General Distribution.—British Isles; France; Mediterranean; Madeira.

Odontosyllis ctenostoma, Claparède.

1908. McIntosh. Tom. cit., p. 182.

Salthill, 21, viii, 1883.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

Bullock Harbour, Dalkey, 2, ii, '09.

General Distribution.—This appears to be a southern form. It has only been recorded from the English Channel, Mediterranean, and Madeira.

Pionosyllis hyalina (Grube).

1908. McIntosh. Tom. cit., p. 166.

Howth, south shore. 6, x, 09.

One young specimen of this species, with seventeen setigerous segments, was obtained.

General Distribution.—Plymouth; Mediterranean; Madeira.

Syllis armillaris (Müller).

1908. McIntosh. Tom. cit., p. 188.

Two miles south-east of Bailey Light. 13, vii, '07. Dredge, 13–18 fms.

Howth, south shore, 6, x, '09. In crevices of the schist.

General Distribution.—British Isles; France; Madeira; Faroë; Norway; Sweden; Greenland; Behrings Sea.

Syllis gracilis, Grube.

1908. McIntosh. Tom. cit., p. 203.

Lambay, 1906; Seapoint shore, 26, v, '07; Howth, south shore, 6, x, '09.

Several buds of the "Ioida" type were found at Howth.

General Distribution.—Great Britain; France; Madeira; Mediterranean; Black Sea; Red Sea; Virginia; Ceylon; West Indies.

Autolytus pictus (Ehlers).

1908. McIntosh. Tom. cit., p. 211.

Malahide Inlet, 27, vii, '08. Dredge, 2 fms.

The sexual nurse-stock was dredged at Malahide, and exhibited to the Dublin Microscopical Club.[1]

General Distribution.—Great Britain; France; Mediterranean; White Sea; Madeira.

(?) **Autolytus prolifer** (O. F. Müller).

1908. McIntosh. Tom. cit., p. 215.

Malahide Inlet, 17, vi, '08. Dredge, 2 fms.

One specimen, a female bud, was found, which agreed exactly in colouring with that figured by McIntosh (tom. cit., pl. xlix, fig. 7). Its colouring is very like that of the nurse-stock of *A. pictus*; and I am inclined to think that it belongs to the latter species.

General Distribution.—British Isles; North Sea; Greenland; Norway; Atlantic; Mediterranean; Madeira; South Africa.

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[1] "Irish Naturalist," 1908, vol. vii, p. 262.

Autolytus megodon, de Saint-Joseph.

1886. de Saint-Joseph. Tom. cit., p. 240.

A single specimen was taken in the dredge, at Malahide Inlet, in 2 fms. of water in August, 1907. It agrees closely with the brief description given by de Saint-Joseph.

Starting just behind the head, in the median line, are two conspicuous brown bands which curve outwards and run along the body just above the parapodia. The proboscis is terminated by a crown of nine large teeth (de Saint-Joseph says ten). The proventiculus is three times as long as broad, and has fifty-five rows of glands. The dorsal cirri are short. Behind the setae there is a broad lobe. The setae are rather short and thick, and the end of the shaft is conspicuously swollen and hispid. The dorsal finely pointed seta is just as de Saint-Joseph figures it. This species has apparently not been recorded since it was originally described.

General Distribution.—Dinard, north of France.

Autolytus Edwardsi, de Saint-Joseph.

1886. de Saint-Joseph. Tom. cit., p. 237.

Malahide Inlet. 11, xi, '08; also 3, vii, '09. Dredge, 2 fms.

This species is characterized by the presence of twenty-four equal teeth on the proboscis.

General Distribution.—North of France.

Autolytus ehbiensis, de Saint-Joseph.

1886. de Saint-Joseph. Tom. cit., p. 228.

Dredged off the Bailey Light, 7, ix, '07.

This species is distinguished by the presence of thirty small equal teeth at the entrance of the proboscis.

General Distribution.—Torquay; France.

Autolytus longeferiens, de Saint-Joseph.

1886. de Saint-Joseph. Tom. cit., p. 217.

Dalkey Sound. April, 1907. Dredge, 6 fms.

This species is characterized by the structure of the proboscis, which is extremely long, and is thrown into numerous folds. It has a crown of teeth, ten of which are large, and are separated from each other by two or three smaller ones. The dorsal cirri are alternately long and short. De Saint-Joseph states that in his specimens the anterior end is marked by three longitudinal red lines. These are absent in the Dublin

Bay specimens. There are, however, in each segment two transverse brown bands, which the microscope shows to be formed by small brown papillae on the epidermis.

This species is very close to the *A. brachycephala* described by Marnezeller,[1] which has, however, only a short proboscis.

General Distribution.—Torquay; Coast of France.

Myrianida pinnigera (Montagu).

1908. McIntosh. Tom. cit., p. 229.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

A single specimen of this well-marked species was found on an old oyster-shell.

General Distribution.—British Isles; France; Madeira.

Family **HESIONIDAE.**

Castalia punctata (O. F. Müller).

1908. McIntosh. Tom. cit., p. 121.

Two miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Off north of Howth, 7, ix, '07. Dredge, 15 fms.

General Distribution.—British Isles; Norway; Iceland; North Sea.

Castalia fusca (Johnston).

1908. McIntosh. Tom. cit., p. 127.

Lambay, April, 1906.

Howth, north shore, in rock-pools, 14, vi, '08.

Malahide Inlet, 27, vii, '08. Dredge, 2 fms.

General Distribution.—British Isles; France; Mediterranean. In contrast with the last species, this appears to be a southern form.

Magalia perarmata, Marion and Bobretzsky.

1908. McIntosh. Tom. cit., p. 136.

Malahide Inlet, 30, v, '08. Dredge, 2 fms.

General Distribution.—Plymouth; Torquay; Marseilles; North of France; Madeira. Judging from the scarcity of records, this species appears to be rare. This is the first Irish record, though I have found it at several places on the west coast.

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[1] Zur Kenntniss der Adriatischen Anneliden. Sitz. der k. Akad. Wiss. Bd. lxix. I Abth., p. 54.

Family **APHRODITIDAE**.

Aphrodite aculeata, L.

1900. McIntosh. A Monograph of the British Annelids, vol. i, Part ii, p. 247.

Off Howth (McIntosh).

On the Burford Bank, 13, vii, '07. Dredge, 13 fms.

Off Dalkey Island.

Lambay Deep (S. 224. 22, vi, '04. Trawl, 44 fms.).

General Distribution.—British Isles; Atlantic; Mediterranean; Iceland; Red Sea; North America.

Lepidonotus squamatus (L.).

1900. Mackintosh. Tom. cit., p. 274.

This species is very common, extending from the littoral zone to 60 fathoms in Lambay Deep.

General Distribution.—British Isles; Greenland; Iceland; Atlantic.

Lepidonotus clava, Montagu.

1900. McIntosh. Tom. cit., p. 280.

Lambay, April, 1906.

This species has a southern and western distribution. It is common on the west coast of Ireland and south coast of England, and goes as far north as the west coast of Scotland. It was somewhat surprising therefore to find it in this district. Only a single specimen was found.

General Distribution.—West coasts of Ireland and Scotland; English Channel; Mediterranean; Canaries.

Gattyana cirrosa (Pallas).

1900. McIntosh. Tom. cit., p. 285.

Dalkey Sound, 1892 (McIntosh).

Two miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

General Distribution.—A northern species living on the shores of the British Isles, Northern Europe, Spitzbergen, Iceland, Greenland, and Eastern North America.

Lagisca floccosa (Savigny).

1900. McIntosh. Tom. cit., p. 298.

Malahide, 1886 (McI.).

3 miles south of Nose of Lambay (S. 533, 9, viii, '07. Trawl, 10½–20 fms.).

4½ miles east of Kingstown (S. 554, 16, viii, '07. Trawl, 14–19 fms. In

Buccinium shells, together with *Nereilepas fucata* and *Eupagurus Bernhardi*).

Malahide Inlet, 24, viii, '07. Dredge, 2 fms.

General Distribution.—British Isles; Northern Europe; Greenland; Eastern Canada; Madeira.

Lagisca Elizabethae, McIntosh.

1900. McIntosh. Tom. cit., p. 303.

Lambay, April, 1906; Seapoint, May, 1907.

Malahide Inlet, 30, v, '08. Dredge, 2 fms.

General Distribution.—McIntosh described this species from a single specimen found at St. Andrews; and it has not since been recorded. It appears to be fairly common on the Irish coasts, especially on the west.

Harmothoe imbricata (L.).

1900. McIntosh. Tom. cit., p. 314.

One of the commonest littoral Polychaetes in Ireland.

General Distribution.—British Isles; Europe; Mediterranean; Eastern North America; Siberia; Japan; Greenland; Iceland; Spitzbergen; Siberia.

Harmothoe setosissima (Savigny).

1900. McIntosh. Tom. cit., p. 345.

10 miles east of Bailey Light (S. 553, 16, viii, '07. Trawl, 41–52 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

This species has not previously been recorded from Irish waters.

General Distribution.—Great Britain; Scandinavia; Eastern Atlantic; Mediterranean.

Harmothoe antilopis, McIntosh.

1900. McIntosh. Tom. cit., p. 334.

13 miles E.S.E. of Lambay (S. 236, 29, vi, '04. Trawl, 39–52 fms.).

This species has not previously been recorded from Irish waters.

General Distribution.—Scotland; Atlantic; Mediterranean.

Evarne impar (Johnston).

1900. McIntosh. Tom. cit., p. 353.

Salthill and Dalkey (McI.).

Dalkey Sound, April, 1907. Dredge, 7–9 fms.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

North Bull; thrown up during a gale.

General Distribution.—British Isles; Iceland; European and American shores of Atlantic.

Halosydna gelatinosa (M. Sars).

1900. McIntosh. Tom. cit., p. 384.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

General Distribution.—British Isles ; European shores ; Madeira.

Polynoe scolopendrina, Savigny.

1900. McIntosh. Tom. cit., p. 389.

Dalkey (McI.).

Dalkey Sound, April, 1907. Dredge, 6 fms.

Malahide Inlet, 17, vi, '08. Dredge, 2 fms.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

4½ miles east of Kingstown (S. 554, 16, viii, '07. Trawl, 14–19 fms.).

Howth ; south shore between tide-marks. Commensual with Terebellid worm *Thelepus setosus* (Quat.).

General Distribution.—British Isles ; Scandinavia ; France; Mediterranean.

Sthenelais boa (Johnston).

1900. McIntosh. Tom. cit., p. 408.

Bray Head, 23 fms., 1892, and Malahide, 1886 (McI.). Lambay (Wilson).

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13-18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

Howth, south shore, 6, x, '09.

General Distribution.—British Isles ; Eastern Atlantic ; Iceland ; Madeira ; Mediterranean.

Sthenelais limicola, Ehlers.

1900. McIntosh. Tom. cit., p. 417.

Off the Bailey Light. 7, ix, '07. Dredge, 7 fms.

General Distribution.—British Isles; Norway; Mediterranean; North America.

Phloe minuta (Fabricius).

1900. McIntosh. Tom. cit., p. 437.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

Howth; south shore, 6, x, '09 ; north shore, 10, x, '09.

General Distribution.—British Isles ; eastern and western shores of the Atlantic.

Family **PHYLLODOCIDAE**.

Eulalia bilineata (Johnston).

1908. McIntosh. Tom. cit., p. 50.

Dalkey Sound, April, 1907 ; also 14, xii, '07. Dredge, 6–8 fms.

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

General Distribution.—Scotland ; Guernsey ; Finmark ; Canaries.

Eulalia viridis (O. F. Müller).

1908. McIntosh. Tom. cit., p. 55.

Rush (Duerdon).

Salthill (McI.).

Shennick's Island, Skerries, 22, vii, '07.

Malahide Inlet, 17, vi, '08. Dredge, 2 fms.

Howth, south shore, 6, x, '09.

Malahide, February, 1910.

Var. **ornata**, de St.-Joseph.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Var. **aurea**, Gravier.

Dalkey Sound, 14, xii, '07. Dredge, 8 fms.

The species *E. ornata*, de St.-Joseph, and *E. aurea*, Gravier, are regarded by McIntosh, with good reason, as only colour varieties of *E. viridis.* Forms closely resembling in colour pattern the figures given by McIntosh have been found in Dublin Bay.

General Distribution.—Common round the British Isles. Greenland; Iceland; Faroë; Atlantic; Mediterranean; South Africa; Behrings Sea.

Eumida sanguinea (Oersted).

1908. McIntosh. Tom. cit., p. 66.

Salthill (McI.).

3 miles south of Lambay Deep (S. 127, 19, v, '03. Townet on Trawl, 31–32 fms.).

Malahide Inlet, 17, vi, '08, also 11, xi, '08. Dredge, 2 fms.

General Distribution.—British Isles; Iceland; Norway; Baltic; North Sea; France; Mediterranean.

Phyllodoce groenlandica, Oersted.

1908. McIntosh. Tom. cit., p. 86.

13 miles E.S.E. of Lambay (S. 236, 29, vi, '04. Townet on Trawl, 39–52 fms.).

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

General Distribution.—A northern form. British Isles; North Sea; Greenland; Spitzbergen; Nova Zembla; Scandinavia; Siberia; Behrings Sea; North America.

Phyllodoce maculata (L.).

1908. McIntosh. Tom. cit., p. 89.

Salthill, 20, viii, '81; also 21, viii, '83.

2 miles S.E. of Bailey Light, 13, vii, '07. Dredge, 2 fms.

Off north of Howth, 7, ix, '07. Dredge, 15 fms.

Malahide Inlet, 17, vi, '08. Dredge, 2 fms.

Sandymount Strand, in sand.

General Distribution.—British Isles; North Sea; Iceland; Norway.

Family TOMOPTERIDAE.

Tomopteris helgolandica, Greeff.

1900. Apstein. Die Alciopiden und Tomopteriden der Plankton-Expedition, Kiel, p. 38.

First recorded by R. Ball, in Dublin Bay (*vide* Bibliography). In the last few years this species has been frequently taken in various parts of the district by the Scientific Staff of the Irish Fisheries Branch. For further particulars reference must be made to their 'List of Stations.' (S. 96, 15 specimens. S. 126, 1 sp. S. 196, 1 sp. S. 204, 2 sp. S. 235, 10 sp. S. 252, 1 sp. S. 287, 9 sp. S. 337, 3 sp. S. R. 460, 28 sp.)

The seasonal distribution of this species in Irish waters has recently been investigated, and an account will shortly be published in the "Scientific Investigations" of the Fisheries Branch.

General Distribution.—Atlantic; Mediterranean.

Family NEREIDAE.

Nereis cultrifera, Grube.

1868. Ehlers. Die Borstenwürmer, p. 461.

Malahide and Bray (McI.).

Lambay (Wilson).

Howth. South shore, 6, x, '09. North shore, 10, x, '09.

General Distribution.—British Isles; European shores; Mediterranean; Madeira.

Nereis Dumerilii, Aud. et Edwards.

1868. Ehlers. Tom. cit., p. 535.

Common in all parts of the district, ranging from between tide-marks to 20 fathoms.

General Distribution.—British Isles; Europe; Mediterranean; Madeira; Eastern North America; Japan.

Nereis pelagica, L.

1868. Ehlers. Tom. cit., p. 511.

Common in all parts of the district, ranging from between tide-marks to 20 fathoms.

General Distribution.—British Isles; shores of North Atlantic; Japan; Spitzbergen; Nova Zembla.

Nereis zonata, Malmgren.

1867. Malmgren, Annulata Polychaeta, p. 46.

Portmarnock Strand, 27, i, '07.

10 miles east of Bailey Light (S. 553, 16, viii, '07. Trawl, 41–52 fms.).

This species has not been previously recorded from the shores of the British Isles. It was, however, taken by the German Deep Sea Expedition some miles off the north-east coast of Scotland.[1]

General Distribution.—Boulogne; North Sea; Spitzbergen; Siberia; Nova Zembla; Greenland; Eastern North America.

Nereilepas fucata, Savigny.

1868. Ehlers. Tom. cit., p. 546.

This species is common in a few fathoms (in Lambay Deep, at 38 fathoms) in all parts of the district, and is occasionally found between tide-marks. Almost every Buccinium shell that is inhabited by a hermit-crab also contains this worm, coiled in the upper whorls of the shell. According to Thompson (1856, p. 433), the Dalkey fishermen found this worm, which they call "Hairy Bait," a most attractive bait for fishing.

General Distribution.—British Isles; North Sea; France; North America.

Family **NEPHTHYDIDAE**.

Nephthys caeca (O. F. Müller).

1908. McIntosh. Tom. cit., p. 8.

Salthill and Malahide (McIntosh).

General Distribution.—Common in British Isles; Europe; Iceland; Greenland; east and west coasts of North America.

Var. **ciliata**.

1908. Mackintosh. Tom. cit., p. 13.

Malahide, 7, iii, '10. A single specimen, between tide-marks. This specimen closely resembles the variety found by McIntosh in May and June at St. Andrews and Montrose.

[1] 1908. Ehlers. Die Bodensässigen Anneliden der deutschen Tiefsee-Expedition, p. 68.

Nephthys Hombergii, Lamarck.

1908. McIntosh. Tom. cit., p. 17.

Salthill (McIntosh).

Sandymount Strand, common at all seasons.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

This is the commonest species of Nephthys in the district. It is extensively used by line-fishermen as bait, and is known by them as the "herring-bone worm."

General Distribution.—British Isles; Europe; Nova Zembla; Baltic Sea; Mediterranean; Madeira.

Nephthys ciliata (O. F. Müller).

1908. McIntosh. Tom. cit., p. 23.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

Off the Bailey Light, 7, ix, '07. Dredge, 7 fms.

This species has not been previously recorded from Ireland.

General Distribution.—Scotland; widely distributed over the shores of the North Atlantic and Arctic Seas.

Nephthys hystricis, McIntosh.

1908. McIntosh. Tom. cit., p. 27.

Malahide, 1885 (McIntosh).

General Distribution.—Atlantic, usually at considerable depths; Mediterranean.

Family **EUNICIDAE.**

Ophryotrocha puerilis, Clap. et Mecz.

1888. de Saint-Joseph. Ann. des Sc. Nat. Zool. (7), tom. v., p. 240.

Seapoint shore, 26, v, '07.

Sandycove shore, 28, iii, '09.

General Distribution.—British Isles; English Channel; Mediterranean.

Family **GLYCERIDAE.**

Glycera alba, Rathke.

1867. Malmgren. Tom. cit., p. 71.

Dalkey (McI.).

Malahide shore, 7, iii, '10.

General Distribution.—British Isles; North Sea; Atlantic; Mediterranean; Eastern North America.

Goniada maculata, Oersted.

1868. Ehlers. Tom. cit., p. 704.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

A single specimen of this worm was taken in the dredge.

General Distribution.—British Isles; Scandinavia; Spain; Portugal; North Sea; Eastern North America.

Family **ARICIIDAE.**

Scoloplos Mülleri (Rathke).

1898. de Saint-Joseph. Ann. Sci. Nat. Zool. (8), T. v., p. 356.

Malahide (McI.).

Sandymount Strand.

This worm is very abundant in the sand at Sandymount. During the breeding season its eggs, enclosed in a gelatinous mass which is anchored to the sand by a thread, are quite a conspicuous feature.

General Distribution.—British Isles; Europe; Siberia; Eastern North America. This species has been frequently confused with the Arctic *Scoloplos armiger* (O. F. Müller).

Naidonereis quadricuspida, Fabr.

1843. Oersted. Grönland's Annulata Dorsibranchiata, p. 200.

Sandycove shore, 28, iii, '09.

This species is apparently a member of the northern group. In the specimens I obtained the head was considerably broader than is shown in McIntosh's figures,[1] and the branchiae begin on the fifth parapodium, not on the sixth, as he states. The anal segment bears four cirri, equal in length to the width of the posterior part of the body. In all these points the Sandycove specimens agree with those described by Webster and Benedict,[2] from Eastport, Maine.

General Distribution.—Lochmaddy, North Uist; Iceland; Greenland; Eastern North America.

Family **Spionidae.**

Nerine cirratulus (Del. Chiaje).

1896. Mesnil. Bull. Sci. France et Belg., xxix, p. 152.

Poolbeg breakwater; common under stones and in sand.

Malahide, 23, ii, '08.

General Distribution.—Great Britain; North Sea; France; Mediterranean; Eastern North America.

[1] Monog. British Annelids, vol. ii, Part i, Plate lxv, fig. 5.

[2] U. S Commission of Fisheries, 1885, xiii. (1887), p. 738.

Scolecolepis vulgaris (Johnston).

1896. Mesnil. Tom. cit., p. 138.

Howth, south shore, 6, x, '09; north shore, 10, x, '09.

Common in the sandy patches round Howth Head.

General Distribution.—Great Britain; North Sea; France; Mediterranean; Eastern North America.

Spio martinensis, Mesnil.

1896. Mesnil. Tom. cit., p. 122.

Several fragments of a Spio found between tide-marks on Sandymount Strand differ from any recorded British species, and may be provisionally referred to *S. martinensis,* which Mesnil found on the coasts of France. Mesnil's species differs from the widespread *S. filicornis,* Fabricius, in having a rounded prostomium, no occipital tentacle, and in several other points which are more apparent than real. In the structure of the head the Sandymount specimens agree with *S. martinensis.* There are four distinct eyes, the anterior pair being reniform, and further apart than the posterior pair, which are circular. Between each lateral pair there is a patch of pigment formed of small and black grains, which under low magnification has the appearance of a third pair of eyes. Another character which distinguishes these specimens from *S. martinensis* is the structure of the ventral hooks, the upper fang of which is minutely bifid at the tip. The setae are frequently coated with red deposit, and when this deposit is only present in a small quantity, the setae have the punctuated appearance which shows in Mesnil's figures (tom. cit., Pl. vii., figs. 11, 12, &c.), and which McIntosh[1] regards as an important distinction from *S. filicornis.*

Aonides oxycephala (Sars).

1896. Mesnil. Tom. cit., p. 242.

Balscaddon Bay, Howth. October, 1909.

This species has not previously been recorded from Ireland.

General Distribution.—Plymouth; Norway; France.

Pygospio elegans, Claparède.

1863. Claparède. Beobachtungen, &c., p. 37.

Howth, south shore, 6, x, '09. In slender sandy tubes, massed in fissures of the schist.

Sandymount Strand, November, 1909. In sandy tubes in the sand.

General Distribution.—Great Britain; France; Eastern North America.

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[1] Ann. Mag. Nat. Hist. (8), vol. iii, p. 163.

Prionospio Steenstrupi, Malmgren.

1867. Malmgren, Annulata Polychaeta, p. 93.

5 miles N.N.E. of Balbriggan (S. 252. 20, ii, '05. Townet on trawl, 11–13 fms.).

A single small and immature specimen of *Prionospio* was taken in the townet off Balbriggan. I refer it to the above species on account of the structure of the branchiae, which have two rows of branches. The branchiae are small, and the branches few in number. Eyes are absent. The bifid hooks appear in the 12th setigerous segment, and the upper fang is minutely bifid. The peculiar curved "bayonet" seta is present in the ventral branch of the parapodium.

This species belongs to the small group of species with a northerly distribution, which is found in the northern part of the Irish Sea.

The genus *Prionospio* has not previously been recorded from the British Isles.

General Distribution.—Norway; Iceland; Greenland; Eastern North America.

Polydora ciliata (Johnston).

1896. Mesnil. Tom. cit., p. 210.

Malahide, 1887 (McI.).

Howth, south shore, 6, x, '09; north shore, 10, x, '09, in crevices of the rock.

Salthill.

General Distribution.—British Isles; shores of Atlantic; Mediterranean; Baltic; Pacific.

Polydora flava, Claparède.

1896. Mesnil. Tom. cit., p. 182.

Howth, south side, 6, x, '09.

Not previously recorded from Ireland.

General Distribution.—Great Britain; France; Mediterranean.

Family **CIRRATULIDAE**.

Cirratulus cirratus (Müller).

1843. Rathke. Beiträge zur Fauna Norwegens, p. 180.

Dalkey Sound (Thompson, 1856, p. 428).

Salthill, 1881 (McI.).

Poolbeg breakwater, 11, iii, '07.

10 miles east of Nose of Lambay (S. 553. 16, viii, '07. Trawl, 41–52 fms.).

North Bull, 21, x, '07. In old pile, washed ashore.

Sandycove, 28, iii, '09.

Howth, south shore, 6, x, '09; north shore, 10, x, '09.

This species is very common under stones and in muddy sand, at various points along the coast.

General Distribution.—British Isles; east, north, and west shores of Atlantic.

Cirratulus tentaculatus (Montagu).

1894. de Saint-Joseph, Ann. Sci. Nat. Zool., t. xvii, p. 49.

Shennick's Island, Skerries, 22, vii, '07.

This species is much less common in this district than the previous one.

General Distribution.—British Isles; North Sea; France; Mediterranean.

Dodecaceria concharum, Oersted.

1896. de Saint-Joseph, Ann. Sci. Nat. Zool., t. v., p. 346.

Howth, south side, 6, x, '09. In crevices of the schist, and in cavities in coralline seaweeds.

General Distribution.—England; Norway; North Sea; Madeira; Eastern North America.

Family **TEREBELLIDAE.**

Lanice conchilega (Pallas).

1894. de Saint-Joseph. Tom. cit., p. 211.

Howth, north shore, 10, x, '09.

Malahide, 7, iii, '10.

The tubes of this worm are common all round the coast.

General Distribution.—British Isles; Europe; Mediterranean; Madeira.

Nicolea venustula (Montagu).

= *N. zostericola* (Oersted).

1865. Malmgren, Nord. Hafs.—Annulater, p. 381.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

10 miles east of Bailey Light (S. 553. 16, viii, '07. Trawl, 41–52 fms.).

Malahide Inlet, 11, xi, '08. Dredge, 2 fms.

General Distribution.—Great Britain; North Sea; North Atlantic; Mediterranean.

Thelepus cincinnatus (Fabr.).

1865. Malmgren. Tom. cit., p. 387.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

General Distribution.—Great Britain; Siberia; shores of Atlantic; Mediterranean.

Thelepus setosus (Quatr.).

1894. de Saint-Joseph. Tom. cit., p. 230.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

Howth, north side, 7, ix, '07. Dredge, 15 fms.

Howth, south shore, 6, x, '09. In crevices of the schist. One specimen had *Polynoe scolopendrina* in its tube.

General Distribution.—Plymouth; France.

Family AMPHICTENIDAE.

Pectinaria auricoma (Müller),

1865. Malmgren. Tom. cit., p. 357.

Off Skerries, 9, vii, '07. Dredge, 5 fms., on muddy ground.

This specimen was exhibited at the Dublin Microscopical Club.[1]

Off Dalkey Island, 22, iv, '08. Dredge, 15 fms. One large specimen.

General Distribution.—British Isles; Norway; North Sea; Mediterranean.

Pectinaria belgica (Pallas).

1865. Malmgren. Tom. cit., p. 356.

4½ miles north-east of Nose of Lambay (S. 445. 21, vii,' 06. Townet. 26 fms.

General Distribution.—Great Britain; Norway; North Sea; Belgium.

Family MALDANIDAE.

The material belonging to this family has recently been sent to Herr Ivar Arwidsson, the eminent authority on this group. His report, which promises to be of great interest, will shortly be published in the "Scientific Investigations" of the Irish Fisheries Branch. The collection contains two species from Dublin Bay.

[1] Irish Naturalist, 1908, vol. xvii, p. 63.

Family **AMPHARETIDAE.**

Ampharete Grubei, Malmgren.

1897. Fauvel. Bulletin Sci. France et Belg., tom. xxx, p. 13.

13 miles E.S.E. of Lambay (S. 236, 29, vi, '04. Townet on Trawl, 39–52 fms. 2 sp.).

General Distribution.—Irish Sea (Hornell); Spitzbergen; Iceland; Greenland; Scandinavia; Siberia; Nova Zembla; North France.

Family **CAPITELLIDAE.**

Capitella capitata (Fabricius).

1887. Eisig. Die Capitelliden des Golfes von Neapel, p. 849.

Salthill (McI.).

Howth, North shore, 10, x, '09.

Sandymount Strand, common.

General Distribution.—British Isles; shores of Atlantic; Mediterranean; Black Sea.

Family **ARENICOLIDAE.**

Arenicola marina, L.

1900. Gamble and Ashworth. Quart. Journ. Micr. Sc., xliii, p. 419.

Common in sandy flats all round the district. It is used very largely as bait by line-fishermen.

A post-larval stage, $7\frac{1}{4}$ mm. long, with 19 setigerous segments, and no gills, was dredged in 2 fms. at Malahide Inlet, on the 24th of August, 1907. A later stage, with eleven pairs of gills, was found in sand on Sandymount Strand.

General Distribution.—British Isles; east, north, south, and west coasts of Atlantic; Mediterranean; Pacific.

Arenicola ecaudata, Johnston.

1900. Gamble and Ashworth. Tom. cit., p. 419.

Salthill (McI.).

McIntosh[1] records a post-larval stage of this species from Salthill, Co. Dublin. No adult specimen has apparently yet been found in the district.

General Distribution.—British Isles; Norway; English Channel.

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[1] Ann. Mag. Nat. Hist., 1908 (8), vol. i., p. 382.

Family **OPHELIIDAE.**

Ophelia limacina (Rathke.).

1843. Oersted. Grönlands Annulata Dorsibranchiata, p. 204. (As *O. bicornis*, Sav.).

Killiney Bay, 31, vii, '08. Dredge, 5 fms.

Poolbeg breakwater, 18, x, '08. One specimen under a stone between tide-marks.

This species belongs to the northern group.

General Distribution.—Great Britain; Scandinavia; Siberia; North Sea; Nova Zembla; Spitzbergen; Iceland; Greenland; eastern North America.

Family **SCALIBREGMIDAE.**

Scalibregma inflatum, Rathke.

1901–02. Ashworth. Quart. Journ. Micr. Sc., xlv, p. 237.

Malahide, 1886 (McI.).

This species has not hitherto been found on the east coast of Ireland, and this is apparently its most southerly European station.

General Distribution.—British Isles; North Atlantic; Arctic; South Africa; New Zealand.

Family **CHLORHAEMIDAE.**

Stylaroides plumosus (Müller).

1894. de Saint-Joseph. Tom. cit., p. 101.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

General Distribution.—British Isles; Scandinavia; Nova Zembla; Spitzbergen; Greenland; France; North America.

Stylaroides glaucus (Malmgren).

1867. Malmgren. Tom. cit., p. 82.

5 miles N.N.E. of Balbriggan (S. 252, 20, ii, '05. Townet on trawl, 11–13 fms.).

4½ miles north-east of Nose of Lambay (S. 445, 27, vii, '06. Townet on trawl, 26 fms.).

General Distribution.—Norway; Scotland.

Flabelligera affinis, M. Sars.

1900. Newbigin. Ann. Mag. Nat. Hist (7), vol. v, p. 190.

Dalkey Sound (McI.).

Malahide Inlet, 30, v, '08. Dredge, 2 fms. Common in the sponge *Halicondria panicea.*

General Distribution.—British Isles; Spitzbergen; Greenland; Iceland; Scandinavia; Mediterranean; France; North America.

Family SABELLIDAE.

Sabella pavonina (Savigny).

1894. de Saint-Joseph. Tom. cit., p. 267.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 12 fms.

10 miles east of Bailey Light (S. 553, 16, viii, '07. Trawl, 41–52 fms.).

Malahide Inlet, 24, viii, '07. Dredge, 2 fms.

General Distribution.—British Isles; Greenland; Norway; English Channel; North America.

Dasychone bombyx (Dalyell).

1894. de Saint-Joseph. Tom. cit., p. 309.

Dalkey Sound, April, 1907. Dredge, 6–8 fms.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

Malahide Inlet, 17, vi, '08. Dredge, 2 fms.

This species is very common in Dublin Bay. It was exhibited at the Dublin Microscopical Club, December 11th, 1907.[1]

General Distribution.—Great Britain; Scandinavia; France; North Sea.

Chone infundibuliformis (Kroyer).

1865. Malmgren. Tom. cit., p. 404.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

General Distribution.—Great Britain; Norway; Faroë; Spitzbergen; Nova Zembla; Greenland; Iceland; North America.

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[1] Irish Naturalist, 1908, vol. xvii, p. 40.

Jasmineira elegans, de Saint-Joseph.

1894. de Saint-Joseph. Tom. cit., p. 316.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

A single specimen of this Sabellid was found in Dublin Bay. It has not previously been recorded from Ireland, though it appears to be fairly common on the west coast. A single specimen was also dredged in the Clyde area by M. I. Newbigin.[1]

General Distribution.—Clyde; north coast of France.

Fabricia sabella, Ehrbg.

1894. de Saint-Joseph. Tom. cit., p. 319.

Lambay shore, 1906.

Howth, north shore. Common amongst weeds in rock-pools.

General Distribution.—Great Britain; Mediterranean; and east, north, and west shores of North Atlantic.

Haplobranchus aestuarinus, Bourne.

1883. Bourne. Quart. Jour. Micr. Sc., xxiii., p. 169.

Bourne states that Mr. Thomas Bolton found this species in mud from the mouth of the Liffey.

General Distribution.—Isle of Sheppey.

Family **SERPULIDAE.**

Pomatoceros triqueter (L.).

1894. de Saint-Joseph. Tom. cit., p. 353.

Very common in all parts of the area. It is found between tide-marks, and down to 60 fathoms in Lambay Deep. Almost every stone and shell is encrusted with it.

General Distribution.—British Isles; Scandinavia; France; Iceland; Mediterranean.

Hydroides norvegica (Gunnerus).

1907–8. de Saint-Joseph. Ann. des Sc. Naturelles (8), T. v., p. 440.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13–18 fms.

Kingstown—Dalkey, 20, vii, '07. Dredge, 8–12 fms.

General Distribution.—Great Britain; Norway; North Sea; Mediterranean.

[1] 1900. Millport Marine Biological Station, Communications i, p. 3.

Spirorbis borealis, Daudin.

1894. de Saint-Joseph. Tom. cit., 345.

Howth, south shore, 6, x, '09. On *Fucus*.

General Distribution.—British Isles; Iceland; Arctic Ocean; Atlantic; Mediterranean.

Spirorbis spirillum, L.

1882. Levinsen. Systematisk-geografisk Oversigt, etc., ii, p. 208.

Dalkey Sound, April, 1907. Dredge, 6 fms. On *Polyzoa*.

General Distribution.—British Isles; Scandinavia; North Sea; Faroë; Nova Zembla; Iceland; Greenland; North America.

Family **HERMELLIDAE**.

Sabellaria alveolata (L.).

1867. Malmgren. Tom. cit., p. 102.

Lambay, 1906.

Portmarnock Strand.

Howth, south shore, 6, x, '07.

This species, which usually lives between tide-marks, forms tubes of sand-grains, which are massed together like honey-comb. On the strand between Portmarnock and Malahide they can be seen in great masses, covering the rocks, and forming quite a conspicuous feature in the landscape.

General Distribution.—British Isles; English Channel; Mediterranean.

Sabellaria spinulosa, Leuckart.

1867. Malmgren. Tom. cit., p. 102.

2 miles south-east of Bailey Light, 13, vii, '07. Dredge, 13-18 fms.

Shennick's Island, Skerries. At low-water.

This species usually frequents the deeper waters near the coast. It is however, occasionally found between tide-marks, as at Skerries. It was dredged in large quantities in the Bay. The interlacing tubes form masses on stones and old shells; but their arrangement is not so regular as those of *S. alveolata*.

General Distribution.—British Isles; North Sea; English Channel.

Order **OLIGOCHAETA**.

The Oligochaeta occurring between tide-marks in Co. Dublin have recently been recorded at some length in the following papers:—

SOUTHERN, R. Notes on the Genus Enchytraeus. Irish Naturalist, 1906, vol. xv, p. 179.

Oligochaeta of Lambay. Irish Naturalist, 1907, vol. xvi., p. 68.
Contributions towards a Monograph of the British and Irish Oligochaeta. Proc. Roy. Irish Acad., 1909, vol. xxvii., p. 119.

I shall therefore content myself with enumerating a list of the known species.

Family TUBIFICIDAE.

Clitellio arenarius (Müller).
Tubifex Benedeni (Udekem).
T. costatus (Claparède).
T. Thompsoni, Southern.

Family ENCHYTRAEIDAE.

Marionina semifusca (Claparède).
Lumbricillus litoreus (Hesse).
L. verrucosus (Claparède).
L. fossorum (Tauber).
L. Pagenstecheri (Ratz.).
L. niger, Southern.
L. Evansi, Southern.
Enchytraeus albidus, Henle.
E. sabulosus, Southern.
E. lobatus, Southern.

The last-named species has only been found in moss and sea-weed on a cliff at Howth, over which fresh water trickled. It is undoubtedly covered with sea-water at certain tides; but it is difficult to say whether this species is really a littoral form, as it has not been found elsewhere; and it was accompanied by other worms, some of which are marine and others fresh-water.

Class HIRUDINEA.

Only one species of marine leech has been found in this district. It was recorded in the "Handbook to the Dublin District," 1908, p. 199.

Pontobdella muricata, L.

1894. Blanchard. Boll. Mus. Torino, vol. ix, No. 192, p. 20.

In the National Museum there are two specimens of this leech, taken in the trawl off Howth in 1891, by W. F. de Vismes Kane and the late Dr. Ball. This leech is parasitic on various species of ray and shark.

General Distribution.—British Isles; Atlantic; Mediterranean.

Class **GEPHYREA.**

1856. THOMPSON, W.—The Natural History of Ireland, vol. iv, p. 444. Records *Priapulus caudatus*, Lam., from Dublin Bay.

1861. KINAHAN, J. R.—Report of the British Association, p. 31. Records from Dublin Bay:—*Syrinx Harveii* (Forbes) = *Phascolosoma vulgare*. *S. granulosus* = *Phascolosoma vulgare*. (?) *Sipunculus Bernhardus* = *Phascolion strombi*. *Priapulus caudatus.*

1908. NICHOLS, A. R.—Handbook to the City of Dublin. Section Gephyrea, p. 200. Records *Phascolion strombi* from Dublin Bay.

1908. SOUTHERN, R.—A new Irish Gephyrean. Irish Naturalist, vol. xvii, p. 171. Record and description of *Petalostoma minutum*, Kef.

1910. COLGAN, N.—Dublin Microscopical Club. Irish Naturalist, vol. xix, p. 6. Mr. Colgan exhibited *Phascolion strombi* from Dublin Bay.

Petalostoma minutum, Keferstein.

1908. SOUTHERN, R.—Irish Naturalist, vol. xvii, p. 171.

Dalkey Sound, April, 1907. Dredge, 6 fms.

Sandycove, under stones between tide-marks, 7, vi, '08.

Howth, south shore, 7, x, '09.

General Distribution.—Plymouth; north coast of France.

Phascolosoma vulgare (Blainville).

1904. Théel, Hj. Kungl. Svenska Vet.—Akad. Hand. Bd. 39, No. 1, p. 60.

Dublin Bay (Kinahan).

10 miles east of Bailey Light (S. 553. 16, viii, '07. Trawl, 41–52 fms.).

General Distribution.—British Isles; Greenland; Europe; Atlantic; Mediterranean; Red Sea.

Phascolion strombi (Montagu).

1904. Théel, Hj. Tom. cit., p. 86.

Dublin Bay (Kinahan; Nichols; Colgan).

Dalkey Sound, 27, iv, '09. Dredge, 7 fms.

Dalkey, November, 1909. In *Dentalium* shell.

10 miles east of Bailey Light (S. 553. 16, viii, '07, Trawl, 41–52 fms.).

General Distribution.—British Isles; Arctic Seas; east, north, and west coasts of North Atlantic; Mediterranean.

Priapulus caudatus, Lamarck.

1906. Théel. Hj. Kungl. Svenska Vet.—Akad. Hand. Bd. 40, No. 4, p. 15.

Dublin Bay (Dr. Coulter; Kinahan).

In stomach of a plaice taken off Ireland's Eye (S. 56. 15, iv, '02. Beam trawl, 13 fms.).

General Distribution.—British Isles; Arctic and Antarctic Seas; east, north, and west coasts of the North Atlantic.

This species is remarkable in having a bipolar distribution.

VII.

A REVISION OF THE GORGONELLIDAE: 1. THE JUNCELLID GROUP.

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PLATES I–XIX.

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CONTENTS.

I.—Introduction.

Systematic description of Alcyonarians is beset with many difficulties, sometimes due to our ignorance of intimate structure—as in the case of the genus Telesto, which Prof. Bourne (1, p. 29) refers to the Steleckotokea, but which Prof. Hickson (XII A, p. 348) considers should be placed in the Alcyonacea—and sometimes to the large number of forms separated by minute and very variable characters, as in the case of Dendronephthya. These difficulties are sometimes increased by the inadequacy of the diagnostic descriptions given in previous records. This may be illustrated, possibly with some useful result, by a consideration of the Gorgonellid genera Juncella, Ellisella, Scirpearia, Scirpearella, Ctenocella, and Nicella. These may be briefly included in the term "the Juncellid-group" of the Gorgonellidae.

My attention was first drawn to this group in 1905, while assisting Prof. J. Arthur Thomson in classifying some Indian Ocean Alcyonaria. The Indian Museum deep-sea collection contained a large number of these forms, as also did the collection made by Prof. Herdman in the Ceylon seas. Owing to the unsatisfactory nature of the classification of the group, and also owing to the extreme fertility of variation which occurs not only in different colonies, but even in different parts of the same colony, Prof. Thomson, in reporting on these collections, decided to give descriptions of most of the specimens, but refrained from naming any but undoubted species. The following note from the latter report sums up the situation:—"It may seem of little service to suggest problematical species based on a study of fragments; but, as we have given some description of each, our procedure is probably preferable to that of some other students of Alcyonacea, who have given names nude of any description. Our impression is that the elongated forms of Scirpearella, Juncella, and the like, so monotonous in general appearance, so perplexingly different when one gets beneath the surface, are subject to great variability."

Ridley, in his "Report on the Alcyoniid and Gorgoniid Alcyonaria of the Mergui Archipelago" (Journ. Linn. Soc., vol. xxi., 1888), says, with regard to Juncella:—

"This is a most difficult genus. Looking at the variations in the external form and in spicules of the specimens here referred to this genus, and comparing them with facts previously known about it, one is struck by the extremely slight nature of the points separating some of the species. Had not *Juncella juncea* and *Juncella fragilis* been simple, while the present specimens of *Juncella gemmacea* are branched, it would have been difficult to distinguish the three species as in spiculation every fresh specimen appears to present some slight difference; while the total differences of spiculation in these species are slight, and thus admit of little specific distinction. Then again *Juncella gemmacea*, though commonly branched, may be simple. Colour, too, appears to afford little help in the determination of species. The form, size, and distribution of the zooid-verrucae, and the proportions of the corallum as a whole, seem to be the best points to rely upon. *Junceila elongata*, however, seems to be distinct in spiculation."

In reporting on the Littoral Alcyonaria of the Indian Ocean (Thomson and Simpson, 1909), we drew up a comparative table of all the specimens in this group which could not with certainty be referred to unquestionable species.

These specimens, along with those of other collections on which Prof. Thomson has reported, have been kindly handed to me as a basis for this memoir.

Since 1905, however, it has been my privilege to do some biological work on board the Royal Indian Marine Survey ship "Investigator"; and during that time I had an opportunity of collecting and observing a very large number of specimens belonging to this group in the waters around the Mergui Archipelago—a happy hunting-ground for Juncellids. By this means an extended study of variability was rendered practicable in a way which would otherwise have been impossible; and this has been of immense value in generic and specific determination.

The writer has also been fortunate in visiting a number of museums in which old specimens are deposited, and there examining these forms; while others, more inaccessible, have been kindly lent for examination.

The following list gives the more important collections in which specimens of this group occur, all of which have been systematically examined in the preparation of this report.

II.—MATERIAL EXAMINED FOR THIS MEMOIR.

1. The Hunterian Collection of Gorgonellids in the Museum of the Royal College of Surgeons, London. This is a very old collection, and contains many interesting specimens which were of great use in determining the nature of the spiculation in some of the older species whose descriptions dealt entirely with macroscopical characters.

2. The Gorgonellid specimens in the collection of the Natural History Section of the British Museum, which include (1) most of the specimens on which the voluminous work of Gray was based, (2) the specimens of the "Alert" collections, and (3) the type-specimens of the "Challenger" expedition.

3. The collection made by Professor Herdman in the Ceylon seas (1902), described in the Ceylon Pearl Oyster Report (Roy. Soc.), and now deposited in the British Museum.

4. The specimens collected around the Cape of Good Hope and in the possession of the Cape Museum. These were reported upon in the "Marine Investigations in S. Africa."

5. The collection made by Mr. J. Stanley Gardiner in the Maldive Seas in 1900, and described in the "Fauna and Geography of the Maldive and Laccadive Archipelagoes."

6. The deep-sea collection, deposited in the Indian Museum, Calcutta, made during the different cruises of the Royal Indian Marine Survey ship "Investigator" in the Indian Ocean, and reported on in a Memoir published by the trustees of the Indian Museum.

7. The Littoral Collection made by the "Investigator," deposited and published as above. Very few of these specimens, however, received specific determination in that report, but they are fully dealt with in this memoir.

8. The "Wood-Mason Collection," made by Mr. J. Wood-Mason in the Indian Ocean. Some of these are described along with the Indian Museum Littoral Collection; but most of them were left over for incorporation in this memoir, and are here identified and described for the first time.

9. The collection made by "S. A. S. le Prince de Monaco," on the yacht "Hirondelle," during 1900–1902.

The type-specimens of this collection are deposited in the Oceanographical Museum at Monaco.

10. The collection made by Mr. J. Stanley Gardiner in the Indian Ocean around the Maldive Islands, and reported on in the Transactions of the Linnean Society (1910).

11. A partly undescribed collection made around the Cape of Good Hope and in the possession of the Cape Museum.

12. Specimens collected at Naples by Professor Thomson, and handed to me for identification. These are dealt with in this memoir, and are deposited in Aberdeen University.

13. The "Mergui Collection," made by the writer in the waters around the Mergui Archipelago, Burma, in 1897. These are here described for the first time, and the type-specimens are deposited in the Natural History Museum of Aberdeen University.

I am pleased to have this opportunity of expressing my thanks to all those who have so generously placed specimens at my disposal; for only through their kindness has it been possible to render this study in any way complete. I am specially indebted to Professor F. Jeffrey Bell, of the British Museum, for the facilities he provided me in examining the magnificent collection in that institution; to Dr. Burne, of the Royal College of Surgeons, London, for an excellent sketch of a colony in that museum (fig. 46); to Professor Sydney J. Hickson, Manchester, for kindly sending me portions of the specimens and also the preparations of spicules on which the descriptions given in his memoirs are based; but most of all to Professor J. Arthur Thomson, who has entrusted the greater part of the new material to me for identification, including the collection of the Indian Museum, Calcutta, the Monaco collection, and the Cape collection referred to above. I cannot sufficiently express my thanks to him for placing his splendid series of Alcyonarian literature at my disposal, for the personal interest he has taken in the work, and for much kindly criticism and advice.

I must also thank the Trustees of the Carnegie Trust for a grant towards defraying the cost of illustration, and also the two artists, Mr. George Davidson and Mr. William Smith, for the trouble they have taken in preparing the drawings.

III. BIOLOGICAL NOTE.

The Juncellid-group of Gorgonellids are typically shallow-water forms, and occur both in tropical and temperate seas, chiefly, however, in tropical waters, but have not so far been found in Arctic or Antarctic seas. They are usually found within the hundred-fathom line, and exist in very shallow water. On the coral reefs of the Mergui Archipelago, numerous colonies may be seen swaying to and fro in the air when uncovered by the water at low tide. This power to survive the heat of the sun in the tropics for as much as two hours daily is proof of great vitality in the group.

The colonies may be simple or branched, and when simple may attain to great lengths; specimens of over six feet long are not infrequent. This great length is all the more remarkable when it is remembered that there is no jointing of any sort, as is seen in Isis, Melitodes, and the like. They are extremely flexible, sway to and fro in the ocean, and when living may be bent into the form of a figure 8 without the least chance of fracture. This is of great morphological significance, and is paralleled in the animal kingdom only by (1) Pennatulids (e.g. Umbellula), (2) Antipatharians, and (3) Nemerteans.

Nemerteans, however, live a free existence; Umbellula is also free, and lives embedded in mud at great depths. The analogy, therefore, restricts itself to Juncellids and Antipatharians. In the former the axis contains lime; in the latter it is composed entirely of a horny substance.

The proportion of coenenchyma to axis is very different, however, in the two cases. In the former the coenenchyma preponderates over the axis, but in the latter the reverse holds true.

The extraordinary power of regeneration as seen in this group is of great physiological interest. Normally they are attached to rocks or corals; but even shells—e.g., *Margaritifera margaritifera*—may form a basis of support. Ridley records the case of a colony in the "Alert" Collection which had been broken from its attachment, and in which the coenenchyma had quite overgrown the fractured part, which had continued its existence as a free colony, floating in the ocean. A similar case has been recorded by the writer for *Isis hippuris* (Journ. Linn. Soc. Zool., vol. xxxvii., pp. 421–433, pl. 43).

These large Juncellid colonies also form bases of attachment for numerous kinds of animals. Ophiuroids and crinoids are constantly found attached to them, but equally common and more permanent are acorn-shells and bivalves. The former settle down in the larval stage, bore their way through the coenenchyma, and remain attached for life to the axis. The Alcyonarian colony responds to the stimulus, and continues to develop coenenchyma at the fractured part, so that eventually the acorn-shell is quite overgrown by polyp-bearing coenenchyma, leaving only a small oval aperture, by means of which the acorn-shell derives its food—a characteristic form of commensalism.

Of more economic interest, however, is the case of *Pteria macroptera*, which is eagerly sought for on account of its pearl-bearing proclivities.

While examining the marine fauna of the Mergui Archipelago, one of the most striking phenomena encountered was the fact that on nearly every colony of *J*[illegible] obtained there were abundant specimens of this oyster. Some idea of the strength of these colonies may be gathered from the fact that on one individual colony there were over a hundred oysters. The greater number of these were almost full-grown, and each of them weighed on an average more than the colony itself. The byssus was usually overgrown by coenenchyma, but the great rate of growth of the shell itself precluded the possibility of the Alcyonarian keeping pace with it.

Reproduction.—A large proportion of the colonies examined contained [illegible] spherical reproductive bodies. Serial sections of some of these were made, and Professor Hickson also kindly sent me some sections prepared by him. These bodies consisted of two kinds:—

(1) Ova with a large nucleus and a distinct nucleolus almost identical with the figures given by von Koch.

(2) Spermathecae or sperm sacs in which it was possible to trace spermatogenesis almost up to the stage of fully formed spermatozoa.

No trace of segmentation of ova was discernible; and it is more than probable that this does not take place within the parent body.

It is also worthy of note that the ova and spermathecae occurred in different specimens, so that it is almost certain that in this group the colonies are dioecious.

IV.—HISTORICAL SUMMARY OF THE GROUP.

Family **GORGONELLIDAE**.

The family Gorgonellidae is here regarded, on the whole, in the sense of Wright and Studer (L, p. lxiv), who, accepting Kölliker's diagnosis, define it in the following terms :—

" In the species of this family the coenenchyma is thin, smooth on the surface, with small spicules in the form of warty double-clubs and stellate forms. The polyps have more or less well-developed verrucae and are usually biradially disposed. The axis is lamellar and calcareous, but retains its shape after the extraction of the calcareous matter."

The colonies in the Gorgonellidae form simple or branched masses whose calcareous axis gives to the whole a rigid appearance. The branches and twigs are frequently flattened; and the polyps are either distributed in two rows on the edges thereof, or are so disposed in lateral bands that a free space is left in the middle, in which are to be found one or more longitudinal furrows. The longitudinal canals are partly of small diameter, partly large. Two usually occur on the surfaces of the stem which are destitute of polyps. On the surface of the coenenchyma in dried specimens their position is marked by longitudinal grooves.

It includes the following genera :—

NICELLA, ...	Gray.
SCIRPEARIA, ...	Cuvier, emend. Studer.
SCIRPEARELLA, . . .	Wright and Studer.
JUNCELLA,[1]	Valenciennes, emend. Studer.
ELLISELLA, ...	Gray, emend. Studer.
VERRUCELLA, . . .	Milne-Edwards.
CTENOCELLA, . . .	Valenciennes.
PHENILIA, ...	Gray.
HELIANIA, ...	Gray.

The two genera Phenilia and Heliania are only imperfectly known; and the diagnoses, as given by Gray, leave much to be desired. Studer considers Phenilia as synonymous with Gorgonella; and it is more than likely that Heliania cannot now be considered as a distinct genus. The spicules of

[1] The original spelling of this genus was "Junceella," but it is now generally written "Juncella," so that, except in references, the more common spelling has been adopted in this report.

these two genera have never been investigated; and I have been unable to obtain an authentic specimen of either of these, so that, for the present, they must remain as problematical genera.

It is extremely doubtful whether Verrucella and Gorgonella can be regarded as distinct; but, in the present memoir, it is not proposed to deal with the various species which have, from time to time, been referred to them. At the same time it must be noted that a very fruitful study might be made with regard to these forms.

Excluding, then, Phenilia, Heliania, Gorgonella, and Verrucella, it might be of advantage, before proceeding to examine and differentiate the various genera and species, to trace briefly the different bases of classification which have from time to time been adopted in regard to the six genera under consideration.

The oldest of the genera under consideration is Scirpearia, which was established by Cuvier (Règne Animal, p. 319) in 1830. There is still doubt, however, as to the exact identity of Cuvier's species.

Wright and Studer (l., p. 154) give a detailed account of the history of the name Scirpearia from the time of Cuvier to the time of publication of the "Challenger" Report.

In 1855 Valenciennes (Comptes Rendus, xli., p. 14) established the family Gorgonellaceae, with the following diagnosis: "Axis effervescing with hydrochloric acid," to include two new genera, namely, Juncella and Ctenocella. He defined them thus:—

JUNCELLA—Stems straight, covered with polypiferous cells scattered upon the sclerobase.

CTENOCELLA—Sclerobase forming straight rods, pectinated only on one side of the principal stem.

In the former genus he recognized the following new species:—*J. juncea*, *J. surculus*, *J. vimen*, *J. elongata*, *J. calyculata*, and *J. hystrix*.

In the latter *C. pectinata*.

Two years later Gray (P.Z.S., 1857, p. 159) proposed to re-arrange these genera thus: "This genus (Suberogoria) and the genera Juncella, Ctenocella, and Gorgonella of Valenciennes should be arranged with Corallium under the family Corallidae characterized by having a calcareous axis." In the same year, however (P.Z.S., 1857, p. 287), he abolished the genus Ctenocella, divided up the genus Juncella, established the genus Ellisella, and gave the following diagnoses and sub-divisions to include one new and several previously described species:—

ELLISELLA.—Coral simple or furcately branched; branches subcylindrical, with a more or less distinct lateral groove, especially at the base. Axis continuous, opaque, solid, calcareous, hard at the base and softer above. Bark when dry, granular, thin, with numerous series of sunken or slightly prominent polypiferous cells on each edge of the stem and branches.

(1) *E. juncea,* coral simple, sub-compressed beneath; Juncella Val.

(2) *E. elongata,* coral furcately branched, branches sub-cylindrical.

(3) *E. coccinea,* furcately branched, branches sub-cylindrical, very long, virgate.

(4) *E. pectinata,* coral branched fan-like, branches with a series of virgate branches on the upper side only. (Ctenocella.)

He also revived the genus Scirpearia in the following terms:—Coral slender (simple or sub-simple), rod-like. Axis slender, cylindrical, hair-like, solid, white, calcareous, attached by a broad base. Bark (when dry) thin, smooth, granular, with a series of sub-cylindrical polypiferous cells placed alternately on each side of the stem.

S. mirabilis.—Two years later (P. Z. S., 1859, pp. 479–486) he established the family Elliselladao, and gave the following diagnosis:—"The axis solid, calcareous, not jointed. Bark granular, cells on the sides of the stem and branches separated by a lateral groove." (*a*) Cell more or less elongate.

(1) ELLISELLA.

Coral tree-like, sub-cylindrical; branches free; cells numerous, small, crowded. *E. juncea, E. elongata, E. coccinea, E. pectinata.*

(2) SCIRPEARIA.

Coral simple or forked; cells sub-cylindrical in two alternate series.

S. mirabilis, coral simple.

S. dichotoma, coral branched, forked.

From this résumé it will be seen that, up to this time, identification was based on external characters alone; but in 1864 a great advance was made when Kölliker investigated the spicules, and defined Juncella as having "clubs, double-clubs, and double-stars. The spicules of the polyps are small spindles." He recognized the following three species:—

(*a*) With clubs: *Juncella juncea, J. gemmacea.*

(*b*) Without clubs: *J. elongata.*

Gray, however, seems to have been unacquainted with Kölliker's contribution, for in 1870 (Cat. Lith., B. M.), he, without taking into account the nature of the spiculation, overturned his previous classification; and in the family Ellisselladae placed Juncella, Ellisella, along with many others which do not concern us here; at the same time he re-established the genus Ctenocella, and formed a new one, viz., Viminella, in the same family.

The genus Scirpearia he relegated to a heterogeneous group, which he called the Caligorgiadae, in which he established the genus Nicella, to include his *Scirpearia dichotoma*. The following synopsis brings out the general plan in this classification:—

Family **ELLISELLADAE.**

JUNCELLA.—Coral simple, sub-compressed near the base; branches sub-cylindrical, with a more or less distinct lateral groove, especially at the base. Axis continuous, opaque, solid, calcareous, hard at the base, white and softer above. Bark, when dry, granular, thin, with numerous series of sunken or slightly prominent polypiferous cells on each side of the stem and branches: *J. juncea.*

ELLISELLA.—Coral tree-like, furcately branched; branches spreading and then ascending; lateral groove very narrow, but well marked; the rest like Juncella: *E. elongata*; *E. coccinea*; *E. gemmacea*; *E. calyculata.*

CTENOCELLA.—Coral branched, fan-like, expanded in a plane; branches with a series of virgate branchlets on the upper side; lateral line well marked, but narrow: *C. pectinata.*

VIMINELLA.—Coral simple, elongate, flagelliform. Bark thin; lateral space broad, with a sunken line. Polyps-cells, cylindrical, prominent, in three or four series on each edge of the stem. Axis grey, calcareous:—

V. juncea	=	*J. vimen.*
V. flagellum	=	*J. extans* and *J. flagellum.*
V. hystrix	=	*J. hystrix.*
V. laevis	=	*J. laevis.*

Family **CALIGORGIADAE.**

SCIRPEARIA.—Coral slender (simple or sub-simple), rod-like. Axis slender, cylindrical, hair-like, solid, white, calcareous, attached by a broad base. Bark (when dry) thin, smooth, granular, with a series of sub-cylindrical, polypiferous cells placed alternately on each side of the stem. Lateral groove indistinct. *S. mirabilis, S. funiculina, S. barbadensis, S. monilliformis.*

NICELLA.—Coral fan-like, on one plane, branched: branches forked, rather diverging. Bark smooth, brown. Polyps-cells cylindrical, truncated, diverging from the stem at nearly right angles, mouth open. Axis calcareous, white, solid. *N. mauritiana.*

In 1878, Studer still further advanced Kölliker's contribution, and noted that when one investigated the spicules of the various species in the family, one found two definite groups:—

(1) Those with an outer layer of *clubs* and an inner layer of *double-clubs*; and

(2) Those with only *double-clubs* and *spindles.*

The latter group he again sub-divided on the basis of the nature of the verrucae. His classification would appear thus:—

(1) Spicules, clubs, and double-clubs, Juncella.
(2) Spicules, double-clubs, and spindles—

A. Calyces not prominent, Ellisella.
B. Calyces markedly projecting, Scirpearia.

JUNCELLA.—Colony simple or forked; verrucae club-shaped, prominent or otherwise. In the coenenchyma, an outer layer of clubs and an inner layer of double-clubs. *J. juncea*, *J. gemmacea*, *J. flexilis* nov.

ELLISELLA.—Colony simple or forked. Verrucae hardly projecting, in two rows on the sides of the stem and branches. In the coenenchyma only double-clubs and spindles. *E. maculata* nov., *E. calamus* nov.

SCIRPEARIA (including Nicella, Raynerella, and Viminella).—Colony simple or branched. Axis cylindrical, calcareous, and horny. Coenenchyma thin, with prominent polyps, which are disposed in two rows on the sides of the stem and branches. Spicules, double-clubs, and spindles. *S. mirabilis*, *S. flagellum* (= *J. extans* and *V. flagellum*).

NOTE.—Studer includes in Scirpearia *Nicella mauritiana*, and says that the only type of spicule in this species is "spindles thickly covered with warts." Ridley, however, doubts whether the specimen examined by Studer was really *N. mauritiana.* This is extremely probable in view of the fact that *N. dichotoma* (which is a synonym of *N. mauritiana*) contains both double-clubs and spindles. (See subsequent discussion of this species.)

Wright and Studer (L.) united all these genera under the family Gorgonellidae, which they placed in the Holaxonia, near the Gorgonidae and Plexauridae. At the same time, they, while recognizing Juncella, Nicella, Ctenocella, Scirpearia, and Ellisella, established a new genus under the name of Scirpearella, which they defined thus:—"Colony simple or very feebly branched. Axis calcareous, brittle, smooth, or grooved. Polyps arranged in rows or spirals, retractile, with more or less prominent verrucae. The coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs."

The following species are described:—*S. monilliforme* nov., *S. profunda* nov., *S. gracilis* nov., *S. rubra* nov.

Hickson (xv, p. 819), in discussing this group, says that the four genera Juncella, Ellisella, Scirpearia, and Scirpearella are undoubtedly related. He takes exception, however, to the distinction between Juncella and Ellisella based on spicular characters, and proposes to unite them under the name Juncella. At the same time he refers the genera to two groups—

(1) those with club-shaped spicules, and
(2) those without club-shaped spicules.

On this system he gives the following arrangement of the species:—

With clubs:—

J. juncea Pallas.
J. gemmacea (Milne-Edwards).
J. flexilis (Studer).
J. fragilis (Ridley).
J. barbadensis (Wright and Studer).

Without clubs:—

J. elongata (Valenciennes).
J. calamus (Studer).
J. maculata (Studer).
J. spiralis Hickson.

He also makes the following note:—"*J. hepatica* (Klz.) may not be distinct; and *J. funiculina* (M. and D.) and *J. laevis* Verrill are not sufficiently well known to be classified in this system."

The genera Scirpearia and Scirpearella he, however, retains as being capable of identification as follows:—

Scirpearia—prominent verrucae in two rows.

Scirpearella—prominent verrucae arranged in a spiral manner.

Before considering to what extent any or all of these systems of classification may be regarded as an aid to the determination of natural affinities, it will be well to review all the characters, macroscopic and microscopic, upon which stress has been laid, and also any others which might serve to elucidate the relationships existing in this group.

V.—MACROSCOPIC AND MICROSCOPIC CHARACTERS AS A BASIS OF CLASSIFICATION.

(1) COENENCHYMA.

(*a*) *Surface.*—The surface of the coenenchyma is generally smooth to the naked eye, but presents a glistening, arenaceous appearance when viewed with a lens. This is due to the small spicules, which project slightly, either singly or in small clusters.

Thickness.—The thickness varies in different species; e.g., in *Juncella juncea*,[1] *Juncella gemmacea*, and *Scirpearia furcata* it is usually thick; but in *Juncella racemosa*, *Scirpearia alba*, and *Scirpearia flagellum* it is generally thin.

On the other hand, however, extremes may be found in different specimens of the same species. No better example of this can be cited than *Juncella juncea* (see later). For this reason the thickness of the coenenchyma cannot be regarded as a specific criterion. It does, however, affect the general appearance of the colony, inasmuch as the verrucae are capable of greater retraction in those specimens in which the coenenchyma is above the average thickness. (See figs. 9 and 10 (*a*, *b*, and *c*) of *Juncella juncea*, fig. 100 of *Scirpearia andamanensis*, and figs. 83 and 88 of *Scirpearia furcata*.) As a contrast to these, figs. 49 and 56 of *Scirpearia flagellum* may be taken as typical. One very important feature in regard to the thickness of the coenenchyma is the fact that this is almost a constant in any one specimen; the difference in the thickness of the colony is really due to the axis.

It, therefore, follows that, although the thickness of the coenenchyma varies very little in any individual specimen, it may vary considerably in different specimens of the same species, and is therefore of little if any taxonomic value.

Consistency.—The coenenchyma is densely packed with minute spicules, and is consequently very granular and brittle, especially when dry. It presents a gritty, uneven surface when cut with a knife.

(*b*) *Histology.*—The coenenchyma is divided into an outer non-canal-bearing part in which the polyps are embedded, and an inner part in which small canals ramify in all directions (figs. 10 and 19). These are separated by a series of longitudinal canals, which are arranged peripherally. The proportionate thickness of these two parts varies greatly in different specimens, and is of no taxonomic value.

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[1] The generic and specific names given in this part of the memoir are those which are adopted in the final classification (q.v.).

(c) *Colour.*—The colour of the colonies is due almost entirely to the pigment in the calcareous spicules, so that there is very little change after long preservation in spirit. The fleshy part of the coenenchyma is generally pinkish; but the loss of this, due to immersion in alcohol, is hardly perceptible in the final tint. It is worthy of note, however, that in white colonies the coenenchyma is almost transparent; and immersion in alcohol results only in rendering the colony more opaque. When dried, the colonies acquire a very dull opaque colour: but the warm tones, which are so characteristic of the group, may be restored on immersion in alcohol.

The colour of a colony is of no taxonomic importance, as this may vary in different specimens of the same species. Two very good examples of this are *Scirpearia flagellum* and *Scirpearia furcata*. A few notes on these two species may be of interest; but it is worthy of note that, without some definite and recognized colour-scheme, precise description of colour is impossible. The following colours are, however, given by the different authors. The exact specimens will be better recognized if given under the names by which they were originally described.

Scirpearia furcata (emend.).

S. sp. Thomson and Henderson: "The general colour of the colony is reddish orange; but the verrucae are distinctly red."

S. furcata Hickson: "Orange red coenenchyma, with dark red dome-shaped verrucae."

S. furcata var. Hickson: "The colour is not so much a pure red, but tinged with orange."

S. [illegible] Hickson: "The colour varies in different specimens. In one the coenenchyma is white; but the tips of the verrucae are red. In another the verrucae are white throughout; but there are streaks of pink along the coenenchyma, running irregularly and uniting at the base to give a general pale-red colour."

S. [illegible] β. Thomson and Henderson: "The general colour is pale salmon-pink; but the verrucae are white, and streaks of the same colour permeate the coenenchyma."

J. elongata Hickson: "The colour is pale pink, and the verrucae are white."

Mergui specimen: The colour is orange, but the anthocodiae are white.

Type specimen (sens. emend.): "The colony is of a pale yellow colour, with red verrucae. Near the base long streaks of red extend longitudinally from the verrucae and interlock, giving a peculiar tessellated pattern."

In the Cape and Mergui Collections are a number of colonies: (1) creamy white, (2) pale orange, (3) bright orange, (4) dull orange red, (5) brick-red, (6) pale orange yellow, with reddish tips to the verrucae.

Scirpearia flagellum.

Monaco specimens: Dull white, creamy-white, pale yellow, orange yellow.

Naples specimen: The general colour of the colony is reddish orange, but the tips of the verrucae are distinctly more reddish.

On the whole, the colour schemes of Juncellids are defined by the coenenchyma proper and the verrucae, but in a few cases the colour of the verrucae extends in streaks along the coenenchyma, and gives very pretty tessellated patterns. Good examples of this are seen in some forms of *Scirpearia furcata* (*sens. emend.*) (see fig. 77).

(2) CANAL SYSTEM.

This is a feature to which little or no attention has so far been paid, but which is of great taxonomic importance, and which also exerts a great influence on certain superficial appearances which have been used for specific diagnosis.

Description.—In all Juncellids it is essentially of the same type, and consists of (1) an inner longitudinal series separating the inner canal-bearing part of the coenenchyma from the axis, (2) an outer longitudinal series separating the two divisions of the coenenchyma (see above), and (3) a transverse series ramifying in all directions through the inner part of the coenenchyma and uniting the two longitudinal series.

This is common to all Juncellids (see figs. 10 and 13 of *Juncella juncea*, fig. 19 of *Juncella gemmacea*, fig. 25 of *J. trilineata*, fig. 114 of *Juncella quadrilineata*, and fig. 43 of *Scirpearia pectinata*).

As has been already remarked, the thickness of the coenenchyma is almost a constant, and consequent upon this the thickness of the canal-bearing parts separating these two series of canals is also a constant (see figs. 10, *a*, *b*, and *c*).

With regard to the longitudinal series, it is essential to note that the number varies in the different parts of the colony, or, in other words, diminishes from the base upwards.

We have made an extended study upon a large number of specimens, and the following observations may prove useful:—

1. The outer series of canals communicates directly with the polyps, and, by means of the transverse canals, communicates with the inner series.

2. The cause for the diminution in number is not far to seek. The number of polyps is smaller in the younger parts, and consequently the number of canals communicating with these is smaller.

3. The number of canals in the outer series bears no proportion to the number in the inner series in the different parts, although the number diminishes in both cases from the base upwards. It diminishes more rapidly in the inner series.

Let us consider the different series, and see to what extent these may be considered of taxonomic value.

1. *Transverse series.*—This series, as has been pointed out, serves to connect the outer longitudinal series with the inner longitudinal series, and, as might be expected, is of no specific importance.

2. *Outer longitudinal series.*—The canals of this series communicate directly with the polyps, are all of equal size, have no influence on external or internal form, are constant in all specimens, and cannot therefore be taken into account in specific determination.

3. *Inner longitudinal series.*—We have here to deal with a series which has the following characteristics:—

(*a*) The canals are not all of equal value.
(*b*) They exert an influence on the external form of the colony.
(*c*) They produce an effect on the surface of the axis.

The superficial results produced by this series of canals have been used by different authors as a basis of classification; but no systematic examination has ever been attempted nor has any causal explanation ever been given, so that it may serve some useful purpose to study the actual influence exerted and the constancy of the results.

Studer (XXXVIII) in 1901 makes the following note:—"A transverse section of a colony of *Scirpearia flagellum* (Pl. IX, fig. 11) shows that the polyps arise on two sides of the axis; there are two large longitudinal canals in the plane perpendicular to that of the polyps."

Thomson and Henderson (XXXIX, p. 315, in describing *Juncella trilineata* say:—"Polyps arise in three different bands, leaving three narrow bare strips, each of which has in its centre a slight rib or keel. Under each bare strip lies a large longitudinal canal. The axis shows longitudinal grooves."

These are practically the only two references to the phenomena under investigation.

Let us consider each in detail:—

(*a*) *The canals are not all of equal value.*—A transverse section of any Juncellid colony reveals the fact that there is a certain number of the canals much larger than the others, and, no matter at what level the section be taken, this number is constant for the specimen (see figs. 80, 13, 19, 24, and 111). There is only one exception to this rule, namely, *Scirpearia pectinata* (fig. 43*a*); but in this case the conditions which occasion it are themselves exceptional, and will be described later. In the polyp-bearing branches the rule, however, holds good (fig. 43*b* and *c*).

In the great majority of cases the typical number is *two*—e.g. *J. juncea*, *J. gemmacea*; but in two colonies examined, viz., *Juncella trilineata* (Thomson and Henderson), and *Scirpearia quadrilineata* n. sp., there is a departure. In the former there are *three* and in the latter *four* (see figs. 25 and 111). These large main longitudinal canals are always symmetrically arranged, either

(1) diametrically opposite (two) (fig. 10), or
(2) at the ends of radii enclosing equal angles (three) (fig. 25), or
(3) at the ends of two diameters at right angles to one another (four) (fig. 111).

(*b*) *They exert an influence on the external form of the colony*:—(1) A very characteristic feature of Juncellids is the fact that in nearly every colony examined there is a certain number of longitudinal tracts devoid of polyps. This may be very marked, as in the case of *Scirpearia flagellum*, *Scirpearia ceylonensis*, and *Juncella ramosa*, or less marked in, e.g., *Scirpearia verrucosa*. In all these the number is always *two*.

In *Juncella trilineata*, however, the number is *three*, and in *Scirpearia quadrilineata* the number is *four*.

(2) These longitudinal bare tracts are symmetrically disposed, and correspond in position to the internal large main canals. The presence therefore of a certain number of bare tracts, and the consequent grouping of the verrucae into a corresponding number of longitudinal series, are thus the outward manifestation of the internal structure as expressed in the inner series of longitudinal canals. These bare tracts are sometimes marked by a longitudinal ridge or depression; but this is due to the large canal being either distended or in a collapsed state.

Since this phenomenon is a constant for any individual specimen, it seems to us that it may with safety be considered of taxonomic importance.

(*c*) *They produce an effect on the surface of the axis.*—"The surface is marked by longitudinal striae"; "Ridges and furrows occur on the surface of the axis"; such statements enter into the description of a great number of specimens given by various authors. A close examination of a transverse section reveals the fact that the furrows correspond in position to the canals of the inner longitudinal series.

Consequently, since the number of these canals diminishes from the base upwards, the number of ridges and furrows also diminishes, so that the actual number of furrows seen at any one level is not characteristic of the colony as a whole (see fig. 11*a*, *b*, and *c*). It is unfortunate, however, that several authors have used the number of furrows as a character on which to separate different forms; for it is at once evident that such diagnosis must be negatived.

In some cases—perhaps in all—although it is not very marked, two of the furrows are deeper than the others, and these correspond to the two large canals.

Thus, then, we see that the inner longitudinal series of canals has several well-defined characteristics, two, at any rate, of which may with safety be regarded as specific, namely:

(1) A certain number, constant for the specimen, are decidedly larger than the others.

(2) These large main canals determine the distribution of the verrucae, and manifest themselves externally by longitudinal bare tracts.

For these reasons we have decided to use this character as a basis for specific diagnosis.

(3) Polyps.

(*a*) *Structure.*—The polyps vary greatly in shape, not only in different specimens, but also in different parts of the same specimen. The structure is essentially simple; fig. 1 of *Scirpearia pectinata* may be taken as typical. (See also fig. 74 of *S. furcata.*) It consists of (1) the verruca, and (2) the anthocodia. There is no distinct point of demarcation between the two, but the one merges imperceptibly into the other. It may, however, be useful to distinguish between the lower cup-like portion, which may be termed the verruca, and the upper tentacle-bearing portion, the anthocodia.

The verruca arises from the general coenenchyma, but is supported by spicules of a different type, as will be explained further on; these have no definite arrangement. Near the summit there are usually eight triangular lobes or teeth which are also densely spiculose. From these arise the short, stumpy pinnate tentacles; these are usually very broad, conical in shape, and bear short, simple pinnules about six to ten in number.

The anthocodiae are usually white, no matter what may be the colour of the colony, and the tentacles bear a number of small, flat, scale-like spicules on the aboral surface. These are very easily overlooked in a preparation;

and in fact they are so similar in all species as to be of no specific importance, so that their inclusion in each individual description is hardly necessary.

(*b*) *Motility.*—To define the shape of the verrucae would be to describe the various phases through which it passes from complete expansion to extreme retraction. It may be well, however, to consider some of the phases presented in the same and different specimens, and note to what extent motility occurs. Fig. 32 of the Cape specimen of *Scirpearia flagellum* and fig. 64 of the type specimen of *Scirpearia alba* show the verrucae as low cones. Fig. 9*a* of *Juncella juncea*, and fig. 90*a*, *b*, and *c* of *Scirpearia furcata* show them as level with the coenenchyma, or even depressed beneath it.

On the other hand, however, the great majority of the figs.—e.g., 36, 44, 85, and 98—depict them as directed upwards, and adpressed to the coenenchyma.

When we examine these carefully, we find that the upper surface of the polyp is considerably wrinkled, while the lower is decidedly stretched. (See fig. 49 of the Naples specimen, and fig. 36 of the Cape specimen of *S. flagellum.*)

Another phase, however, presents itself. Fig. 2, from a specimen in the Monaco Collection, has been added to show a very peculiar disposition not uncommon in *Scirpearia flagellum*. This species is remarkable for the length of its verrucae, the thinness of the coenenchyma, and the consequent slight retraction of the former into the latter. In this figure the verrucae on one side of the stem are all directed upwards, while on the other they are all directed downwards. In other specimens some are directed upwards, some horizontally, and some downwards, while a very peculiar arrangement is seen in the Naples specimen described in this report. The colony has been broken in two and preserved in this state. In the upper part of the colony the polyps are nearly all directed upwards, while in the lower part they are nearly all directed downwards.

Now it is highly improbable that this state of affairs could have existed while the colony was living in the sea; so that it is not pushing a speculation too far to conclude that the position in which the colony was immersed in alcohol, for killing and preservation, has determined to some extent the direction in which the polyps have retracted. In fact, the probability is that the polyps naturally grow horizontally, but have a power of rotation through 180° both horizontally and vertically, or, in other words, the oral aperture can take up any position on the surface of a hemisphere whose radius is the length of the verruca. The mode in which these colonies obtain their food, and the different positions which they must assume when swayed by currents, are strongly in favour of such an argument.

(*c*) *Retraction*.—That the polyps are capable of great retraction is a fact which is of the utmost importance in specific determination. The manner in which this is accomplished is very simple. The tentacles are first infolded, the eight lobes of the verruca close over them, and then the whole is withdrawn into the coenenchyma. The longitudinal section (fig. 53) of *Scirpearia flagellum* shows the attachment of the strong retractor muscles which accomplish this; and fig. 10 of *Juncella juncea* shows the polyps completely embedded in the coenenchyma.

It would be difficult to imagine that such extreme differences as that given in figs. 49 and 51 of *S. flagellum* could occur in one species, were it not for the fact that as great differences actually occur in one individual colony, e.g. figs. 77, 78, 79, and 80 of *Scirpearia furcata*.

This has been discussed in detail under the different species, so that it is necessary here to refer only to the actual existence of such a phenomenon.

(*d*) *Distribution*.—The distribution of the polyps has been used as a basis for generic diagnosis, so that it is essential to study this character in detail and see to what extent the various distinctions can be said to obtain. Wright and Studer (L), p. lxv, in defining their new genus Scirpearella, make the following statement:—"The polyps are arranged in rows or spirals, retractile with more or less prominent verrucae," thus separating it from Scirpearia, which they describe as having "the polyps seated in two longitudinal rows on each side of the stem."

Hickson, in discussing these, says:—"The genera Scirpearia and Scirpearella however, appear to me to be still good genera. The arrangement of prominent verrucae in *two* rows in the former genus and in a *spiral manner* in the latter, combined with other characters, renders them relatively easy of identification."

Let us for the present disregard the question of spicules, and consider the group as a whole with regard to this character.

It must be borne in mind that since the publication of the work of these authors the species *J.* [illegible] Thomson and Henderson has been established; and the present memoir contains another new species, namely, *S.* [illegible]. The result of this is that unless the distinction drawn between these two genera is modified, these two species would necessitate the establishing of two new genera to include them.

The first problem before us then is:—*What is the factor underlying the* [illegible]? The answer to this question—namely, *the number of main longitudinal canals*—has already been discussed.

The only exception to this rule is what may be termed "the low verruca-type of *Juncella juncea.*" The position of these specimens is discussed later on, so that it is unnecessary to enter into it here.

A short discussion on the distribution of the verrucae in a number of specimens which have come under our observation may prove useful in arriving at some general conclusion. It is unnecessary to take these in any definite order; but a division into three groups may serve to emphasize some of the more salient characteristics.

1. *Scirpearia profunda.*—The polyps are disposed in two longitudinal series; this arrangement may be obscured in the older parts, and then the disposition may simulate a spiral. Near the base four rows may occur in each series; but this number diminishes in the younger parts, so that near the tip there is only a single row alternating on opposite sides.

Scirpearia pectinata.—In no case do the polyps occur on the main stem. On the primary branches they are restricted to the outer aspect, i.e., the side diametrically opposite the one from which the secondary branches arise. On the secondary branches they are disposed on the two inner surfaces. In the upper half of the secondary branches the polyps may encroach on the bare spaces and appear as if distributed all over the coenenchyma.

Scirpearia anomala.—The polyps are confined to two longitudinal lateral tracts separated by two bare spaces. Near the base of the colony and also in the younger parts near the tip there is a single row of polyps in each series; but in the intermediate portion there are two irregular rows owing to crowding and the interposition of young polyps.

Scirpearia verrucosa.—The distribution of the polyps is as follows:—The lower part bears no polyps; this is followed by two bare tracts which diminish in size to two distinct lines from which the polyps diverge at acute angles.

Scirpearia flagellum.—The lower part of the stem is devoid of polyps; this is surmounted by two opposite longitudinal bare tracts which persist to the tip of the colony. On the other two sides the polyps are disposed in a single row in each series. This gives the colony a markedly bilateral appearance. The verrucae stand sometimes in opposite pairs, but the more common arrangement is alternate.

Scirpearia thomsoni.—The polyps are disposed in two longitudinal series on opposite faces, each of which consists of from two to four irregularly alternating rows.

Scirpearia furcata.—The polyps are arranged in two longitudinal series separated by two narrow bare strips which become more indistinct, but still visible towards the tip. In each series the polyps appear in rows diverging from the bare tracts. Transversely, four or five is a common number in each series.

2. *Juncella trilineata.*—The polyps are arranged in transverse rows of three to four, but many smaller polyps occur which break this regularity. For a short distance from the ends of the branches the polyps occur in three single rows; but passing downwards two, three, four, or more are to be seen, and, scattered amongst these, are immature forms, so that all that may be said with regard to the disposition of the verrucae is that they occur in three longitudinal groups. The exact number in a transverse row depends on the position in the colony and on the stage of development. The three longitudinal series are separated by three distinct bare tracts.

3. *Scirpearia quadrilineata.*—The polyps are grouped in four definite longitudinal series separated by four bare spaces which correspond in position to the four main canals. Each series consists of a single row; but near the middle of the colony they are somewhat crowded, and give an appearance of two rows, due, in great part, to displacement and the interpolation of young polyps.

From these descriptions the following conclusions will be at once evident:—

(1) The polyps are always arranged in a certain number of longitudinal series which are definite for the species.

(2) This number is dependent on and is the same as the number of longitudinal main canals.

(3) The number of transverse rows in each series may vary according to the position in the colony, so that no definite number can be regarded as specific.

(4) The number of rows generally increases in the older parts.

(5) This is due to the interpolation of young polyps.

(6) Near the base of a colony the different series may so approximate, owing to overcrowding, as to almost obliterate the bare tracts.

(7) This may result in a spiral appearance which is not inherent, but secondarily produced.

(8) A similar false spiral appearance may be produced by a torsion of the whole colony.

We have now reached a point when it is necessary to ascertain to what extent the distribution of the verrucae may be regarded as of taxonomic importance.

The question of a spiral arrangement is certainly inadmissible, as is also the number of transverse rows in any series; so that to us it seems that the only character which may with certainty be used as a basis of classification is *the number of longitudinal series* as defined by the number of large main canals.

(4) AXIS.

The axis consists of a horny substance whose chemical composition has never been thoroughly investigated, and which is insoluble in the more common organic solvents.

This is impregnated with carbonate of lime.

The axis is deposited in the form of thin concentric laminae, so that a cross-section (fig. 3) shows annular markings. These are more densely calcareous towards the centre and appear whiter, so that the axis has often been described as having a calcareous core. This is not actually the case, however, as the horny material exists even in the very innermost layers. In the younger parts of the colony there is very little lime deposited, so that it is softer and more flexible.

It is noteworthy, however, that even in colonies attaining a height of 6 feet or more the axis is flexible almost to the very base. Near the base, however, it is very hard, and is cut with a knife only with difficulty. The actual hardness varies in different specimens of the same length.

There are small ridges and furrows on the surface (fig. 3) which give the cross-section a serrated outline. These, as has been already explained, correspond to the canals of the inner longitudinal series and diminish in number from the base upwards (fig. 11, *a*, *b*, and *c*).

The colour varies in the different colonies; but, as a rule, it is olive-green towards the base, passing to pale yellow near the tip. In some specimens, however, it is almost white throughout, due in great part to a larger deposition of lime, and consequently, in these, the axis is less flexible and more brittle.

The increase in the thickness of the older part of a colony is due, not to an increase in the thickness of the coenenchyma, but almost entirely to an increase in the thickness of the axis (see figs. 10, 13, 19, and 43).

(5) SPICULES.

The spicules of this group are characterized by their extreme smallness; in fact, in no other group of Alcyonaria do we find the predominant spicule so minute. Measurements of these with any precision are only possible with a high magnification.

The largest measurements for the group, viz., those in *Nicella dichotoma*, are only 0·25 mm. × 0·06 mm.; but in the genus Juncella the largest are those in *Juncella trilineata*, which are over 0·076 mm. × 0·038 mm.; while in

Scirpearia the largest are those of *S. anomala*, viz., 0·15 mm. × 0·034 mm.; while in *S. pectinata* the largest are only 0·061 mm. × 023 mm.

It is not necessary here to enter into the details of all the different kinds of spicules and their variations which occur throughout the group, as this is more fully dealt with under the various species, and the figures given there will, moreover, give a much better idea of these than a lengthy description. At the same time it might be well to define in a general way the various *types* which have been described.

(*a*) *Clubs.*—Fig. 4 (*a–g*) gives some idea of the variations of this type. The general shape approaches that of the well-known Indian-club; and the most important characteristic is the fact that the warts or spines on the club-portion are all directed away from the shaft, the central part of which is smooth. The spines do *not* arise perpendicularly (see also figs. 14, 23, and 26).

(*b*) *Double-clubs.*—Fig. 5 (*a–b*) shows two variations of this type. They have the shape of what are usually known as dumb-bells. There is a distinct median constriction which may be more or less well defined, and may vary in length as well as in breadth (see figs. 27, 65, 75, and 113). The warts may be large or small, smooth, papillose, or very warty, but all arise perpendicularly from the *head* (figs. 87 and 113), or they may be situated either close together or wide apart; and, according to which method occurs, the head will be regular or irregular in outline (contrast figs. 63 and 65). The head itself may be hemispherical or slightly conical (contrast figs. 54 and 65). Fig. 6 (*a–d*) shows characteristic variations of this type as seen in Juncella.

(*c*) *Double-wheels* or *capstans.*—Fig. 7 (*a* and *b*). This type consists of a cylindrical shaft on which there are two whorls or warts. The ends of this shaft (the hubs) may be either almost smooth or markedly warty.

(*d*) *Elongated double-clubs.*—This type may be derived from the typical double-clubs, and merges gradually to another form which is sometimes described as *double spindles*, and this again may pass into the *simple spindle*. Fig. 8 *a*, *b*, and *c* show how these merge imperceptibly into one another. In the cases we have described, however, these spicules are all of about the same size, so that the distinction is made chiefly on the basis of the amount of constriction visible and the proportionate length of the "head" to the constriction (see figs. 63 and 65).

(*e*) *Simple spindles.*—In certain species, e.g. *Nicella dichotoma* (see fig. 114), there is a type of spicule which may be described as a simple spindle, and which in size contrasts so strongly with the double-clubs that there are no intermediate stages connecting the double-club with the spindle. (See also fig. 118 of *Nicella moniliforme*.)

The different variations which occur in these types will be considered in detail in describing the different species; but certain generalizations must be briefly referred to here.

It is very important when describing spicules from any colony to state precisely from what part of the colony the preparation has been made. New species have been established on slight differences in the size and shape of spicules, and also on the preponderance of one type of spicule over another.

With a view to testing the degree of certainty with which this procedure might be justified, we have made different preparations under different conditions from the same colony; and we now give the results derived from over 500 preparations.

(1) The different types of spicules retain their own distinct characteristics, no matter from what *level* of the colony they may be taken.

(2) Spicules from different levels of the same colony or from colonies of different ages show marked deviations in absolute size, but *not in proportionate size.*

(3) Spicules in the coenenchyma alone differ from those in the verrucae alone, e.g. in *Scirpearia furcata*, the double-club type, with hemispherical ends, is confined to the coenenchyma, whereas the elongated double-club is restricted to the verrucae. This obtains in all specimens examined.

It therefore follows that when examining spicules for specific determination the factor of primary importance is the *character* of the spicules. Next comes the average size of these spicules; while of no importance whatever is the proportionate numbers of each type, as this depends on the proportion of coenenchyma and verrucae taken for the preparation.

If, then, a single preparation be made from a certain part of a colony, and no criterion be given as to the exact age of this portion, subsequent workers will experience great difficulty in making preparations from a similar part. To obviate this difficulty another method may be employed, namely, to take coenenchyma and verrucae from different levels for the single preparation, and so obtain a *representative sample* of the spicules of the specimen. This method has been found to be of great service in identification, and is the one employed in the preparation of this memoir.

Now it has been seen that the disposition of the verrucae is not a constant even in a single specimen, and that its inclusion as a generic character is untenable. If therefore the separation of the specimens of this Juncellid-group of the Gorgonellidae into genera is to be accomplished, it must be based on the character of the spiculation.

If a preparation of spicules be made in the manner described, there should be no difficulty in at once deciding whether or not the type described and figured, as a "club," is present or not. (See figs. 4, 14, 23, and 26.) On the other hand, figs. 114, 115, 116, and 118 give a good idea of the "long-spindle type" and its proportion to the small double-club. Any of the figures given of the various species of Scirpearia—e.g. figs. 27, 31, or 65—will at once mark these off as quite distinct from the other two types.

VI.—Possible Affinities of the Gorgonellidae.

In the "Challenger" Report on the Alcyonaria (vol. xxxi.), Wright and Studer divide the Gorgonacea into two large sections:—

I. Scleraxonia, and
II. Holaxonia.

In the Scleraxonia they recognize the Sclerogorgidae as a distinct family, with the following characters:—"In the representatives of this family a distinct axis is formed of a tissue consisting of numerous closely intercalated elongated spicules, with dense horny shields. The axis is surrounded by longitudinal canals, into which there open the reticulated coenenchymatous canals uniting the polyps."

In the Holaxonia there occurs the family Gorgonellidae, in which "the axis is lamellar and calcareous, but retains its shape after the extraction of the calcareous matter."

The nature of the "calcareous matter" is, however, not specified, so that it is very difficult to interpret exactly what may have been the opinion of these authors.

In "A Treatise on Zoology," part II., Bourne divided the Alcyonaria into five large orders as follows:—

(1) Stolonifera.
(2) Alcyonacea.
(3) Pseudaxonia.
(4) Axifera.
(5) Stelechotokea.

The Stolonifera, Alcyonacea, and Stelechotokea are sufficiently distinct, and most certainly have no connexion with the Gorgonellidae, so that any further reference to them would be superfluous.

The Pseudaxonia have been described as "Synalcyonacea forming upright, branched colonies. The zooid cavities short; the zooids embedded in a coenenchyma containing ramifying solenia and numerous spicules. The coenenchyma differentiated into a cortical and medullary portion, the latter containing spicules different from those of the cortex, densely crowded together, and *sometimes cemented together to form a supporting axis.*"

One of the families of this order—namely, the Sclerogorgidae—is thus defined:—"The medullary mass forms a distinct axis, consisting of closely packed, elongate spicules, with dense horny sheaths. The axis does not contain solenia, but is surrounded by longitudinal canals—i.e., by large solenia—which are connected with the zooid cavities by ramifying solenia." Of the genus Suberogorgia, Gray, in his original description (Proc. Zool. Soc., 1857, p. 159), says:—"Axis pale-brown, formed of rather loosely concentric fibrous laminae, containing a large quantity of calcareous matter."

From the Pseudaxonia the Axifera are thus differentiated:—"Synalcyonacea forming colonies consisting of a coenenchymatous rind, investing a horny or calcified axis. The axis may be horny or composed of a calcified horny substance. . . . It never contains solenia, and is never formed of fused spicules. The coenenchyma completely invests the axis, and contains solenia, and calcareous spicules embedded in the mesogloea."

Bourne does not include the Gorgonellidae in his scheme of classification; and as the nature of the calcareous constituent in this family has never been investigated, or even commented upon, it is impossible to say whether they are Pseudaxonia or Axifera.

The time at our disposal has not permitted of a detailed investigation of this very important problem; but as a contribution to this study the following observations may be useful:—

Suberogorgia.—An examination of the axis of a specimen of this genus reveals the following features:—

(1) It consists of a horny matrix, in which large irregular spicules are embedded longitudinally. These spicules are easily seen with a strong lens, and appear to be deposited concentrically.

(2) The axis after decalcification retains its original shape.

(3) Prolonged boiling in caustic potash causes a slight disintegration; and the individual spicules may thus be separated.

(4) The spicules of the axis are quite different from those of the coenenchyma.

(5) A thin horny layer may be detached from the axis, in which the spicules may be seen embedded.

Juncella elongata var. *capensis.*—Hickson (XIII.) described an Alcyonarian from Cape Colony under this name, but at that time the spicules of this species were unknown. Subsequent study, and a consequent resuscitation of that old but imperfectly known species, have necessitated the removal of the Cape specimen from this genus.

In many respects this colony is unique; and the writer has described it separately as *Dendrogorgia* (n. g.) *capensis,* Proc. Roy. Phys. Soc., Edin., vol. xviii. (1910), p. 62. The following notes on the axis are of great importance in this connexion:—

(1) The axis consists of concentric laminae.

(2) These laminae are composed of a horny matrix, in which long irregular spicules are embedded horizontally.

(3) The horny substance preponderates in amount over the calcareous matter, so that even with a lens the spicules are not very evident.

(4) The spicules differ greatly in size and shape from those of the coenenchyma.

(5) Prolonged boiling in strong caustic potash results in a partial separation of these spicules.

(6) *When the coenenchyma is detached from the axis, a thin, white, transparent film is generally found adherent to it. If this be peeled off and placed under a microscope with a one-sixth objective, spicules identical with those of the axis are seen embedded in it.*

From these facts it is at once evident that the axis in the case of this specimen is distinctly sclerogorgic. It consists of spicules different from those in the coenenchyma embedded in a horny matrix, the individual components of which are laminae deposited concentrically; and, further, it is possible to separate the outer layer, which is usually detached with the coenenchyma.

Juncella juncea may be taken as a type of gorgonellid axis, and the following are the chief points observed:—

(1) The axis consists of a horny substance impregnated with lime.

(2) The horny material greatly preponderates over the calcareous.

(3) The axis is very hard, and is cut with difficulty.

(4) It is impossible to see individual spicules either in a cross-section or a longitudinal section; but

(*a*) The axis is deposited in the form of concentric laminae.

(*b*) A thin layer is usually found adherent to the detached coenenchyma,

(*c*) This layer may be separated from the coenenchyma.

(5) It contains small spicules not very unlike those of the coenenchyma, but different from them.

With regard to the coenenchyma in these three groups, the following notes are interesting:—

(1) In all of them there is a circle of large canals separating the coenenchyma from the axis.

(2) Near the periphery of the coenenchyma there is also a circle of longitudinal canals which communicate directly with the polyps.

(3) These two series are united by numerous interlacing transverse solenia.

The polyps are very similar in all three groups. There is no definite distinction into verruca and anthocodia. There is a pseudo-operculum formed of small spicules on the aboral surface of the tentacles in all three groups. The polyps are in all cases capable of complete retraction into the coenenchyma.

A further point of similarity may be pointed out in the case of Suberogorgia and Juncellids, namely, the possession of a definite number of longitudinal canals in the inner series larger than the others, which determine the distribution of the polyps.

It would be premature to draw any hard and fast conclusions from these few observations; but it may be considered a question whether the three groups taken in the following order, (1) Suberogorgia, (2) *Dendrogorgia capensis*, and (3) the Juncellids proper, may not represent a line of evolution. In the first of these the spicules of the axis are large, and there is only a small amount of horny matrix; in the second the spicules are smaller, and there is a larger proportion of horny material; while in the last the spicules (if such is the nature of the calcareous matter) are extremely small, and the proportion of horny substance to the calcareous is enormously increased.

For the present, and until the exact nature of the limy deposition in the axis of the Gorgonellidae is investigated, it is therefore inadvisable to rank them with the Axifera, and it is more than probable that their affinities are closer to the Pseudaxonia.

VII.—Division of the Gorgonellidae into Genera.

Before proceeding to formulate a scheme of classification which may approximate to a natural classification, and which will be based on the foregoing considerations, it may be well here to recapitulate the most recent diagnosis of the genera under consideration, and see to what extent each of these may be considered valid.

Juncella.—The colony is simple or branched, the polyps are sometimes small, disposed in two lateral rows, sometimes with well developed and elongated verrucae. The coenenchyma is thick, with an external layer which contains simple and double clubs.

Scirpearia.—The colony is simple, with a cylindrical calcified axis and thin coenenchyma. The polyps are seated in two longitudinal rows on each side of the stem. The spicules are double-clubs and spindles.

Scirpearella.—The colony is simple or very feebly branched. The axis is calcareous, brittle, smooth or grooved. The polyps are arranged in rows or spirals, retractile, with more or less prominent verrucae. The coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs.

Ellisella.—The colony is simple or dichotomously branched, with a thick coenenchyma, and slightly developed verrucae, which are disposed in two rows on the axis. The coenenchyma contains both double-clubs and spindles.

Ctenocella.—The colony is branched in one plane, and so that all the simple twigs arise in an ascending order from the upper surface of the stem. The verrucae are short on two sides of the twigs. There are distinct median furrows. The spicules are mostly double-clubs; those of the polyp-calyces are, according to Ridley, somewhat different from those of the coenenchyma, being longer and provided with two, often three whorls of tubercles. The inner whorls so approach in the middle of the spicules, that the median naked zone, which is characteristic of the spicules of the coenenchyma, is here absent.

Nicella.—The colony is upright, branched, with a thin coenenchyma, and protruding verrucae, which arise perpendicularly, and appear to be terminally truncated. The polyps arise from either side of the stem and branches, leaving a middle space free. The spicules form a cortical layer of small double-clubs, and an internal layer of long densely warty spindles.

An examination of these diagnoses reveals the fact that we have here to deal with three distinct groups. The first of these is represented by the various species of the genus Juncella, and is characterized by the fact that its spicules include simple clubs. The second is restricted to the genus Nicella, and is distinctly separated by the character of its spicules, which include small double-clubs and long, densely warted spindles.

The third comprises Ellisella, Scirpearia, Scirpearella, and Ctenocella, which agree in having neither clubs nor long spindles, but whose spicules all include double-clubs. These distinctions may be tabulated thus:—

A. Spicules include clubs (Juncella).

B. Spicules do *not* contain clubs—

(1) Spicules include extremely elongated spindles (Nicella).

(2) Spicules do not contain elongated spindles (Ctenocella, Ellisella, Scirpearia, Scirpearella).

In view of our previous discussion on the various characters which may be considered of taxonomic importance, we may now take each of these genera in rotation.

(1) *Ctenocella.*—Only one species of this genus has so far been described, so that the generic diagnosis given above is a recapitulation of its specific characters. In spiculation it is essentially of the Scirpearia-type; and the particular kind of spicules described above is quite characteristic of the group. It corresponds to the elongated double-club, which may approximate to the double-spindle, and eventually to the simple spindle which has been already described. It has been my privilege to examine a large number of colonies of this species (*pectinata*), and the only character in which it differs essentially from other genera is its peculiar mode of branching. The secondary and tertiary branches (see figs. 36–41), however, are long, simple, and flagelliform; and if one of these detached branches be taken for identification, it will at once be referred to the genus Scirpearia. The disposition of the verrucae and the *types* of spicules correspond in every detail with the diagnosis of Scirpearia. Is it justifiable, then, to continue recognizing a genus on the basis of its branching alone, when a part of the same colony may be indisputably referred to another genus? We prefer to answer this question in the negative, and consequently abolish the genus Ctenocella, and rank the only known species under the name *Scirpearia pectinata.*

(2) *Ellisella.*—It will be remembered that Kölliker in 1864 first drew attention to the spicules of this family, and, with the small amount of material at his disposal, separated the genus Juncella into two groups.

(1) Those with clubs (*J. juncea* and *J. gemmacea*), and (2) those without clubs (*J. elongata*).

Studer (1878) in revising the family limited the generic diagnosis thus:—

(1) Spicules: clubs, and double-clubs (Juncella).

(2) Spicules: double-clubs, and spindles—

A. Calyces not prominent (Ellisella).

B. Calyces markedly projecting (Scirpearia).

In discussing the question of the nature of the verrucae we pointed out that this character could not be relied upon for even specific determination, so that Studer's groups A and B, or, in other words, the genera Ellisella and Scirpearia, cannot on this basis be regarded as distinct.

In the descriptions of the various species of Ellisella which have since been established no further character of generic importance has been added, and an examination of the generic diagnosis of Ellisella and Scirpearia, given by Wright and Studer, shows them to be identical. We have examined the type specimens of Ellisella, and compared them with authentic species of Scirpearia, and could find no reason for separating them.

Hickson (xv, pp. 818–819), in his valuable contribution to the study of this group, has suggested the abolition of the genus Ellisella and has united the species included under that name to those of the genus Juncella. He, however, divides the species so included into two groups—(1) those with clubs and (2) those without clubs, the former of which, as will be evident, corresponds to Juncella; and the latter, with the exception of *J. spiralis*, which will be discussed later, to Ellisella as defined by their spiculation.

The result of this is that the genus Juncella, which was distinguished by the presence of the clubs amongst its spicules, now includes forms whose spiculation is identical with that of Scirpearia and Scirpearella.

The question now resolves itself into, "How are we to distinguish between (1) those species of Juncella whose spicules contain no clubs, (2) Scirpearia, and (3) Scirpearella?" In other words, we have still to find generic characters and separate Ellisella, Scirpearia, and Scirpearella.

As the result of an examination of *all* the type species of Ellisella, Scirpearella, and Scirpearia (with the exception of *S. flagellum*, of which, however, we have seen numerous authentic specimens in the Monaco collection), we are fully convinced that nothing in the spiculation of these types is of sufficient importance to be used as a generic character, so that it is incumbent upon us to examine in detail the other features which have been used as diagnostic.

Branching.—Scirpearia is described as simple, Scirpearella as simple or very feebly branched, and Ellisella as simple or dichotomously branched. Now the question of branching, as has been already shown, is of no importance in diagnosis. Specimens otherwise identical are described in this memoir, in which one may be of great length and simple, another elongated and bifurcating, while a third may be of no exceptional height and yet very markedly branched. A very good example of this may be seen in *Scirpearia furcata*. Contrast (1) the specimens from Mergui—(2) that orginally described by Thomson and Henderson as Scirpearia, sp., and (3) the specimen from Providence Island, all of which are included in this report. The very fact, however, that a species of Scirpearia has been described in which branching occurs shows the futility of relying upon this feature.

Nature of the Verrucae.—The question of prominent or non-prominent verrucae has already been discussed, and, as it has implicitly been abandoned by most authors, need not occupy our time here; but it is essential to point out that the omission of this as a generic character almost finally necessitates the abolition of the genus Ellisella.

We would, therefore, in view of these considerations, put forward the following emended classification, and proceed to define the various genera in terms of such characters as seem to warrant attention.

Family **GORGONELLIDAE**..

JUNCELLID GROUP.

Division 1. Spicules include *clubs* (Juncella).

Division 2. Spicules do not include *clubs*—

A. Spicules include *long* warty spindles and *small* double-clubs (Nicella).

B. Spicules include double-clubs and elongated double-clubs (Scirpearia).

VIII.—EMENDED DIAGNOSES OF THE FAMILY AND GENERA.

Family **GORGONELLIDAE**.

Specimens belonging to this family may be either simple or branched. When simple, they frequently attain a length of three feet, though colonies of five or six feet long are not uncommon. When branched, the branching may be (1) very sparse, (2) more frequent and dendriform, or (3) flabellate. The branches are usually long and flagelliform. The coenenchyma is usually thin, arenaceous on the surface, and very granular throughout; it is densely packed with small spicules, and is separated into an outer non-canal-bearing part and an inner canal-bearing part.

The canal system consists of two longitudinal series, situated circumferentially; the inner series separates the coenenchyma from the axis, and the outer separates the two parts of the coenenchyma mentioned above. Between these two series, solenia ramify in all directions and unite them. The canals of the outer series are all equal in size; but in the inner series there is a certain number, definite for the specimens, larger than the others. These are known as the main longitudinal canals. The most frequent number is *two*, but *three* and *four* also occur.

The polyps are disposed in a certain number of longitudinal series, which are defined by and correspond to the number of main longitudinal canals; these are separated by longitudinal bare tracts, which occupy the region of the main canals. The verrucae vary greatly in shape, not only in different specimens, but in different parts of the same colony. They may project considerably or may be depressed below the surface of the coenenchyma. In each series there may be one or more longitudinal rows; but the number is not constant at the various levels in any one colony. The anthocodiae are very simple; the tentacles are short and conical, and bear a single row of short, simple pinnules on each side. There are scale-like spicules on the aboral surface of the tentacles.

The axis is composed of a horny substance impregnated with carbonate of lime. It consists of concentric laminae, which are deposited on the periphery; and it retains its shape on decalcification.

The spicules are extremely minute, and contain the following types:—(1) Indian club-shaped forms known as *clubs*; (2) dumb-bell forms known as *double-clubs*; and (3) spindle-shaped forms or *spindles*. Intermediate forms such as elongated double-clubs and double-spindles may also occur.

Genus **Juncella** emend.

Colony simple or branched; the coenenchyma is usually thick; the polyps are distributed (1) irregularly over the whole coenenchyma or (2) in definite longitudinal series, defined by the position of a number of main canals, constant for the species. The verrucae (1) may be sunk within pit-like depressions, (2) may be low and dome-like, or (3) may be sub-conical and adpressed to the stem; all these conditions may appear in one colony. The axis is formed of concentric layers of a horny substance impregnated with lime; there is usually a more densely calcareous core.

The coenenchyma consists of two layers—(1) an outer, containing no canals, in which the polyps are retracted; and (2) an inner, which is bounded both externally and internally by a circle of small canals, and which is penetrated by a network of small solenia uniting these two series.

The outer series of canals communicates directly with the polyps. A certain number, two or three, of the canals of the inner series, symmetrically arranged, are larger than the others, and are known as the main canals. Their position defines in most cases the distribution of the polyps. The spicules are extremely small; they contain *clubs*, but otherwise are typical of the family.

Genus **Scirpearia** emend.

The colony may be (1) simple and flagelliform, (2) slightly branched, (3) much branched and dendriform, or (4) branched in one plane. The branches themselves are usually long and flagelliform. The coenenchyma varies greatly in thickness in the different species. The canal system is typical of the group; so far only species with two or four large main longitudinal canals are known. The verrucae are disposed in a number of longitudinal series, the number of which is the same as the number of main canals. As in Juncella the number of transverse rows in each series varies in the different parts of the colony. The verrucae themselves vary in shape and size according to the stage of retraction and also according to their position in the colony. They may be elongated and conical, wart-like, or even depressed below the surface of the coenenchyma. The axis is composed of concentric laminae impregnated with lime; the surface is marked by longitudinal ridges and furrows; but the number of these diminishes towards the tip of the colony. The spicules contain "double-clubs," but neither "clubs" nor *extremely long* "double-spindles" or "spindles."

Genus **Nicella** emend.

The colony may be simple, slightly branched, dichotomously branched or variously branched, with frequent anastomoses in one plane. The coenenchyma is thin and finely granular; the surface presents an arenaceous appearance. The polyps are disposed in longitudinal series which alternate with, and correspond in number with, the main longitudinal canals. In the species so far known there are two main longitudinal canals. The number of rows in any series varies according to the position in the colony; and in the older parts the polyps may encroach on the bare tracts so as to almost obliterate them. The verrucae vary in shape and size according to the stage of retraction; when expanded they stand usually at right angles to the stem and are terminally truncated; when fully retracted they are low and conical or dome-like; intermediate stages always occur. The axis is composed of concentric laminae, and is densely calcareous; it is typically Gorgonellid in character. The spicules consist of small double-clubs and slightly elongated double-clubs, but characteristic are *elongated double-spindles and spindles.* These latter types are quite distinct, and there are no intermediate forms linking the two sets—i.e. double-clubs and spindles—together. They are also usually large in most species.

IX.—Genus **Juncella** emend.

A historical review of this genus has already been given, and also an emended diagnosis. In the restricted emended sense—i.e. those Gorgonellids whose spicules include "clubs"—the following species must be taken into consideration:—

1. *Juncella juncea* Pallas.
2. *Juncella fragilis* Ridley.
3. *Juncella flexilis* Studer.
4. *Juncella barbadensis*[1] Wright and Studer.

[1] It is extremely doubtful whether the specimen identified by Wright and Studer as *J. barbadensis* is the same as the original specimen of that name, so that it has been considered advisable to keep them separate. The "Challenger" *J. barbadensis* is a *Juncella*; the original may not be.

5. *Juncella gemmacea* Valenciennes.
6. *Juncella racemosa* Wright and Studer.
7. *Juncella miniacea* Thomson and Henderson.
8. *Juncella trilineata* Thomson and Henderson.

But in addition to these the following species have been also referred to this genus :—

9. *Juncella santae-crucis* Duch. and Mich.
10. *Juncella funiculina* Duch. and Mich.
11. *Juncella barbadensis*[1] Duch. and Mich.
12. *Juncella vimen* Ellis and Solander.
13. *Juncella calyculata* Ellis and Solander.
14. *Juncella hystrix* Valenciennes.
15. *Juncella surculus* Johnson.
16. *Juncella laevis* Verrill.
17. *Juncella extans* Verrill.

Species 9–17 are, however, so imperfectly known that it is absolutely impossible to include them in any scheme of classification. In several cases they are names without descriptions : and in the others, the descriptions are extremely vague, and are based on characters which are now known to be of no specific value. In no case have the spicules been investigated, so that it is even impossible to say whether they actually belong to this genus or not; in fact, it is more than probable that they are not all referable to *Juncella.*

I have carefully searched through several old collections for authentic specimens of any of these ; but the result has been negative, so that in the absence of type-specimens, but for the sake of completeness, it has been decided to place them in a group—" incertae sedis "—by themselves, and give such references and descriptions as are available.

An attempt, however, has been made to trace the affinities of species 1–8 Each of these is discussed in detail under its place in the emended classification suggested later, so that it is necessary here only to consider the characters on which the classification is founded.

The first and most important of these is "*the number of main longitudinal canals*," and this at once separates off *Juncella trilineata* from the others.

An examination of the spicules marks *Juncella racemosa* as distinct (see figs. 14 and 23). In addition to this, however, the general nature of the colony and the mode of branching are distinctive for this species, which under the present system includes *Juncella miniacea*. There, therefore, remain only species 1–5 to be considered. *Juncella flexilis, J. fragilis,* and *J. barba-*

densis have proved to be but young stages of *J. juncea*, and must therefore be included under the older name; so that the number of species is now restricted to two, viz., *Juncella juncea* and *Juncella gemmacea*. There can be no doubt that these two names have been very loosely used in the identification of specimens, and with great justification; for after an examination of the macroscopic and microscopic characters of a very large number of each of these, it must be confessed that it is almost impossible to distinguish between a branch of *Juncella gemmacea* and a portion of a colony of *Juncella juncea* of about the same size.

Large specimens of *J. juncea* and *complete* colonies of *J. gemmacea* are unmistakable on account of the great difference in the nature of the colonies.

In the former the colonies are always simple or sub-simple, while in the latter they are very much branched and markedly dendriform. Solely for this reason has it been considered justifiable to maintain these as distinct species.

The spicules are identical both in type and measurements; but the extreme nature of the branching, which commences almost at the very base of the colony in the case of *J. gemmacea*, and the normally simple character of *J. juncea*, and the great length and size to which colonies of the latter species may attain, seem to justify their recognition as distinct species. It must be noted, however, that it would be extremely inadvisable to attempt to distinguish between one of the long terminal twigs of *J. gemmacea* and the tip of a colony of about the same thickness as *J. juncea*. For this reason it is difficult to decide exactly to what species certain records refer when these have been based on fragments.

In *J. juncea* there are two externally different types, but morphologically these are the same. In one of these the lateral bare tracts which correspond to the two main longitudinal canals are evident throughout, but in the other there is no trace of these.

The importance of this has been discussed under the species; and it has been considered highly inadvisable to separate them, unless as varieties. This step has been taken only to obviate any future misapprehension.

I would therefore suggest the following classification:—

Species of Juncella.

A. Longitudinal main canals *two* in number.

(1) Colony simple, flagelliform—*J. juncea* Valenciennes, emend.

(2) Colony much branched and somewhat bushy; branches flagelliform—*J. gemmacea* Valenciennes, emend.

(3) Colony delicate, branched in one plane; branches tending to arise from one side—*J. racemosa* Wright and Studer.

B. Longitudinal main canals *three* in number.

(4) Colony branched as in *J. gemmacea*—*J. trilineata* Thomson and Henderson.

X.—Juncella juncea.

Junci lapidei Pliny, Hist. Nat., p. 13, c. 25.
Palmijuncus albus, Rumph, Amb. vi, p. 126.
Keratophyton simplex Seba, Thes. 111, t. 105, fig. 1a.
Gorgonia juncea Pallas, xxviii, p. 180.
,, ,, Pallas, xxvii, p. 226.
,, ,, Esper, vii, ii, p. 26, Pl. LII.
,, ,, Lamarck, xxiv, ii, p. 15, n. 34.
,, ,, Lamouroux, xxv, p. 419.
,, ,, Dana, iii, p. 664.
Heliella ,, Gray, xi, p. 481.
Juncella ,, Val., xvi, p. 14.
,, ,, Val., xlv, p. 182.
,, ,, Milne-Edwards and Haime, xxvi, p. 186.
,, ,, Verrill, xlvii, p. 37.
,, ,, Gray, xii, p. 204.
,, ,, Kolliker, xxiii, p. 140, t. 18, f. 45, 46.
,, ,, Thomson and Henderson, xxxix, p. 314.
,, *[illegible]* Thomson and Henderson, xxxix, p. 313, Pl. IV, figs. 4 and 5.
,, *juncea* Ridley, xxxiii, p. 345.
,, ,, Gray, xii, p. 25.
,, ,, Hickson, xv, p. 820.
,, ,, Studer, xxxiv, p. 659.
,, ,, Studer, xxxvii, p. 116.
,, ,, Wright and Studer, l, p. 158, Pl. XXXIV, fig. 12; Pl. XLI, fig. 35.
,, ,, Kent Saville, xxi, p. 92.
,, *[illegible]* Studer.
,, ,, Germanos, viii.
,, ,, Hickson, xv, p. 821.
,, *fragilis* Ridley, xxxiii, p. 347, Pl. XXXI, fig. D.
,, ,, var., xxxiii.
,, ,, Thomson and Henderson, xxxix, p. 314.

Juncella fragilis var. rubra Thomson and Henderson, xxxix, p. 314.
„ *barbadensis* Duch. and Mich., v, p. 22, Pl. v, fig. 5.
„ „ Wright and Studer, l, p. 159, Pl. XXIV, fig. 14.

Juncella juncea.

This is a very old species, as may be seen from the Bibliography. Pallas referred it to the genus Gorgonia; but Valenciennes, in 1841, rightly considered it as a Juncellid, and placed it in the genus Juncella; and in this genus it has remained, and has been so regarded by most authors; but, in 1859, Gray, for no apparent reason, established the genus Helicella to include it. No one has, however, confirmed his opinion, so that it is unnecessary to discuss its position there. The species is a fairly distinctive one; but very little positive content has ever been given to it. Ridley, in his Report on the Alcyonaria collected by H.M.S. "Alert," says:—"Neither Milne-Edwards and Haime nor Valenciennes give details full enough to enable the student to identify their species satisfactorily with that of Pallas and Esper. In the 'Alert' specimens and that figured by Esper the verrucae are closely packed over the cortex. In our specimen, which is about 46 inches (1150 mm.) long by 6 mm. thick at the present broken base and 3·5 mm. thick at the tip, the basal end is almost smooth, the verrucae being either level with the surface or depressed below it; towards the middle of the length they become projecting until they reach a height of about 1·25 mm.; they are then adpressed against the surface of the cortex. A distinct median groove is to be traced along most of the stem."

This was a most important contribution, and was the first description of the variation in the size of the verrucae, which is such a marked feature in this species, and which has led to several mistakes in identification.

Kölliker, in 1865, first introduced the question of spicules into this species, and gives two figures of these (Tab. XVIII, figs. 45 and 46). One of these represents a thick single-club, and the second a double-club. In the many records and short descriptions which occur scattered throughout Alcyonarian literature very little further was added, so that the following short description sums up the chief points upon which the species was identified. The colony is simple and elongated; the cortex is thick; the spicules contain clubs and double-clubs; the verrucae vary in size in the various parts of the colony (Ridley); the axis is hard and calcareous; there are usually two bare streaks in the coenenchyma.

Practically no attention was paid to the extraordinary fertility of variation which occurs with regard to all these characters, not only in different specimens, but also in different parts of the same specimen; nor was there any allowance made for different stages of development. As a result of this, three species—viz., *J. fragilis*, *J. flexilis*, and *J. barbadensis*—were established on what must now be regarded as young colonies of this species. The large number of specimens, which undoubtedly belong to this species which we have been able to examine in detail with respect to the differences on which these three species were based, confirm beyond doubt the opinion of several authors—notably Ridley, Studer, Hickson, and Thomson, that these cannot be regarded as distinct.

I give here a short description of these three species, followed by a systematic study of a large number of specimens which may help to give a true estimate of the variability of certain characters and the constancy of others, and so form a basis for a definite specific diagnosis.

J. fragilis Ridley.

In 1884 Ridley established the species *fragilis* for two specimens from Queensland with the following characteristics:—Stem long, unbranched, diminishing very slowly to the tip, which may be either clavate or sharp-pointed, flexible, and easily broken. The diameter at the base is 5 mm., at the apex 3–4 mm., except when the apex consists of a fine point. The cortex is thick and creamy-white when dry; there is no trace of a lateral line in the upper three-fourths. The verrucae are small, about 1 mm. in height, clavate, closely adpressed against the cortex, crowded over all parts; axis very slender, about 1 mm. in diameter at the base and hair-like at the apex; near the base it is olive-brown, hard, and beset with longitudinal striae. The cortical spindles are the same as in *J. gemmacea*. He points out the following differences between this species and *J. gemmacea*:—

(1) The verrucae are small and crowded.
(2) There are no lateral lines in the upper three-fourths.
(3) The colour is pale creamy-white.
(4) The heads of the double stellate spicules are more abundantly tuberculated.

Later, in 1887, Ridley referred, with doubt, two colonies from Mergui to this species as a variety. One of these was white or cream-coloured, the other was pale brick-red. He notes that these specimens approach *J. juncea*, which, he says, is distinguished from *J. fragilis* by its greater size, its red colour, its larger and more distant polyp-verrucae, the presence of a space bare of verrucae above the base and by the possession of equal-ended double-stars. These specimens, he says, stand midway between *juncea* and *fragilis*.

In 1905 Thomson and Henderson referred several fragments from Ceylon to this species. The axis was marked by longitudinal striae. In some the verrucae were nearly 2 mm. in height, and the diameter of the axis was 1 mm.; in others the verrucae were much smaller, and the diameter of the axis was 2 mm. The spicules showed some variation from those in Ridley's specimens.

Juncella fragilis var. **rubra.**

In the same paper Thomson and Henderson established a new variety, namely, *rubra*, to include a long, flexible, complete colony, which tapered gradually throughout its entire length. There was no trace of a lateral line or groove. The verrucae were numerous and closely adpressed, measuring about 1 mm. in height.

From the above descriptions it is evident that this species has no definite specific character. Ridley himself had doubts as to its distinctiveness; but its "simple" character at once separates it from *J. gemmacea*. The specimens from Mergui are undoubtedly *J. juncea*; but Ridley practically acknowledges this. I have examined the specimens described by Thomson and Henderson, and although these undoubtedly coincide with the description of *J. fragilis*, they also agree with young forms of *J. juncea*. A comparison of these specimens and Ridley's descriptions, with the numerous colonies of various ages which I was fortunate in obtaining at Mergui, proves beyond doubt that this species was based on young stages of *J. juncea*, so that I would suggest the merging of this species into *J. juncea*. At the same time the variations in the different characters, as seen in these specimens, are of great interest, and show how difficult it is to be certain of any species on a single or even a few specimens, especially if they are young. The question of the size of the verrucae and the presence or absence of bare spaces in this species is discussed further on, so that it is necessary here to note only its relative position in classification.

Juncella flexilis Studer.

This species was established by Studer for a small specimen (probably young) with the following characters:—

"The stem is simple, rising from a flat base. The colony is only 20 cms. in height. The axis is thin and flexible, but contains lime The polyps first arise at a level of 2 cms. from the base; they occur at first in two lateral rows, soon increasing in number, and occupying in the upper part the whole surface of the stem. The verrucae are 2 mms. long, are club-shaped, and are curved towards the stem. The coenenchyma is thin, and contains an external layer of clubs, and below this a layer of double-clubs. The colour is dark red.

Germanos (VIII) identified a small specimen from Ternate with this species. It had two branches[1] (the type specimen is simple). He makes the following observations:—

The colour is orange-red. The stem is cylindrical, with a rigid axis consisting of several concentric and horny layers. The branches are much compressed, and have a flexible axis. The spicules of the coenenchyma are clubs and double-wheels. The verrucae are high, club-shaped, and are curved towards the stem; they contain club-shaped spicules; the anthocodiae are white, entirely retractile, and have small spindles.

Hickson (XV) provisionally referred some specimens to this species, but expressed an opinion that they might be young forms of *J. juncea*.

The remarks which we have made with regard to *J. fragilis* apply equally well to this species; and we would confirm Hickson's opinion and merge this species into the older *J. juncea*.

Locality.—Between Flat Island and Mauritius (Studer). Ternate (Germanos). S. Nilandu, Maldives, 25–30 fms. (Hickson).

Juncella barbadensis.

Juncella barbadensis, Wright and Studer, I. p. 159, Pl. XXXIV, fig. 14.

When Duchassaing and Michelotti described this species, they emphasized characters which have since proved to be of no specific importance.

Wright and Studer, however, with considerable hesitation, regarded two small fragments in the "Challenger" collection as young stages of either *[illegible]* or *J. juncea*, but at the same time note that certain identification is impossible, owing to the very brief description given by the authors and the absence of the type specimen to which reference might be made.

In the "Challenger" specimens the coenenchyma is thin, and the spicules resemble closely those of the *J. juncea*. They consist of unsymmetrical clubs, double-stars and spindles which give the same measurements as those of *J. juncea*.

Wright and Studer note that in some respects their specimens resemble *J. flexilis* Studer.

From the foregoing it is quite evident that this is not a distinct species and I have no hesitation in referring it to *J. juncea*.

Locality.—Off Sombrero Island. 450 fathoms.

[1] It is not improbable that this was a young colony of *J. gemmacea*.

Juncella juncea.

In the Mergui Collection there are numerous specimens of this species; and a study of these has enabled me to define this species with some precision. A superficial examination of these reveals two distinct types which, for the present, may be regarded as varieties with the following distinction:—

Var. *a*—with slightly protruding verrucae and with the polyps all over the coenenchyma.

Var. *b*—with markedly protruding verrucae and with two bare longitudinal spaces.

I would emphasize the fact that these are but *superficial* differences, and that no taxonomic importance can be attached to them—consequently I refrain from naming them. I shall first examine them macroscopically with regard to their superficial differences.

Var. *a*.—Fig. 9 (*a*, *b*, and *c*) gives a very good impression of the external appearance of this variety. The polyps are distributed irregularly over the *whole* coenenchyma, so that, at any one level, the arrangement is the same from any aspect. In the younger part of the colony—that is towards the tip—the verrucae are slightly club-shaped, and are adpressed to the axis, and are sunk in very shallow pits. About seven or eight may be seen on one transverse line (fig. 9*c*).

Towards the middle of the colony the number increases to nine or ten, the verrucae project less, appear smaller, and are sunk in deeper pits. They are not so closely packed as in the younger part (fig. 9*b*).

Near the base of the colony the appearance is quite different. The polyps are separated by intervals two, three, or more times the diameter of the verrucae. They are much smaller than in the upper parts, and the verrucae are now almost surrounded or engulfed by the coenenchyma (fig. 9*b*).

Var. *b*.—(See corresponding figures, 12*a*, *b*, and *c*.)

In this variety the polyps are restricted to two definite longitudinal series, separated by two bare spaces, whose position is marked by a more or less distinct groove. Throughout the whole colony the polyps are more protruded than in the previous variety. The colony is more slender and tapering, and the coenenchyma is thinner.

Near the tip of the colony there are usually two or three polyps in each series (fig. 12*c*).

Towards the middle of the colony four or five is a common number in a corresponding position. (Fig. 12*b* gives a view of the pit-like depression in the area devoid of polyps.)

Near the base the number increases to seven or eight (fig. 12*a*). The verrucae throughout are sub-conical and are adpressed to the stem, although in some cases they are slightly dome-like.

The following tables give a few measurements from several colonies of both of these varieties:—

TABLE A.

Specimen.	Height of Colony in Centimetres.	Diameter of Colony in Millimetres.			Diameter of axis at base.	Thickness of Coenenchyma at base.	Thickness of Coenenchyma near tip.
		Base.	Midway.	Near apex.			
1	89	7	7	5	4	1·5	2·5
2	82 +	6	5·5	5	3·5 (·5)	1·25	2·5
3	76	8	7·5	5·5	5	1·5	2·75
4	74	8·5	7·5	5	5	1·75	2·5
5	72	7	7	6·5	3·5	1·75	3·25
6	71	7	7	6·5	3·5	1·75	3·25
7	68	5	4·5	4	2·5	1·25	2
8	65	5·5	5·5	4·5	3·5	1	2·25
9	63	5	5	4·5	3	1	2·25
10	57	6	6	4·5	3	1·5	2·25
11	52 +	7·5	7	5	4·5 (·5)	1·5	2·5
12	46	6	5·5	5·5	3	1·5	2·75

TABLE B.

Specimen.	Height.	Diameter of Colony.			Diameter of axis at base.	Thickness of Coenenchyma at base.	Thickness of Coenenchyma at apex.
		Base.	Midway.	Apex.			
1	156	7·5	6·5	5	5	1·25	2·5
2	115	5	7	6·5	4	0·5	3·25
3	114	5·5	5	4·5	3	1·25	2·25
4	110	5·5	7·5	5	4	0·75	2·5
5	110	8	8	4	4·5	1·75	2
6	105	5·5	7·5	6	3·5	1	3
7	101	6·5	5	4	4	1·25	2
8	100 +	7	8·5	6	4·5 (0·5)	1·25	3
9	100	6	5	4·5	3·5	1·25	2·25
10	91	7	7	5	4	1·5	2·5
11	90	7	7	6·5	4	1·5	3·25
12	86	6	6	5	3	1·5	2·5
13	83 +	8·5	9	6	5·5 (0·5)	1·5	3
14	82	6	6	4	2	2	2
15	76	6·5	7	5	3	1·75	2·5
16	72	5	5	4	2	1·5	2
17	66	7	7	5·5	4	1·5	2·75
18	64	5	5·5	3·5	2·5	1·25	1·75
19	61	5·5	6	4·5	3	1·25	2·25
20	61	4·5	4	3·5	2	1·25	1·75
21	60	4·5	4·5	4	3	0·75	2
22	57	5·5	6	6	3·5	1	3
23	53	4·5	4·5	3·5	1·5	1·5	1·75
24	52	4·5	4·5	4	2	1·25	2
25	49	7·5	6	5	2·5	2·5	2·5
26	45	3·5	6	5·5	3	0·25	2·75
27	41	3·5	3	2·5	1·5	1	1·25

The superficial differences between the two varieties having been noted, we may consider the general morphology of the species, and see to what extent the varieties are worthy of distinction.

Coenenchyma.—Figs. 10 (*a*, *b*, and *c*) and 13 (*a*, *b*, and *c*) are given to show the structure of the coenenchyma at the same levels as the corresponding figs. 9 (*a*, *b*, and *c*) and 12 (*a*, *b*, and *c*) respectively. The coenenchyma may be differentiated into two distinct regions—(1) an outer superficial layer, in which the polyps are embedded, and which contains no canals; and (2) an inner layer, which is intersected by a meshwork of transverse canals.

In var. *a* the superficial layer is much thinner than the inner layer; but in var. *b* the superficial layer is the thicker of the two. At the tip of the colony there is a conical growing point devoid of polyps and having no canals. The thickness of the coenenchyma hardly varies throughout the colony.

Canal Systems.—This consists of (1) a longitudinal system and (2) a transverse system. The longitudinal system is composed of two series of longitudinal canals—(*a*) an outer, situated between the two layers of the coenenchyma, and with which the polyps connect directly; and (*b*) an inner, situated between the inner layer of the coenenchyma and the axis. These two systems are united by the transverse canals which penetrate the inner layer of the coenenchyma.

The number of canals in each of the two longitudinal series diminishes in number from the base of the colony upwards. This, of course, is natural, since the number of polyps also decreases.

In the inner series of longitudinal canals there are two, situated diametrically opposite one another, which are much larger than the others. They occur in both varieties; but in the case of var. *b* they correspond to the position of the longitudinal bare spaces.

The greater thickness of the coenenchyma in var. *a* may explain the absence of this phenomenon in the latter variety.

Axis.—The axis is marked by longitudinal ridges and furrows. The number of these correspond to the number of canals in the inner longitudinal series, and consequently diminishes towards the apex, so that this character is of no taxonomic importance (fig. 11 (*a*, *b*, and *c*)). The structure of the axis is very well seen in this species. It is composed of concentric laminae of horn, impregnated with small limy sclerites. To the inside of the canals of the inner longitudinal series a layer may be detached showing the sclerites *in situ*. The innermost layers are much more densely spiculose than the outer. The diameter of the axis (unlike the coenenchyma) gradually diminishes towards the tip of the colony, where it becomes almost hair-like, and contains very little lime.

Spicules of J. juncea.

The characteristic spicule is the simple-club, which has been described already. A few typical variations are also shown in fig. 14. These are also double-stellate forms and double wheels or capstans. The following are some of the measurements, length by breadth, in millimetres :—

(1) *Clubs.*—0·11 × 0·04; 0·1 × 0·035; 0·09 × 0·034; 0·085 × 0·032; 0·08 × 0·03; 0·08 × 0·02.

(2) *Double Stars.*—0·01 × 0·05; 0·09 × 0·045; 0·08 × 0·04; 0·08 × 0·03.

Distribution of J. juncea.

(1) *Australia.*—Port Denison, Queensland, 4 fathoms (as *J. juncea* and *J. fragilis*); Dirk Hartog, W. Australia, 45 fathoms; Mermaid Straits, N.W. Australia, 50 fathoms; Torres Straits, 7–11 fathoms.

(2) Off Sombrero Island, West Indies (as *J. barbadensis*).

(3) King Island Bay and elsewhere (Mergui).

(4) Ceylon Seas (as *J. juncea*), Gulf of Manaar (as *J. fragilis*).

(5) Bourbon, and between Flat Island and Mauritius (as *J. flexilis*).

(6) Ternate (as *J. flexilis*).

(7) Maldives (as *J. flexilis*).

(8) Off Table Island, Cocos Group, Andamans, 15–35 fathoms.

Specific Diagnosis of J. juncea.

Colony simple or sub-simple, elongate, sometimes filiform, sometimes very thick: the coenenchyma varies greatly in thickness in the different specimens, but is constant in each; this affects the external appearance of the colony. The canal system is of the typical Gorgonellid structure, and there are *two* main longitudinal canals. These may or may not produce an external impression; in colonies with a thin coenenchyma their position is denoted externally by two longitudinal bare tracts; but in those with a very thick coenenchyma, no trace of this is to be seen. The polyps are distributed differently in these two types; in the former they are disposed in two longitudinal series, in which there is a varying number of rows, which diminish from the base upwards; in the latter they are crowded all over the coenenchyma. The verrucae vary greatly in shape in the different parts of the colony; near the base they are low and dome-like, or may even be depressed beneath the surface of the coenenchyma; they gradually increase in size until near the top they are usually sub-conical, directed upwards, and adpressed to the coenenchyma. The axis is hard and flexible; it is composed of concentric laminae, which consist of a horny substance impregnated with some form of calcareous matter. The surface is marked by longitudinal grooves, which correspond in number to the inner series of longitudinal canals, and therefore diminish from the base upwards. Sometimes two larger than the others are to be seen, and these represent the position of the two main canals. The spicules consist of the usual Juncella types, and include clubs, double-wheels, and double-stars. The colour varies from pure white, through orange, to dark red.

XI.—**Juncella gemmacea.** Figs. 15–19.

Gorgonia gemmacea		Valenciennes, MSS. dans la Coll. du Mus. Paris.
Verrucella	„	Milne-Edwards and Haime, xxvi., p. 185, B 2, f. 7.
Juncella	„	Kölliker, xxiii., p. 140, t, 14, f. 4.
„	„	Wright and Studer l., p. 158, Pl. XXXIV, fig. 13.
.	„	var. Ridley, xxxii., p. 241.
.	„	Studer xxxvii., p. 117.
„	„	Thomson and Russell, xliii., p. 162.
Ellisella	„	Gray, xii., p. 26.
Ellisella maculata		(pars) Wright and Studer, l.
Juncella elongata		var. Ridley xxxiii., p. 346.

Valenciennes in 1855 established this species to include a specimen in the Natural History Museum in Paris, under the name of *Gorgonia gemmacea* (MSS. dans la collect. du Museum Paris).

In 1857 Milne-Edwards and Haime referred the species to the genus Verrucella, and defined it as follows :—

Polypiéroïde dont les branches, assez nombreuses et cylindriques, se dichotomosent de loin en loin, et s'écartent beaucoup entre elles ; les ramuscules terminaux allongés. Coenenchyme très-friable, d'un jaune ferrugineux à la surface et blanchâtre puis de l'axe. Verrues calicifères très-saillantes, arrondées et dressées contre la tige."

They give a very good figure, showing the mode of branching. In 1865 Kolliker removed the species from the genus Verrucella to Juncella, and noted for the first time that "clubs" occurred amongst the spicules just as in *J. [illegible].* He gives two figures—(1) a club-shaped spicule (woodcut 19, 1); (2) a cross-section of the axis (Pl. XIV, fig. 4).

Gray in 1870 referred this species to the genus Ellisella with no apparent justification. (See our Historical Note.) This change, however, was not recognized by any subsequent authors, so that Ridley in 1884 identified some specimens from Queensland, under the name of *J. gemmacea*, and remarked that the spicules are almost indistinguishable from those of *J. juncea*, while at the same time he expressed the opinion that *J. flexilis* Studer might not be a distinct species. The position of this species has already been discussed.

It would be useless to go in detail into all the records of this species; and in fact, it is very difficult to say whether the records of *J. juncea* and *J. gemmacea* are all correct in identification, as several authors do not mention whether their colonies were simple or branched. Another complication, however, creeps in. When fragments of colonies were examined, is it not possible that a branch of *J. gemmacea* might be referred to *J. juncea*, especially when we remember that the question of branching is the chief distinction between the two species?

Before going on to discuss the various characters of this species in detail, I would give the following quotation, as it is not only of great interest, but has apparently been overlooked by several authors in their identification of this species.

Ridley (1884) referred a colony from the N.-E. coast of Australia to the species *elongata*; but in 1887 (xxxii., p. 241) he replaced it in the species *gemmacea*, noting that he had overlooked the fact that *J. elongata* had no "clubs." He says :—"It will be seen that we probably have a very variable species before us, colour, form, and size being alike not to be depended on by themselves. The spiculation is fairly constant, but differs so little from that of the allied forms (*J. juncella* and *fragilis*) as to be scarcely a sufficient guide *per se* to the recognition of the species."

From the fact that the specimen referred to was dichotomously branched, I feel justified in recognizing it as J. *gemmacea*. An interesting feature about this specimen is the fact that when found it had been broken off at the base, and the broken part had been overgrown with coenenchyma, so that it had been living free in the water. An analogous state was observed in the case of a specimen of *Isis hippuris* Linn. in the Littoral Collection from the Indian Ocean.

In the Mergui Collection there is a large number of specimens of this species, and these are augmented by several from the Indian Ocean Collection from the Indian Museum, Calcutta. By means of these it has been possible to study and compare several characters which are very variable in a manner which would have been impossible with only a single or even a few specimens.

Branching.—The mode of branching is of the nature of a false dichotomy. The large main branches of the colony are again branched almost in one plane, but the general appearance of the colony is bushy.

The distance between branchings, though not constant, seems to increase from the base upwards, so that the longest unbranched parts are the terminal twigs. This is more marked in the taller colonies. In young dwarf specimens the relative distances between the origin of the several branches in ascending order is less pronounced, and the branches themselves are proportionately thicker. These latter specimens therefore have a different appearance from the older and more elongated colonies, but must be ranked in this species when we take into consideration the mode of growth, which will be discussed later.

Before doing so, however, it will be well to tabulate corresponding measurements in individual colonies, and see how far these give us a clue to the mode of growth. Fortunately we have in our possession intermediate stages which show the different developments during growth from the shortest to the tallest.

The following tables may serve to form a basis for such a study. In Table A the measurements are all given in centimetres. The symbol + indicates that the exact length is not known, owing to the basis of attachment having been broken off.

TABLE A.

Specimen.	Height.	Length of main stem.	Distance between branches.	Length of twigs.
I.	90	6	3–18	26
II.	80	12 +	2–10	28
III.	75	4 +	2–10	22
IV.	70	4 +	2–12	22
V.	65	5 +	2–12	16
VI.	62	5	2–11	15
VII.	55	4	2–9	16
VIII.	55	2 +	2–14	14
IX.	54	3 +	2–10	13
X.	53	8 +	3–10	14
XI.	44	7	2–10	12
XII.	42	3 +	2–7·5	13

Figures 15, 16, and 17 show the branching in the colonies, which have been proportionately reduced. The largest (fig. 10) was 800 mm. in length.

Let us consider two colonies which in general build are quite unlike one another. The large specimen is from the Mergui Archipelago and the smaller is from the Andamans.

The former is 400 mm. in height; the latter is 230 mm. in height: the longest twig in the former is 220 mm., that in the latter 70 mm. The greatest distance between branchings in the former is 120 mm.; in the latter it is only 27·5 mm. So far, then, the measurements are proportionate; but when we take into consideration the corresponding diameters in the various parts, the difference is at once very marked. In the *smaller* colony the total diameter of the several branches and twigs is greater than in the larger; so that, at first, it is difficult to conceive that the dwarf colony could develop into a colony similar to the larger.

TABLE B.

Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.	Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.	Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.
	25				70	5			70	9	
	20				20	5·5			70	9	
	27·5				20	5·5			65	8	
	15	6·5			40	5·5			110	7	
230	25	6	70	440	45	5·5	120	700	100	6	220
	22·5	6			40	5·5			55	5	
	22·5	6			40	5			95	4·5	
	17·5	5·5			50	5			65	4	
	12	5·5			Twig	4·5			120	3·5	
	Twig	5							Twig	3	

Table B gives several measurements from three colonies of different sizes. One large branch has been selected and followed to the tip of the colony. The various lengths represent the consecutive distances at which branches arise from it. The first feature which may be seen from this Table is the fact that the distances at which the different branches arise do not increase proportionately from the base upwards. (2) Such increase as exists is more marked in the taller specimens. (3) In the very dwarf colony, the distances actually diminish in the upper half.

Let us now critically examine the measurements given in the same Table of the diameters at the corresponding parts. (1) The diameters of the branches in the young colony are equal to, and, in some cases, greater than, corresponding measurements in the older colonies. The series of measurements of twelve specimens given in Table C shows that (1) the length of the main stem varies very little; (2) there is a distinct tendency towards an increase of length in the younger branches and twigs in the older specimens.

TABLE C.

			Main Stem.			Branch.			Twig.	
Specimen.	Height in centimetres.	Breadth in centimetres.	Total diameter.	Diameter of axis.	Thickness of Coenenchyma.	Total diameter.	Diameter of axis.	Thickness of Coenenchyma.	Total diameter.	Thickness of Coenenchyma.
I.	90	20	9	8	0·5	4	2	1	2	1
II.	80	35	9	7·5	0·75	3·5	2	0·75	2	1
III.	75	24	9·5	8	0·75	4	2	1	2	1
IV.	70	18	9	8	0·5	3·5	2	0·75	2	1
V.	65	15	7·5	6	0·75	4	2	1	2	1
VI.	62	24	6	5	0·5	4	2	1	2	1
VII.	55	30	6·5	5	0·75	4	2	1	2	1
VIII.	55	23	6	5	0·5	4	2	1	2	1
IX.	54	20	7	5	1	4	2	1	2	1
X.	53	16	7	5	1	4	2	1	2	1
XI.	44	20	4·5	3	0·75	4	2	1	2	1
XII.	42	27	8	6	1	4	2	1	2	1

In Table C we have sought to analyse the nature of the constitution of the diameter—in other words, to find the actual proportion of axis and coenenchyma, and here several very interesting and useful facts have come to light.

(1) The thickness of the coenenchyma at the tip of the twigs is almost a constant; in reality it is slightly thicker in the smaller specimens. It is noteworthy that the diameter of the axis at this part is negligible, being of a hair-like fineness.

(2) Although the total diameter of branches lower down is greater than in the twigs, the actual thickness of the coenenchyma is never greater, and, in some cases, is actually less.

(3) The thickness of the coenenchyma in the main stem is seldom as great as in the branches or twigs, and is usually from 0·75 to 0·5 times its thickness.

Bearing these facts in mind, let us see if any inference may be made as to the mode of growth, and also as to the possibility of these apparently diverse forms being referable to a single species.

(1) We find that what obtains with regard to the various measurements in different parts of the same colony also holds good in the corresponding parts of colonies of different sizes.

(2) It is also obvious that increase in thickness in the older parts of a colony is due, not to increase of thickness in the coenenchyma, but to increase in the diameter of the axis.

(3) Increase in length in the younger branches and twigs is not proportional to increase in the thickness of the coenenchyma, but tends rather to the reverse of this situation.

We are therefore in a position to conclude that increase in the thickness of the coenenchyma is not proportionate to the age of the colony, but that the coenenchyma attains to its typical thickness at a very early stage, and that further elongation and consequent thickness are caused more by the growth of the axis than the coenenchyma; or, in other words, the earlier period of growth consists chiefly in development of the coenenchyma, while the strengthening of the axis and elongation of the colony come at a later period. Consequently the younger colonies are more bushy and fleshy, and the older colonies have proportionately a greater amount of axis, and are therefore more rigid.

The distribution of the polyps, the nature of the verrucae, and the details of the canal-system are exactly similar to those described for the protruding verrucae variety of *Juncella juncea*. Figs. 18 and 19 have been added to show the leading characteristics; and these should be compared with the corresponding figures (12 and 13) of *J. juncea*.

Colour.—The great majority of the specimens examined in this species are of a dark brick-red colour; but the following tints also occur:—(1) reddish orange, (2) brownish yellow, (3) orange-yellow, (4) lemon, and (5) creamy-white. There is thus almost a series of gradations from white through orange to red.

Spicules of J. gemmacea.

The spicules of this species, as has already been pointed out, are identical both in types and measurements with those of *J. juncea*, so that the description and measurements given for the latter may be taken as typical.

Distribution of J. gemmacea.

Red Sea.

Providence Island.

Mascarene Island, 19 fms.

Mermaid Straits.

Queensland, N.-E. Australia: Percy Island, 0–5 fms.; Port Molle, 12–20 fms. and between tide-marks; Port Denison, 4 fms.; Fitzroy Island, 11 fms.

Amirante Island, 32 fms.

Malacca.

Singapore.

King Island Bay, and elsewhere in the Mergui Archipelago, between tide-marks and up to 30 fms.

Torres Straits, 8 fms.

Gulf of Manaar.

Torres Straits (as *Ellisella maculata pars.*).

XII.—**Juncella racemosa.** Figs. 20–23.

J. racemosa Wright and Studer, l, p. 159, Pl. XXXIV, fig. 11.

J. miniacea Thomson and Henderson, xl, p. 81, Pl. v, figs. 7 and 12.

J. racemosa Thomson and Simpson, xli, p. 268.

This species was established by Wright and Studer for several small, delicate, branched specimens in the "Challenger" Collection, with the following features:—The branches arise all in one plane; in one specimen all the branches, to the very summit, are given off from the right side of the main stem, which is curved. Several of these are short and simple, while others are again branched. All the branchlets are given off from one side of the branch, and, when branched to a third degree, the same fact holds true. The polyps are numerous; and on the stem and branches they show an eight-rayed star; on further contraction, they appear as small papillae; when fully contracted, they are 1 mm. in height and 0·5 mm. in diameter. On one surface of the stem and branches polyps are absent; and on this naked portion a feebly marked groove winds up the stem. The polyps are much more numerous and crowded on the smaller branches, where they are placed in three or four rows. The colour of the coenenchyma and polyps varies from reddish yellow to dark red. The bases of the polyps and tentacles are of a much lighter hue. The coenenchyma is thin, and has the characteristic spicules of Juncella.

The figure of the spicules given in the "Challenger" Report (Pl. XXXIV., fig. 11) does not, however, give a good appreciation of their form; and this led

Thomson and Henderson to establish a new species (*J. miniacea*) for a small specimen from the Indian Ocean. The long spindles described for the latter species have since proved to be extrinsic.

An examination of the type specimen, and also of the spicules of *J. racemosa* in the British Museum, has proved beyond question that *J. miniacea* is not distinct from *J. racemosa*. This has already been pointed out (Thomson and Simpson, xli.) in connexion with another specimen which occurs in the collection of Littoral Alcyonaria of the Indian Museum, Calcutta (figs. 20, 21, and 22).

In the same collection, but hitherto undescribed, is a small portion of a delicate colony branched in one plane (fig. 21). The base is wanting; and what appears to be the main stem may be only a primary branch which has been broken off at the point of attachment of an acorn shell. It is 30 mm. in length, and is distinctly crescentic in shape. Five thread-like branches arise from the convex side, and one only from the concave. The longest of these is 55 mm.; and it is noteworthy that the branches are also curved. They in turn give origin to finer branchlets, which, with very few exceptions, arise from the convex side. Two acorn-shells have become attached to the colony; and these are overgrown with polyp-bearing coenenchyma; while one of them has given rise to a proliferation of the axis.

The coenenchyma is very thin; and it is impossible to discover the nature and number of the main canals.

The axis is thread-like, and is impregnated with lime.

The polyps are more scattered than in any of the previously described specimens, and stand almost perpendicularly. The arrangement of these is not easily determined. In the finer twigs they occur in two single rows (fig. 22); but the intrusion of young polyps and consequent development tend to obliterate this symmetry, and give an irregular arrangement.

The verrucae, when expanded, are cylindrical, and higher than broad; in this condition an eight-rayed structure is seen at the top. On contraction they become dome-like, and no trace of the rays is to be seen. The colour of the colony is a pale brick-red throughout.

The spicules are of the types characteristic of this species.

Locality.—Andamans.

Diagnosis of J. racemosa.

Colony delicate, branched in one plane; the branches tend to arise from one side of the stem, and the branchlets show a similar tendency; coenenchyma thin; polyps in the finer twigs and at the tips of the branches are usually disposed in two lateral rows; in the older parts of the branches they occur irregularly over the coenenchyma. The verrucae, when expanded, are cylindrical, and either stand perpendicularly or are inclined upwards to the stem; when contracted they are low and dome-like. The spicules are very minute, and are distinctly prickly in appearance (fig. 23). The following types may be distinguished:—

(*a*) *Slender clubs*, with a distinct smooth middle portion, surmounted by a spiny head, only slightly thicker than the constriction.

(*b*) *Short, stumpy clubs*, much broader in proportion to their length, and with the spines slightly more divaricate.

(*c*) *Double wheels*, with an elongated *hub*.

(*d*) Elongated forms, with a distinct smooth constriction, which may be conveniently termed *double spindles*.

(*e*) Occasional *quadriradiates*.

(*f*) *Needles* in the anthocodiae.

The following may be taken as typical measurements in millimetres as they occur in all the specimens so far known:—

(*a*)	0·076 × 0·031	constriction	0·008 × 0·008.
	0·065 × 0·031	„	0·011 × 0·008.
	0·065 × 0·023	„	0·008 × 0·008.
(*b*)	0·053 × 0·034	„	0·008 × 0·009.
	0·053 × 0·031	„	0·011 × 0·008.
	0·049 × 0·031	„	0·008 × 0·008.
(*c*)	0·057 × 0·027	„	0·011 × 0·008.
	0·051 × 0·027	„	0·011 × 0·009.
	0·046 × 0·027	„	0·008 × 0·008.
(*d*)	0·076 × 0·027	„	0·011 × 0·008.
	0·068 × 0·027	„	0·011 × 0·011.
	0·061 × 0·031	„	0·008 × 0·008.
(*e*)	0·038 × 0·034		
(*f*)	0·1 × 0·04, 0·06 × 0·04		

Colour-schemes—Brown throughout.
Vermilion-red.
Orange-red, with tips of the verrucae yellow.
Pale brick-red.

Localities.—Hyalonema-ground, off Japan, 345 fms. (Wright and Studer).
Andamans, 120 fms. (Thomson and Henderson).
Andamans, „ (Thomson and Simpson).
Andamans, „ (as stated above).

XIII.—Juncella trilineata. Figs. 24–26.

Juncella trilineata Thomson and Henderson, xxxix., p. 315.

In 1905 Thomson and Henderson established this very characteristic species, of which the following notes are of particular interest. The specimen was sparingly branched. "The polyps arise in three different bands, leaving three narrow, bare strips, each of which has in its centre a bare rib or keel. Under each bare strip lies a large longitudinal canal."

Only one specimen of this remarkable form has so far been described; it was obtained at Patani, Siam.

The spicules are of the Juncella type, and are hardly distinguishable from those of *J. juncea*. Very characteristic, however, is the presence of *three* main canals situated symmetrically around the axis. The result of this on the external appearance is that there are *three* longitudinal spaces on the coenenchyma devoid of polyps; the verrucae are therefore disposed in three longitudinal groups, and this arrangement is unique amongst Juncellids.

"The polyps, which measure from 1·1 mm. to 1·5 mm. in height, are arranged in transverse rows of 3–4; but many smaller polyps occur which break this regularity."

For a short distance from the end of the branches the polyps occur in three single rows (fig. 24); but passing downwards two, three, four, or more are to be seen, and scattered among these are immature forms, so that all that can be said with regard to the disposition of the polyps is that they occur in three longitudinal groups, the exact number in a transverse row depending on the position in the colony and on its stage of development.

The coenenchyma is of the typical Juncellid type; it consists of an outer non-canal-bearing part and an inner canal-bearing part. These are separated by a concentric series of outer longitudinal canals. In the inner series of longitudinal canals which separate the coenenchyma from the axis there are, however, *three* much larger than the rest; these correspond to the three longitudinal tracts devoid of polyps and separate off the three polyp-bearing ridges (fig. 25).

In the Indian Ocean Littoral Collection there occurs a small, simple colony, 55 mm. in height and 2·5 mm. in maximum diameter. The attachment has been broken off, but has evidently not been far from the present base. For a short distance from the base there is a portion devoid of polyps. Throughout the remainder of the colony the polyps seem to be arranged in three irregular longitudinal series and as a cross-section reveals what are evidently the main canals, we feel justified in referring the specimen to this species. The verrucae are about 1 mm. in height, but are not so densely packed as in the type-specimen (fig. 24); but this may be due to its immature condition.

The colour is orange-yellow, but the verrucae are paler.

Locality—Off Ceylon, 34 fms.

Diagnosis of J. trilineata.

Colony upright, sparingly branched, the branches long and slender. Very characteristic is the presence of *three* main longitudinal canals and the consequent disposition of the polyps in *three* longitudinal groups. The verrucae may show the different stages characteristic of the genus. The following types of spicules may be distinguished (fig. 26).

(*a*) Slender clubs, with a distinct central bare portion; the knobs on the handle stand almost perpendicularly; the projections on the club-portion arise at a slight angle and are directed downwards.

0·068 × 0·019 length of constriction 0·017.
0·068 × 0·017 " " 0·017.
0·068 × 0·019 " " 0·015.

(*b*) Clubs, similar to (*a*), but thicker in proportion to their length.

0·072 × 0·038 length of constriction 0·018.
0·068 × 0·034 " " 0·017.

(*c*) Double-stars, with very few large smooth warts at each end.

0·076 × 0·038 constriction 0·019 × 0·015.
0·066 × 0·042 " 0·015 × 0·015.
0·061 × 0·034 " 0·015 × 0·012.

(*d*) Double-wheels.

0·065 × 0·034 constriction 0·015 × 0·014.

Colour.—Dark red.

Localities.—Patani, Siam. Off Ceylon, 34 fms.

XIII a.—Appendix to Juncella.

"*Incertae Sedis.*"

Juncella santae-crucis.

1. *Juncella santae-crucis* Duch. and Mich., v., p. 21, t. 2, f. 1.
2. *Juncella viminella* (?), *santae-crucis* Gray, xii., p. 29.

1. "Polypario stirpe simplici, rigido; axe terete, lutescente, gracili; cortice cretaceo, albo; calycibus irregulariter biseriatis, inaequalibus, nempe nunc majoribus nunc duplo minoribus; ore terminali, parvo, radiato."

"The polyps are irregularly disposed in a double row on each side of the colony; there is a median bare space on each side of the two flattened faces. The verrucae are unequal in height, and stand at right angles to the colony; they are conical in shape; the summit has a small opening which shows a radiated structure."

Duchassaing and Michelotti had, however, only a fragment devoid of base; the breadth was 5·5 mms., including the verrucae, the longest of which were two mms. in height.

2. Coral simple, rigid; axis cylindrical, yellowish, slender; bark cretaceous, white; cells irregularly disposed in a double row on each edge of the stem, unequal; some twice as large as the others, smooth, terminal, small, and radiated; lateral area flat and naked, with a central groove.

Locality.—Island of St. Croix (West Indies).

Juncella funiculina.

Juncella funiculina Duch. and Mich., v., p. 22, Pl. VII., figs. 9 and 8.

Colony simple, flexible; polyps in a single series on two sides, small, adpressed to the stem, and directed upwards; oval opening small, with a radiate structure; coenenchyma thin, white; axis yellowish.

Locality.—Guadaloupe.

Juncella barbadensis.

Juncella barbadensis Duch. and Mich., p. 22, Pl. V., figs. 5 and 6.

Colony attached, simple, filiform, white; polyps elongated with club-shaped spicules; verrucae in a single series on each side; there is a distinct median groove on each bare space. It is larger and more robust than *J. funiculina*; the verrucae are larger.

Localities.—Barbadoes and Guadaloupe.

Juncella calyculata.

Gorgonia calyculata Ellis and Solander, vi., p. 95.
Juncella calyculata Valenciennes, xlvi.
Gorgonella calyculata Kölliker, xxiii., p. 140.
Ellisella calyculata Gray, ii., p. 26.

Ellis and Solander's description is as follows:—

This Gorgon grows in a sub-divided order, having erect, thick branches with truncated papillae. The flesh is ash-coloured without, and purple on the inside, furnished with large, cup-shaped mouths, disposed close together in a quincunx order, and looking upwards, having polyps with eight fringed claws extending themselves from them. The bone is of a dark-brown colour and horny nature. This sea-shrub sends forth round white eggs, larger than any of the genus.

Locality.—Isle of Bourbon.

Juncella hystrix.

Juncella hystrix Valenciennes, Comptes Rendus, xli., p. 14.
Juncella hystrix Milne-Edwards and Haime, Corall., i., p. 186.
Juncella hystrix Johnson, xix., p. 143.
Juncella hystrix Johnson, xviii., p. 506.

The only description of any importance of this species is as follows:— Stem delicate. Verrucae markedly projecting.

Locality.—Bahia.

Juncella vimen.

Juncella vimen Valenciennes, Comptes Rendus, xli., p. 14.
Juncella vimen Milne-Edwards and Haime, Corall., i., p. 186.

Milne-Edwards and Haime describe this species thus:—

Verrucae disposed laterally in such a manner that a large distinct non-polyp-bearing median space is left.

Locality.—Isle of Bourbon.

Juncella surculus.

Juncella surculus Johnson, xviii., p. 506.
Juncella surculus Johnson, xix., p. 143.

Locality.—Senegal.

Juncella laevis.

1865. *Juncella laevis* Verrill, xlviii., 1865, p. 189.
1870. *Juncella laevis* Gray, xii., p. 29.

Verrill's original description is as follows:—

"Corallum tall, simple, subcylindrical, rather slender, diminishing in size both at the summit and near the base, where the polyps become obsolete. Cells adpressed, scarcely prominent, arranged in two broad bands, *leaving a narrow, median, naked space on each side, along which there is a well-marked groove*; they are placed alternately, at a distance of about one-fifth (·2) inch, in about six vertical rows on each side, pro- [illegible] arrangement; axis slender, cylindrical, *calcareous*, white, [illegible] by about sixteen longitudinal lobes, two of which are larger and correspond with the lateral grooves; the others to the rows of polyps. Length of the single specimen, imperfect at each end, 20 inches; greatest diameter, ¼ (·25) inch. Colour yellowish-brown, in alcohol."

Locality.—Hong-Kong, China.

Gray (XII., p. 29), not having seen the specimen, simply recapitulates the above description.

Juncella extans.

Juncella extans, Verrill, xlvii., p. 37.

"Tall and simple, with the very prominent verrucae curved inwards, and arranged crowdedly in a band on each side of the axis, leaving a wide, naked space on each side. Colour white. Axis greyish-white, stony, and rigid."

Locality.—Fayal, Azores.

XIV.—**Scirpearia** emend.

(*a*) *Discussion of the Genus.*

1830 Scirpearia, Cuvier, i. p. 319.
1878 Scirpearia, Studer, xxxiv., p. 660.
1887 Scirpearia, Studer, xxxv., p. 67.
1901 Scirpearia, Studer, xxxvii., p. 52.
1889 Scirpearia, Wright and Studer, l., p. lxv.
1889 Scirpearella, Wright and Studer, l., pp. lxv and 154.
1855 Ctenocella, Valenciennes, xlvi., p. 14.
1857 Ellisella, Gray, x., p. 287.

This genus was established by Cuvier in 1830 to include *Pennatula mirabilis*, but the following note may be interesting :—Milne-Edwards and Haime (Hist. Nat. Corall., 1. 0. 214) say: "The Alcyonarian described and figured by Cuvier under the name *Pennatula mirabilis* seems to be very little connected with *Virgularia mirabilis*, as some have suggested. It has a slender stem attenuated at the two extremities, and bearing at each side a simple series of widely separated polyps. Cuvier formed of it the genus Scirpearia, which has been adopted by Ehrenberg. Lamarck placed it in his genus Funiculina, near Pavonaria, under the name of *Funiculina cylindrica*. Fleming thought that the species was not distinct from Virgularia; and Blainville affirmed that it was nothing but a Gorgonia. None of these opinions seem to me admissible. It is too imperfectly known to have a place assigned to it in a scientific classification of corals."

In 1878 Studer resuscitated the genus, and gave the following diagnosis :—"Colony simple or branched; axis cylindrical, horny, and calcareous; coenenchyma thin; calyces projecting; in two longitudinal rows on the sides of the stem and branches; spicules double-clubs and spindles."

This, then, must be our starting-point in generic determination.

In 1901 he re-united under the name of Scirpearia all the Gorgonellids with a simple, flagelliform colony which have large verrucae in the form of clubs, and whose spicules are double-clubs and spindles. The coenenchyma is thick and the colony is bilaterally symmetrical. The polyps are disposed on two sides of the axis.

Wright and Studer in 1889 give the following diagnosis:—"Colony simple with a cylindrical calcified axis and thin coenenchyma. The polyps are seated in two longitudinal rows on each side of the stem. The spicules are double-clubs and spindles. The genus may include *Scirpearia mirabilis* Cuvier and *Viminella flagellum* Gray."

It must be remembered, however, that in the same memoir they separated off the genus Scirpearella as follows:—"Colony simple or very feebly branched. Axis calcareous, brittle, smooth, or grooved. Polyps arranged in rows or spirals, retractile, with more or less prominent verrucae. Coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs.

We have already shown, however, that such a distinction cannot be said to obtain, and have already proposed the uniting together of Scirpearia, Scirpearella, Ellisella and Ctenocella, and have given an emended diagnosis.

In this emended sense, then, we now proceed to classify specimens with these characters into different species.

Before doing this, however, it might be well to give the following list of the various species which have, from time to time, been referred to the genus under consideration, under the names Scirpearia, Scirpearella, Ctenocella, and Ellisella:—

Scirpearia flagellum.
Scirpearia furcata.
Scirpearella profunda.
Scirpearella gracilis.
Scirpearella rubra.
Scirpearella indica.
Scirpearella aurantiaca.
Scirpearella alba.
Scirpearella divisa.
Ellisella maculata.
Ellisella calamus.
Ellisella coccinea.
Ellisella elongata.
Ctenocella pectinata.

Some of these—e.g., *flagellum* and *elongata*—have, at times, appeared under other generic names; but these will be discussed later under the species in question.

(b) Classification of the Species.

In formulating a scheme of classification for these different species, and also the large number of undescribed specimens which I have before me for identification, two courses were available, either (1) to describe every individual specimen, and name it on account of certain differences which may or may not be inherent, or (2) to study the group as a whole, tabulate all the points of difference in the various specimens, eliminate all variations, such as occur in the same colony, reject all environmental modifications, and arrange the specimens around some central type. The latter plan has been adopted in the present work; and for this reason it has been necessary to abolish several of the previously described species, not on account of their absolute identity with formerly described species, but on account of the differences which obtain in these different forms having proved to be not greater than differences appearing in an individual specimen. A very good example of this is seen in the case of *Scirpearia furcata.* Such a procedure has been possible in the case under consideration only on account of the large number of specimens which it has been my privilege to examine; and it is more than probable that when a larger mass of material is available, it may still be possible to diminish the number of species in this report.

The characters on which the present classification are based are the following:—

(1) the number of main longitudinal canals,
(2) the nature of the spiculation, and
(3) the nature of the branching.

These, of course, are not all of equal value; but a *very rigid separation* may be made into two classes based on the number of main longitudinal canals. It has been found that in this group specimens have either *two* or *four* main canals.

The nature of the branching when it comes to be a question of "simple or branched," as we have already pointed out, is of little value except in certain well-defined species. This is very evident in such colonies as those described under *Scirpearia furcata.* On the other hand, the very characteristic mode of branching seen in *Scirpearia pectinata* would seem to justify its inclusion as a specific character.

Scirpearia andamanensis and *Scirpearia ramosa* are also worthy of consideration in this respect.

The nature of the spiculation is also a character on which great reliance may be placed as a specific determinant; and, in the case of *Scirpearia*, it has proved to be of great value.

Very good examples of this may be seen in the great contrast between the spicules of *Scirpearia profunda* and *Scirpearia alba*, or between *Scirpearia flagellum* and *Scirpearia ramosa*, or between *Scirpearia furcata* and *Scirpearia thomsoni*.

By means, then, of a combination of these characters, it has been possible to arrange the numerous specimens which have been examined into certain fairly definite groups. It will be seen that in the great majority of cases each group is represented by a single species; but where possible we have suggested affinities. It seems preferable, however, to designate these at present as groups rather than as species, although the latter procedure must also be used for reference.

It is unnecessary to enter into the details of each group here, as that is much better left over until the various specimens are discussed; but we submit the following classification:—

Scirpearia.

Division 1.—*Main Longitudinal Canals*, two *in number*:—

(*a*) profunda-group, . .	*Scirpearia profunda* emend.
" . .	*Scirpearia hicksoni* n. sp.
" . .	*Scirpearia verrucosa* n. sp.
" . .	*Scirpearia anomala* n. sp.
(*b*) pectinata-group, . .	*Scirpearia pectinata* emend.
(*c*) elongata-group, . .	*Scirpearia elongata* emend.
(*d*) flagellum-group, . .	*Scirpearia flagellum* emend.
(*e*) thomsoni-group, . .	*Scirpearia thomsoni* n. sp.
(*f*) alba-group, . .	*Scirpearia alba* emend.
(*g*) aurantiaca-group, .	*Scirpearia aurantiaca* emend.
(*h*) furcata-group, . .	*Scirpearia furcata* emend.
(*i*) andamanensis-group, .	*Scirpearia andamanensis* n. sp.
(*j*) ramosa-group, . .	*Scirpearia ramosa* n. sp.
(*k*) ceylonensis-group, .	*Scirpearia ceylonensis* n. sp.
(*l*) maculata-group, . .	*Scirpearia maculata* emend.

Division 2.—*Main Longitudinal Canals*, four *in number*:—

(*a*) quadrilineata-group, .	*Scirpearia quadrilineata* n. s.p.

Profunda-group.

This group is characterized by the enormous size of the spicules. The two chief types which occur are :—

(1) Double-clubs with almost hemispherical ends, and

(2) Elongated double-clubs, which approach double-spindles and even spindles.

Four species may be recognized :—

1. *Scirpearia profunda* Wright and Studer *emend.*
2. *Scirpearia hicksoni* n. sp.
3. *Scirpearia verrucosa* n. sp.
4. *Scirpearia anomala* n. sp.

The following differential diagnosis of the spicules of these four species may be useful :—

Scirpearia profunda (emend.).

In this species the spindle-type predominates over the elongated double-club. The spindles are massive, very warty, and irregular in outline (fig. 27). Typical measurements are 0·122 × 0·057 ; 0·114 × 0·049 ; and a more slender type 0·106 × 0·034 ; 0·09 × 0·034. The double-clubs have almost hemispherical ends, and have practically no constriction, 0·084 × 0·046 ; 0·08 × 0·053.

Scirpearia hicksoni n. sp.

The spicules of this species are very regular in outline ; they are covered with slightly papillose warts ; and the elongated double-clubs have extremely blunt ends (Fig. 31).

(1) double-clubs :—0·08 × 0·05 ; 0·075 × 0·05.

(2) Elongated double-clubs :—0·11 × 0·045 ; 0·085 × 0·035.

Scirpearia verrucosa n. sp.

In this species the spicules are very irregular in outline ; they are covered with long papillose warts, which are widely separated. The ends of the elongated double-clubs and double-spindles are markedly pointed, and have the form of elongated cones (fig. 33).

(1) Double-clubs :—0·095 × 0·05 ; 0·07 × 0·04.

(2) Elongated double-clubs :—0·14 × 0·04 ; 0·11 × 0·02.

Scirpearia anomala n. sp.

The spicules of this species are not densely covered with warts, and the warts themselves are only slightly papillose. The ends of the elongated double-clubs and double-spindles are markedly conical (fig. 35).

(1) Double-clubs :—0·061 × 0·042 ; 0·06 × 0·04.

(2) Elongated double-clubs : 0·15 × 0·034 ; 0·095 × 0·046.

XV.—**Scirpearia profunda** (Wright and Studer). Fig. 27.

Scirpearella profunda Wright and Studer, l., p. 155, Pl. XXXI., fig. 2; Pl. XXXII., figs. 1 and 1*a*; Pl. XXXIV., fig. 7.

Scirpearella gracilis Wright and Studer, l., p. 156, Pl. XXXI., figs. 1 and 1*a*; Pl. XXXIV., fig. 6.

Scirpearella rubra Wright and Studer, l., p. 157, Pl. XXXIV., fig. 5.

Scirpearella moniliforme Thomson and Henderson, xl., p. 82.

We have examined the type specimens in the British Museum of these three species, and have come to the conclusion that they cannot be regarded as distinct. *S. rubra* is undoubtedly the same as *S. gracilis*; but *S. profunda* differs in that it is branched. When we take into consideration, however, the great length of the flagelliform branches of *S. profunda*, we are quite in a position to conceive the longest fragment of *S. gracilis* as a portion of a branch of a much larger colony than that formed by *S. profunda*. These two species, as Wright and Studer observe, "were taken at the same haul of the dredge from a depth of 130 fms.; although, no doubt, closely related forms, there seem sufficient differences to justify their being for the present treated as distinct."

The spiculation is essentially the same in all three species; and the nature and distribution of the verrucae show variations not greater than those in other cases of specimens undoubtedly belonging to the same species. For this reason we feel justified in merging the three species under the earliest name, *S. profunda*.

The following are the chief characteristics of the different types:—

S. profunda.—The colony is feebly branched. The axis is calcareous, brittle and of a circular outline with some spiral grooves: it is formed of several concentric calcareous layers, which easily peel off.

The polyps are in irregular spirals on the stem and branches, from 2 mm. to 3 mm. apart but closer to one another towards the termination of the branches. The older verrucae are more conical than the younger ones. When fully retracted they are oblong conical.

The coenenchyma is moderately thick and finely granular.

The colour in spirits is a whitish-brown.

Locality.—"Challenger" Station 177, off the New Hebrides; depth, 130 fms.; bottom, volcanic sand.

S. gracilis.—Colony is simple, so far as can be judged.

The axis is calcareous and very brittle; it is grooved. The polyps are arranged on the stem in four rows, the polyps in one row alternating with those in the next row, so as to give a more or less spiral arrangement to the polyps colony. This arrangement is sometimes obscured by the addition of young polyps between the older ones. Towards the apex of the stem the polyps are in three rows, and at the very apex they are opposite. When withdrawn the verrucae are nipple-like.

The coenenchyma is moderately thick.

Locality.—"Challenger" Station 177, off the New Hebrides; depth, 130 fms.; bottom, volcanic sand.

S. rubra.—Colony simple (not complete), but 620 mm. in length. The axis is calcareous, brittle, with two shallow grooves.

The polyps are numerous, arranged in spirals on the stem. Towards the termination of the axis they are disposed in an alternate manner on the opposite sides of the stem.

The coenenchyma is thin, with a compact layer of spindles and warty clubs.

The colour in spirits is light red.

Locality.—"Challenger" Station 232, Hyalonema ground, off Japan; 345 fms.; bottom, green mud.

S. moniliforme Thomson and Henderson is also referable to this species.

Locality.—Eight miles west of Interview Island, Andamans; 270–45 fms.

From the foregoing it is obvious that, except in the question of branching—a character to which very little importance can be attached, since the specimens are nearly all incomplete—the macroscopic structure shows a range of variation, such as we expect to find in long flagelliform colonies. For this reason it is impossible to consider the question of different species on these characters alone. Preparations of spicules from corresponding parts of the different colonies show no great disparity either in the types themselves or in the characters and measurements of the types, so that we are forced to rank these different specimens as one variable species having a type of spiculation different from others known at present.

Amongst the numerous undescribed specimens which have been examined in the preparation of this memoir none were found to agree with the "Challenger" forms; but this fact may not be considered remarkable when we take into consideration the localities from which they were obtained.

The spicules of this species are large and very characteristic (fig. 27 *a–g*). They consist of large warty spindles, some of which show a trace of a constriction. Two forms of these may be recognized—(*a*) slender and very warty, and (*b*) more massive spindles. In addition to these, the most definite type is the large double-club; these have very massive warty ends, and practically no constriction, and some have more hemispherical heads than the others (*c*). These three types may be regarded as characteristic; but other forms occur—e.g. irregular forms (*d*); double-wheels (*e*), crosses (*g*).

The irregular forms (*d*) show variations which might be regarded as departures from double-clubs or from the massive spindles, and may be intermediate between the types (*b*) and (*c*). In the same way those represented by (*f*) may be looked upon as annectant forms between types (*e*) and (*g*).

The crosses (*g*) show great variation.

The following measurements in millimetres may be taken as typical:—

(*a*) Spindles, slender and very warty: 0·106 × 0·034; 0·103 × 0·30; 0·09 × 0·034.

(*b*) Spindles, very warty and massive: 0·122 × 0·057; 0·118 × 0·057; 0·114 × 0·049.

(*c*) Double-clubs, with massive warty ends and practically no constriction; 0·084 × 0·046; 0·072 × 0·046; 0·08 × 0·053.

(*d*) Irregular forms: 0·095 × 0·053; 0·095 × 0·046; 0·076 × 0·053.

(*e*) Double-wheels, a few: 0·072 × 0·034; 0·057 × 0·027.

(*f*) Crosses: 0·11 × 0·076; 0·084 × 0·061; 0·061 × 0·034.

Emended Specific Diagnosis.

The colony is simple and feebly branched; in the latter case the branches are long and flagelliform. The axis is calcareous and brittle; it is composed of concentric layers; the surface is marked by longitudinal grooves; sometimes two of these are deeper than the others. The polyps are disposed in two longitudinal series; this arrangement may be obscured in the older parts; and then the disposition may simulate a spiral. Near the base four rows may occur in each series; but this number diminishes in the younger parts, so that near the tip there is only a single row, alternately on opposite sides. The verrucae when partially retracted are conical, but when more fully withdrawn are nipple-like. The canal-system is typical. The coenenchyma is moderately thin and finely granular. The spicules are characterized by the presence of large, thick, warty spindles longer than the large double-clubs.

XVI. **Scirpearia hicksoni**, n. sp., figs. 28–31.

It has been found necessary to establish a new species for two portions of what must have been a very long, simple colony; they are not continuous, however; and judging from the difference in the diameter of the axis in the two parts an intermediate piece of considerable length must have been lost. The base is wanting, and this must also have been some distance from the present basal part, so that the colony when complete must have been of great length.

The lower of the two parts under examination is 18 cm. in length, the upper part, which bears the tip of the colony, is 15 cm. The axis at the present base is 2·5 mm. in diameter, and tapers after 18 cm. to 2 mm. In the upper portion the axis tapers from 1·5 mm. to a fine point. Thus we see that the part of the colony having an axis varying from 2 mm. to 1·5 mm. is wanting; and this at the lowest estimate cannot have been less than 18 cm., so that, without taking into account the basal part, the colony could not have been less than 50 cm. In all probability the total length would have exceeded 70 cm., so that we are dealing with a very long, simple flagelliform colony.

The surface of the coenenchyma is coarsely granular, and, especially on the verrucae, there are numerous ridges formed by aggregations of spicules (cf. *Suberogorgia ornata*, Thomson and Simpson). The coenenchyma proper is extremely thin; but the large size of the verrucae renders this feature less evident.

The general colour of the colony is brick-red; but where the anthocodiae are not retracted they appear as white specks on the tips of the verrucae.

The polyps have a very characteristic arrangement; but this cannot be regarded as specific, as it is only superficial, and may have been caused during the process of killing.

In the lower portion of the colony about one-third of the surface is bare; and the verrucae seem to arise in the same plane on either side, and are continuous with it (fig. 28). This, of course, causes a crowding on the other two-thirds. On the side diametrically opposite the above bare space there is also a tract devoid of polyps (fig. 29). In the upper portion this arrangement is still visible; towards the tip of the colony, however, the polyps seem to be distributed all round the coenenchyma; but a trace of the bilateral arrangement is still discernible (fig. 30).

The verrucae are large and have the form of truncated cones; they stand perpendicularly to the coenenchyma. The largest are 4 mm. in height and 2·5 mm. in diameter at the base; but towards the tip of the colony they are only 2·5 mm. in height and 1 mm. in diameter.

The larger of the verrucae are markedly conical; but the younger forms are very much flattened owing to the contraction of the thin walls; they are then less definite in position; and many have their tips either incurved or directed upwards. When partially retracted they have a very marked eight-rayed structure at the summit, and show eight to twelve longitudinal ridges formed by segregations of spicules.

The anthocodiae are very minute; the tentacles are short and white, and bear one row of pinnules. They are first infolded, and then the tip of the verruca is introverted.

The canal system is typical; and the two main canals are evident in a cross-section, corresponding to the two bare spaces. There is no inequality in their size, so that we are justified in concluding that the apparent arrangement of the polyps is due to contraction while killing.

The axis is cylindrical and very densely calcareous; it is composed of concentric laminae. Near the base it is dark brown in colour; but in the younger part it is of a golden-yellow hue. The surface is marked with irregular longitudinal striae which correspond to the inner series of canals. There is no suggestion of two depressions larger than the others.

The spicules of this species are very characteristic (fig. 31). They are very regular in outline, and are covered with warts, which are slightly papillose at the summit. The elongated double-clubs are extremely blunt at the ends.

The following are the chief types, with measurements, length by breadth, in millimetres:—

(*a*) Large double-clubs with a short broad constriction. The ends are almost hemispherical; the warts are few in number, large and papillose: 0·08 × 0·05; 0·075 × 0·055; 0·075 × 0·05.

(*b*) Smaller double-clubs very similar to the above: 0·06 × 0·03; 0·05 × 0·025.

(*c*) Elongated double-clubs with round ends. In some of these the constriction is very marked, while in others it is hardly visible, so that this type passes through double-spindles to simple-spindles. They are covered with few, large, papillose warts: 0·11 × 0·045; 0·11 × 0·035; 0·1 × 0·04; 0·085 × 0·035; 0·07 × 0·02.

Locality.—Andamans, 36 fathoms.

XVII.—**Scirpearia verrucosa** n. sp. Figs. 32 and 33.

In the Indian Museum Littoral Collection there occurs a complete simple flagelliform colony, 27 cm. in length, attached to a piece of shell, for which the establishment of a new species has been necessary. The coenenchyma is very thin, and the surface is granular; its maximum thickness is about 0·75 mm.

The general colour of the colony is salmon-pink; but the anthocodiae and the tips of the verrucae, when only slightly retracted, are white. The distribution of the polyps is identical with that in *Scirpearia hicksoni* n. sp.

The lower 4 cm. bear no polyps ; this is followed by two bare tracts which diminish to two distinct lines from which the verrucae diverge at acute angles.

The verrucae have the form of truncated cones ; but the walls are very thin, and even near the base they have collapsed, and present the appearance of those near the tip in the previous specimen. Throughout the whole of the colony they are directed slightly upwards (fig. 32), and the tips are incurved; this is more marked towards the apex. Near the growing point they are wart-like. The largest of the verrucae are 2·5 mm. in height and about 1·5 mm. in diameter at the base.

The canal system is identical with that described in the previous specimen.

The axis is cylindrical, but tapers slightly towards the tip; it is greenish brown near the base, but becomes pale yellow in the younger portion. It is not very calcareous, and the surface has only very indefinite longitudinal striae.

The spicules (fig. 33) of this species are extremely characteristic; they are covered with long papillose warts, which are for the most part widely separated, and so give a very irregular outline to the spicules. The ends of the elongated double-clubs and double-spindles are markedly pointed, and have the form of elongated cones.

The following are the chief types, with measurements, length by breadth, in millimetres :—

(*a*) Double-clubs with a short, broad constriction, with almost hemispherical ends and with large, slightly papillose warts: 0·095 × 0·05; 0·09 × 0·045; 0·08 × 0·05; 0·07 × 0·04.

(*b*) Elongated double-clubs approaching double-spindles and even-spindles; these have markedly conical ends; the constriction may be more or less definite; and they are covered with relatively distant, long, papillose warts: 0·114 × 0·04; 0·13 × 0·035; 0·11 × 0·03; 0·11 × 0·02.

Locality.—Andamans Sea, 55 fms.

XVIII.—**Scirpearia anomala** n. sp. Figs. 34 and 35.

This species has been established for a small, complete, simple colony in the Littoral Collection of the Indian Museum. It is 17 cm. in length, attached to a piece of decayed shell which is overgrown with Polyzoa and worm-tubes. The diameter of the colony near the base is 1·75 mm.; midway it is 2 mm., while near the apex it is 1·5 mm.; so that there is only a slight gradation.

The coenenchyma is moderately thin and finely granular; the general colour of the colony is orange-yellow; but the verrucae are reddish.

The polyps are confined to two longitudinal, lateral tracts, separated by two bare spaces. Near the base of the colony, and also in the younger part near the tip, there is a single row of polyps in each series; but in the middle part there are two irregular rows, owing to crowding and the interposition of young polyps.

The verrucae, when only partially retracted, are cylindrical, elongated, and slightly turned towards the coenenchyma (fig. 34*b*). Near the base (fig. 34*a*) and the tip (fig. 34*c*) they are almost completely retracted, and then appear as low warts, and may even be sunk within pits in the coenenchyma. The great majority of the verrucae are directed upwards, but some are turned downwards. When expanded they are about 1·25 mm. in height and 1 mm. in diameter at the base.

The canal system is typical: the two main longitudinal canals are only slightly larger than the others.

The axis is cylindrical, tapers only slightly, and is calcareous. The colour varies from brown to yellow; the surface is marked by faint longitudinal striae.

The spicules of this species (fig. 35) are very characteristic. They consist of double-clubs, double-spindles, and some which approach spindles. They are not densely covered with warts; while the warts themselves are only slightly papillose.

The following are the chief types, with measurements, length by breadth, in millimetres:—

(*a*) Small double-clubs, with almost hemispherical ends, and irregularly covered with small papillose warts and with a short, broad constriction: 0·061 × 0·042; 0·06 × 0·04.

(*b*) Slightly elongated double-clubs very openly warted and with relatively blunt ends: 0·11 × 0·06; 0·095 × 0·046; 0·099 × 0·049.

(*c*) More elongated double-clubs, approaching double-spindles and even spindles. The ends are markedly conical, and the constriction is more or less definite: 0·015 × 0·034; 0·08 × 0·03.

Locality.—Andamans.

Pectinata Group.

This group is easily distinguished by the character of the spiculation, but also, and more readily, by its unique type of branching.

XIX.—**Scirpearia pectinata** emend. Figs. 36–45.

Keratophyton seba		Thesaurus, t. 111, p. 193, Pl. cv., fig. 19.
Gorgonia pectinata		Pallas, xxvii., p. 224.
,,	,,	Pallas, xxviii., p. 179.
,,	,,	Lamarck, xxiv., t. 11, p. 320, et 2nd edit., p. 498.
Pterogorgia	,,	Dana, cxi., p. 652.
Ctenocella	,,	Valenciennes, xlvi., p. 14.
,,	,,	Milne-Edwards and Haime, xxvi., t. 1, p. 185.
,,	,,	Ridley, xxxiii., p. 348.
,,	,,	Studer, xxxvii., p. 119.
Gorgonella	,,	Kölliker, xxiii., p. 140, Pl. XVIII., fig. 41.

This species, as we have already pointed out, is the sole representative of the genus formerly known as Ctenocella; so that the diagnosis of that genus in the early records summarizes the specific characters.

Valenciennes, in establishing the genus (Comptes Rendus, t. xli., p. 14), gave the following generic diagnosis:—"Le sclérobase s'allongeant en baguettes droites et pectinées d'un seul côté de la tige principale."

Milne-Edwards and Haime in 1857 refer to the genus as follows:—

"Polypiéroïde s'allongeant en baguettes droites et pectinées d'un seul côté"; and also: "Polypiéroide dont la tige et les branches sont cylindriques et ressemblent beaucoup aux Juncelles. Sclérenchyme sub-verruqueux. Couleur jaune-rougeâtre.

"*Localité.*—Mers de l'Inde."

Wright and Studer (l., p. lxvi) gave the following diagnosis:—

"The colony is branched in one plane; and so that all the simple twigs arise in an ascending order from the upper surface of the stem. The verrucae are short on two sides of the twigs. There are distinct median furrows. The spicules are warty double-clubs; those of the polyp-calyces are, according to Ridley, somewhat different from those of the coenenchyma, being longer and provided with two, often three, whorls of tubercles. The inner whorl so approach in the middle of the spicules that the median naked zone which is characteristic of the spicules of the coenenchyma is here absent."

With regard to the "Alert" specimens, Ridley says:—"The front and back of the two main (outer) branches are bare of polyps for from one-third to half their length from their origin. The verrucae are but slightly prominent on the outer branches. The colour is pale salmon."

Localities.—Warrior Reefs, Torres Straits, 12 fathoms.

Of the spicules he says:—"The verrucae spicules show a modification of the same type as those of the general cortex, being only more elongated than those, and bearing two or sometimes three distinct whorls of tubercles, besides a few median terminal ones on each half of the spicule; the two inner whorls almost meet in the middle, so as to obliterate the median bare zone, which is characteristic of the cortical spicules."

While working on the coast of Lower Burmah I was fortunate in obtaining a large number of this very interesting species; and these have formed the basis of a somewhat detailed study. The following table gives a few of the measurements of some of these; and notes have been added where it was considered necessary. Taken in conjunction with the various paragraphs which follow, it may serve to elucidate the more important characters of this species.

TABLE A.

Specimen.	Main Stem.		Primary Branches.				Secondary Branches.					Notes on secondary branches	Angle at which primary branches arise	"Spread," i.e. between tips of primary branches
	Length	Diam.	Lengths		Diameters (base)		Diameter (tip)		Number on primary		Length of longest			
			1	2	1	2	1	2	1	2				
	cm.	cm.	cm.	cm.	mm.	mm.	mm.	mm.			cm.			cm.
I.	3	10·5	53	47	8	8	4	4	44	39	80	Some give rise to tertiaries: in some cases all to inner surface, in others irregularly.	Main branches arise at about 45°	90
II.	2·5	8·5	55	28	7	7	2	2	35	14 + 14	? broken	A large number give rise to tertiaries.	60°	54
III.	3	6	44	39	4·5	5·5	2	2	41	38	35	All are simple.	Primaries arise at 45°	60
IV.	2·5	7	32 +	37 +	6	8	?	?	24 +	35 +	?	All are simple.	60°	44
V.	10	5·5	39	20	5·5	5·5	2	2	35	18	?	Many branched laterally; all directed inwards.	50°	46
VI.	3	7	57	47	7	5	2	2	41	26		Branched as in V.	60°	46
VII.	7	7	48	39	8	7	2	2	52	40	40	All are simple.	45°; colour white	67
VIII.	4	5	38	34	4·5	4·5	1·5	1·5	23	21	31	All are simple.	45°	48
IX.	13 +	6	27	27	5	5	1·5	1·5	19	17	25	One of the secondaries is branched.	90°	58
X.	4	5	33	34	5	3	1·5	1·5	27	11	33	Many are branched.	60°	53

The following notes on some of the aberrant specimens may serve to give an idea of the inherent specific character:—

II. One of the primary branches has been broken off after a distance of 28 cm.: but the branch which arises nearest that point has developed twigs on the inner side, and has so continued the general development as if primary.

VII. One of the primary branches, along with the first two secondaries which arose from it, has been broken off; but the fourth has taken its place, and continued the regular development of tertiaries just as if they were secondaries.

IX. One of the primary branches is only feebly developed, and has six short slender secondaries. The second secondary has developed tertiaries after the manner of a primary.

X. A similar mode of development to that described for II. has taken place in this specimen.

Branching.—The branching of this unique type is extremely characteristic. The main stem is usually very short, and gives rise to two branches dichotomously; these arise at varying angles in the different specimens. In some they lie almost horizontally (fig. 36); in others they are inclined at 45° (fig. 37), or even 60° (fig. 38), to the horizontal. In a typical specimen these primary branches give rise to secondaries on the upper inner aspect in a symmetrical manner, giving a distinct comb-like arrangement. The angle at which these arise is very characteristic. When colonies are preserved in spirits or dried, they usually contract, so that the secondary branches overlap on either side (fig. 39); but a study of these, when immediately taken from the water, shows that this does not occur when growing freely. In this condition all the secondary branches stand vertically, and arise from the primary branches at an angle complementary to that at which the primary branches arise from the main stem. Thus if the primary branches are horizontal, the secondary arise at right angles; if the primary branches arise at an angle of 60° from the main stem the secondary branches come off at an angle of 30°. Stages between these are of course not infrequent. Fig. 3 shows the habit of a colony in the contracted condition, while figs. 36–38 show different angles of origin.

Secondary complications sometimes occur in the branching, but it is noteworthy that these tend to follow the type already described. For example, in several specimens one of the primary branches has been broken off; but the secondary branch which arose at this point has developed tertiary branches in a manner analogous to the primary branch (fig. 40). Occasionally also the majority of the secondary branches may be only feebly developed, but one may give rise to a large number of tertiaries. Sometimes, for no apparent reason, tertiaries may arise from the secondary branches; but in all cases these arise on the *inner* side and ascend vertically, thus maintaining the specific type of branches (fig. 41).

Main Canals.—In every tertiary and secondary branch there are two large canals running from end to end; these correspond with the bare portions of the coenenchyma, and are consequently in the plane of branching. In dried specimens their position is usually denoted by a groove due to the collapse of the canal walls. In young colonies and in the upper part of large colonies these secondary canals unite with the canals in the primary branch, one on either side; but towards the base of older colonies they do not all unite; but the last three to ten may run parallel in the primary branches, and so pass into the main stem, where as many as twenty may be visible (figs. 42 and 43).

Distribution of polyps.—In no case do polyps occur on the main stem. On the primary branches they are restricted to the outer aspect, i.e., the side diametrically opposite the one from which the secondary branches arise. On the secondary branches they are disposed on the two inner surfaces—i.e., the surfaces in the plane of branching are bare (fig. 44). In the upper half of the secondary branches, however, the polyps may encroach on the bare spaces, and appear as if distributed all over the coenenchyma.

Nature of the verrucae.—In the younger parts of the colony the verrucae are low and dome-like; but in the older portions they seem to become smaller, and in the lowest parts may appear as pit-like depressions.

Fig. 1 shows the structure of an expanded polyp.

Spicules.—The spicules of this species might be said to consist almost entirely of double-clubs, or, at any rate, of double-clubs and double-spindles (fig. 45). It is possible to group these into several distinct types which *may* show an evolution-series. It is noteworthy, however, that all are practically of the same length, so that it is improbable that they are different stages in development. The following groups, with their measurements, length by breadth, in millimetres, may be distinguished:—

(*a*) *Double-clubs* with hemispherical ends and a narrow bare constriction definitely marked off: 0·057 × 0·038; 0·053 × 0·053; 0·053 × 0·034.

(*b*) *Double-clubs* with the "heads" much more open than in (*a*), i.e., there is a distinct whorl of warts on either side of the constriction, and the "hub" is very warty: 0·057 × 0·038; 0·057 × 0·034; 0·057 × 0·031.

(c) *Double-clubs* with still more open "heads," i.e., one whorl of warts on either side of the constriction, and the "hub" with only about three warts. These approach *double-wheels*: 0·057 × 0·038; 0·057 × 0·034; 0·053 × 0·031.

(d) More slender *double-clubs* with a proportionately longer constriction, and with no definite arrangement of the warts of the "heads," which might be termed divaricate: 0·053 × 0·031; 0·053 × 0·027.

(e) More elongated *double-clubs* which approximate to *double-spindles*. The warts are large, but have no definite arrangement: 0·061 × 0·023; 0·057 × 0·023; 0·057 × 0·021.

(f) *Double-spindles* not markedly warty (in some there is hardly any constriction): 0·057 × 0·019; 0·057 × 0·017; 0·057 × 0·015.

(g) The type figured as (g) is evidently a developmental form of one of the other types: 0·046 × 0·023; 0·046 × 0·022.

A small portion, about 20 cm. long, of a primary branch of what has evidently been a large colony occurs in the Littoral Collection of the Indian Museum: twenty-seven secondary branches arise from it; all are simple except one which is dichotomously branched; the longest is 17 cm. in length.

The surface of the coenenchyma is granular; the thickness attains a maximum of 1 mm.

The polyps are disposed irregularly; on the primary branch there is one distinct bare tract, with a fairly deep groove, the other is not so evident; on the secondaries it is almost impossible to detect a bare streak.

The verrucae when expanded are slightly adpressed to the coenenchyma; when retracted they are low and dome-like. They are very small, being about 1 mm. in diameter at the base, and varying from 0·5 to 1 mm. in height.

The canal system is typical of the species.

The axis is cylindrical and yellowish; it is composed of concentric laminae, and there is a distinct white core which is more calcareous than the outer laminae. There is a slight trace of grooving on the surface. The anthocodiae and spicules agree in every detail with those described for the species.

Locality.—Andamans.

Note.—This specimen is described in the table given in the Indian Ocean Littoral Alcyonaria Report (Thomson and Simpson) as specimen M.

Distribution:—

Indian Ocean (Pallas).
Seas of the Moluccas (Lamarck).
India and China (Gray).
Cuba (British Museum Collection of H. Christy).
Off North-West Cape, West Australia, 3-4 fathoms (Studer).
Torres Straits (Studer).
Cuba (Ridley).
Warrior Reef, Torres Straits, 12 fathoms (Ridley).
Mergui Archipelago, Burma.
Andamans (Ind. Mus. Litt. Coll.).

ELONGATA GROUP.

This group is easily differentiated from the others by means of its spiculation. The spicules are characteristic and very minute.

XX.—**Scirpearia elongata** (figs. 46–48).

Gorgonia elongata Pallas, xxviii., p. 179.
Gorgonia elongata Esper, vii., t. lv.
Gorgonia elongata Lamarck, xxiv., t. ii., p. 220, 2nd ed., p. 499.
Gorgonia elongata Dana, iii., p. 664.
Juncella elongata Valenciennes, xlv., p. 182.
Juncella elongata Valenciennes, xlvi., p. 14.
Gorgonia elongata Ellis and Solander, vi., p. 96.
Juncella elongata Milne-Edwards and Haime, xxvi., i., p. 187.
Juncella elongata Kölliker, xxiii., p. 140.
Ellisella elongata Gray, x., p. 287.
Ellisella elongata Gray, xi., p. 481.
Ellisella elongata Gray xii., p. 25.
Ellisella coccinea Gray, x., p. 287.
Ellisella coccinea Gray, xi., p. 481.
Ellisella coccinea Gray, xii., p. 26.
Nec. *Juncella elongata* Hickson, xiii., p. 85.
Nec. *Juncella elongata* Thomson and Henderson, xl., p. 81.

This is a very old species, but one which has caused more trouble to systematists than any other in the group, owing to the fact that the spicules have hitherto never been investigated. The descriptions, based on a few superficial characters, are so vague that on these alone it is possible to identify almost any branching Gorgonella with this species.

It is very doubtful if the long list of synonyms given here were in all cases correctly identified; but in the absence of the specimens themselves, it is better to retain them until definite information on this point is forthcoming.

While examining the Alcyonaria in the Museum of the Royal College of Surgeons, London, I came across a beautiful specimen labelled *Gorgonia elongata* (Reg. No. 184), belonging to the Hunterian Collection, of which the following description occurred in the catalogue:—"It consists of a short, broad stem, from which seven main branches arise; these, after proceeding about 6–7 inches, give off a branch which proceeds upwards nearly parallel with the main stem, and about equal to it in thickness. The crust is of a vermilion colour; and the polyp-cells are very numerous and arranged in alternate rows, especially towards the free extremities of the branches, which are all more or less flattened. The axis is of a light yellow colour, and of a small size in comparison with the crust."

Habitat.—West Indies.

As this is the oldest authentic specimen bearing the specific name *elongata*, I have considered it advisable to resuscitate this old species, give it some positive content, and regard this specimen as the type. For this purpose, Dr. Burne has supplied me with a beautiful photograph of the colony and also a sketch drawn with a "camera lucida," on which fig. 46 is based. Preparations of the spicules have also been made for the first time, and fig. 48 gives the chief types which occur.

In the collection of Gorgonellids in the British Museum, there is a very delicately branched colony which Gray referred to the species *Ellisella* [illegible], established by him in 1857, with the following diagnosis:—"Coral furcately branched; branches sub-cylindrical, very long, virgate; bright scarlet." The spicules of this specimen are identical both in types and measurements with those of the specimen in the Hunterian Collection (figs. 47 and 48), and an examination of the general habit of the two colonies will at once render it obvious that they cannot be regarded as distinct. Both the specimens are from the "West Indies."

The type specimen (fig. 46) is almost 1 metre in height, and is complete. There is a large spreading basis of attachment from which a very thick stem about 12 mm. in breadth arises. The branching commences almost at the very base. One of the primary branches is 4·1 mm. in diameter; but the secondary branches, at a considerable distance from this, have a breadth of 4 mm.; about the middle of the colony the smaller elongated branches are 3·5 mm. in diameter, and at 8 cm. from the tip they are 2 mm. in diameter. There is considerable anastomosis in the lower part.

The branching is distinctly dichotomous, and the branches enclose an acute angle; this is also very marked *Ellisella coccinea.*

The coenenchyma is very thin, and in the dried state extremely brittle; it is densely spiculose.

The canal system is not easily recognized, owing to the fact that both the specimens are very old, and have been preserved in a dry condition; but it is still possible to detect two large longitudinal canals. Their position is, however, very marked externally.

The polyps are disposed throughout the whole colony in two very definite longitudinal series, separated by very wide and distinct bare tracts, which, in the lower region, are depressed and furrow-like. In the older branches there are four to six rows of polyps in each series; these are situated in what appears to be diagonal arrangement. In the younger branches and twigs the number diminishes to two, and eventually to a single row situated laterally and irregularly alternating.

The verrucae are slightly elevated, with the oral aperture directed upwards, but they are very much shrivelled, owing to desiccation.

The axis is typically Gorgonellid in structure, and is very hard, especially in the lower portions. The fact, however, that the specimens are dry renders the axis harder and more brittle.

The spicules of this species are extremely characteristic and very minute. They consist of (1) small double-clubs with closely set, almost smooth warts; (2) double-clubs with more irregular heads; (3) small, slender, elongated double-clubs; and (4) spindles. (See figs. 48 and 48A.)

The following are some of the measurements, length by breadth, in mm.:—

(1) 0·068 × 0·042; 0·065 × 0·042; 0·053 × 0·038.
(2) 0·061 × 0·03; 0·057 × 0·025; 0·057 × 0·03.
(3) 0·061 × 0·023; 0·061 × 0·019; 0·057 × 0·015.
(4) 0·06 × 0·023; 0·058 × 0·015.

Locality—West Indies.

FLAGELLUM-GROUP.

This is a very distinct group, and is characterized chiefly by the nature of the spicules. These are remarkable for the great length of the constriction, the open disposition of the warts, and the almost smooth nature of the latter.

XXI.—**Scirpearia flagellum** emend. Figs. 49–60.

1863.	*Juncella flagellum*	Johnson, xviii., p. 505.
1864.	„ „	„ xix., p. 142.
1870.	*Viminella* „	Gray, xii., p. 29.
1881.	*Scirpearia* „	Studer, xxxvi., p. 558.
1891.	„ *ochracea*	Studer, xxxvi., p. 559.
1901.	„ *flagellum*	Studer, xxxviii., p. 53, Pl. IX., figs. 1–3; Pl. XI., figs. 10 and 11.
1901.	„ *ochracea*	Studer, xxxviii., p. 53, Pl. IX., figs. 4–6.
1909.	„ *flagellum*	Thomson and Russell, xliii., p. 163, Pl. 8, fig. 2.

This is a very old species, and was originally referred to the genus Juncella. In 1870 Gray assigned it to his new genus Viminella; but with no apparent reason, and without giving any further specific content. He, however, gives as a synonym, *J. calans* Verrill; but as this was based on purely external characters, it is extremely doubtful whether much stress can be laid on the identity with the latter species. We have for this reason excluded it from the list of synonyms. In 1901 Studer rehabilitated the species, and gave a description of the spicules and, also, very good figures of the colonies. He referred the species to the genus Scirpearia. He, however, established another species—namely, *ochracea*, which cannot now be regarded as distinct from that under consideration, and which we therefore give as a synonym.

With regard to *Juncella flagellum*, Johnson, in establishing the species, says:—

"I have ventured to assign this coral to the genus Juncella. Valenciennes, a naturalist for whom I entertain the highest respect, considers it to be the *Scirpearia mirabilis* of Cuvier. There is, however, so much doubt as to what the coral so named by the illustrious Frenchman really is, that I hesitate to ascribe mine to that species—the more especially as it clearly falls within the definition of the genus Juncella[1] (as it appears in the "Histoire Naturelle des Coraillaires" of Milne-Edwards, vol. I., p. 186), forming a member of the section of Gorgonellaceae, which is made up of Gorgoniform corals having a smooth bark and a sub-lithoid axis, containing so much carbonate of lime as to effervesce in muriatic acid. From *Juncella juncea* Esper and *J. vimen* Val. (species found at the Island of Bourbon) it

[1] The introduction of the study of spicules has, however, removed it from the genus Juncella, from the fact that it contains no club-shaped spicules.

would seem to be distinguished by the large size of the cup-bearing papillae; from *J. elongata*, a Mediterranean species, by its being simple, not branched."

The original description of the species is as follows :—

"Simple, elongated, slender, flexible, slightly twisted on its own axis, and tapering upwards. Bark calcareous, white, smooth, and impuncturate, enveloping a hard, grey axis, which has a somewhat polished surface, marked with straight striae. The axis is highly charged with carbonate of lime. The coral is quadrangular in section, and has on each of the two narrower sides two series of closely set papillae, having the eight-lobed orifices of polyp cells at their apices. These papillae are obpyriform or ovate; and in dried specimens they are turned upwards and adpressed to the stem. Near the base of large specimens the papillae are in three somewhat irregular rows. The other two sides of the stem are free from papillae; but there is a slightly elevated line along the middle. The base spreads out to a moderate extent upon the object to which it is attached. The spicula of which the bark is composed are tuberculated staves, two or three times as long as broad, the tubercles having a tendency to collect at the extremities.

"The longest example of this coral which I have seen measured about 7 feet in length; and it was without its basal portion. The greatest thickness was three-eighths of an inch; the largest papillae were the tenth of an inch in length, and about the same across. In another example, 5 feet in length, the base spread out to the size of a shilling; and the papillae commenced about 3 inches above this basal expansion. The smallest specimen that has occurred was 31 inches long; this is in the British Museum. In the collection of that establishment there is a large stone, with numerous specimens of this coral[1] upon it, alongside examples of *Caligorgia verticillaris* Gray (*Primnoa verticillaris* Milne-Edwards). These were brought from St. Michael's, one of the Azores, and presented to the Museum by Mr. McAndrew."

Studer (xxxviii.) adds the following note with regard to the "Monaco" specimens :—

The colonies are long and flexible, and attain a length of 650 mm. The polyps are club-shaped, slightly inturned towards the axis; they are arranged on two sides of the stem; in the lower part in several rows; but towards the tip in a single row, alternating on the two sides. The spicules are spindles and double-clubs. Their dimensions are 0·067 × 0·015 mm.; 0·061 × 0·0154; 0·056 × 0·015; 0·067 × 0·025.

The colour varies from whitish yellow to red.

[1] It is, of course, doubtful whether these are really *J. elongata*, as it would be impossible to decide their specific or even generic position by a superficial examination.

Locality.—To the east of Graçiosa, Azores, 454 metres.
To the east of Pico, Azores, 318 metres.

With reference to *S. ochracea* Studer (xxxviii.) makes the following observations:—

This species is more delicate than *S. flagellum*. The axis is calcareous; white; rigid near the base, flexible near the tip. The polyps occur on two sides of the stem; towards the base in two irregular rows, but merging into only one row on each side. They have the shape of cylindrical warts or truncated cones, and stand almost perpendicularly to the coenenchyma. They are 2 mm. in height, and about 2 mm. in diameter at the base. The spicules are very like those of *S. flagellum*; they consist of double-clubs, with large warts and spines at the two ends: sometimes of a yellowish ochre, sometimes of a white colour. They are slightly larger than those of *S. flagellum*.

The colour of the colony is yellowish brown to orange.

Taking into consideration what has already been seen with regard to variation in the group, we see no reason for separating this off as a distinct species.

Locality.—To the east of Piço, Azores, 318 metres.

We have examined a beautiful, whip-like colony, 37 cm. in length, from Naples,[1] which we refer to this species. The diameter near the base is 2 mm.; but near the tip it is only 1 mm. It gradually tapers upwards, but the terminal 25 cm. are almost uniform in thickness throughout.

The coenenchyma is very thin and finely granular; the surface is marked by longitudinal ridges and furrows, which are the outward expression of the internal canals; two of these are much deeper than the others. The general colour of the colony is reddish orange, but the tips of the verrucae are distinctly more reddish.

The lower 2·5 cm. of the stem are devoid of polyps; this is followed by two opposite longitudinal bare tracts which persist to the tip of the colony. On the other two sides the polyps are disposed in a single row in each series. This gives the colony a very markedly bilateral appearance. The verrucae are cylindrical, tall, and narrow. They average 2 mm. in height and 1 mm. in diameter. They stand sometimes in opposite pairs; but the more common arrangement is alternate. The polyps on the same side are separated by distances of about 3·5 mm. The verrucae are longitudinally striated; and the summit has a very definite eight-rayed structure. They stand almost

[1] This specimen was given to me for identification by Professor J. Arthur Thomson, who suggested that it might be incorporated in this memoir.

perpendicularly in many cases; but more frequently they are slightly turned towards the stem (fig. 49). A very noteworthy feature in this connexion is to be observed. The colony has been broken and preserved in two portions. In the longer upper part the polyps are nearly all directed towards the tip; while in the lower part they are almost all turned downwards. Taking these points into consideration, it may be inferred that the verrucae have power of rotation through 180° both longitudinally and vertically, or, in other words, the anthocodiae may take up any position on the surface of a hemisphere whose radius is the length of a polyp.

The canal system is well developed, but there are very few canals, owing to the small number of polyps which occur on the colony. The two main canals are very large; and their position is indicated on the surface of the coenenchyma by two very delicate depressions on the axis; also by two grooves larger than the others.

The axis is hard and densely calcareous; it is yellow in colour; and the surface is marked by longitudinal ridges and furrows.

Attached to the colony is a young bivalve (probably *Pteria macroptera*).

The spicules of this specimen consist of the following types (fig. 50):—

(1) Double-clubs with a long, narrow constriction, and with almost hemispherical ends. The warts are irregularly disposed, are few in number, and are almost smooth: $0{\cdot}07 \times 0{\cdot}03$; $0{\cdot}065 \times 0{\cdot}03$; $0{\cdot}065 \times 0{\cdot}023$.

(2) More elongated double-clubs with the same characteristics, and with blunt ends.

A noteworthy feature about this specimen is the fact that there are very few double-spindles or types with conical ends.

Locality.—Naples.

We have also referred to this species a specimen in the Cape Collection. The spiculation is typical; and the only difference is the very close disposition of the verrucae. We have shown, however, that this is a character in which the species shows great variability. It is a very characteristic colony, growing on a piece of branching coral (like Lophohelia) (fig. 51). It is 9 cm. in length, and bears one branch (which has been broken) at a distance of 2 cm. from the base. The coenenchyma is thin and coarsely granular. The general colour of the colony is creamy-white.

The lower 2·5 cm. of the main stem and also the part of the branch which is present (1·5 cm.) are devoid of polyps. On the remainder of the main stem the verrucae are disposed on two sides, and alternate almost regularly. They have the form of flattened domes, and give the sides of the colony a very undulating appearance (fig. 52). Their bases meet in the middle line. The tips of the verrucae have a very definite eight-rayed structure. Fig. 53 was made from a longitudinal section through the colony to show the attachment of the strong retractor muscles of the anthocodiae.

The canal-system is typical, but the inner portion of the coenenchyma, that is to say, the portion between the two longitudinal series of canals, is very minute.

The axis is pale yellow in colour, and very flexible; the surface is marked by indistinct longitudinal striae. The spicules (fig. 54) of this specimen are typical of the species, but are on the whole larger and broader.

Locality.—Buffalo River, East London, N., 15 miles, 310 fathoms. Bottom, coral and mud.

In the Cape Collection there are also a number of small young colonies, which are extremely interesting, and which are undoubtedly young forms of this species. The longest of these is 7·5 mm. and the smallest 3·5 cm. in length. They have all the same general appearance, and maintain the relative proportions throughout, so that a short description of one colony will give the essential characters (fig. 55). All are attached to pieces of rock, coral, or shell.

The stem is about 1 mm. in diameter near the base, and only very slightly less at the tip. The coenenchyma is very thin, and finely granular; the general colour of the colonies is a bright orange-yellow.

The polyps are disposed in two longitudinal series; and although the two median bare tracts are not well pronounced, the colony has a markedly bilateral appearance. They occur in a single row in each series; but the interposition of young forms sometimes masks this distribution. They stand sub-opposite or sometimes alternately; but the young polyps tend to break this otherwise regular structure (fig. 56).

The verrucae are elongated and cylindrical; they are turned towards the stem, and are directed upwards; their surface is marked by longitudinal ridges and depressions; the apex when partially closed has a distinct eight-rayed structure; in many cases the infolded tentacles may be seen projecting around the oval opening.

The canal system is well developed; the canals are distinct but few in number; the two main canals are large. The axis is cylindrical, hard, and very calcareous; the surface is marked by very indistinct longitudinal striae.

The spicules (fig. 57) are characterized by the small number and large size of the almost smooth warts and by the very marked constriction in the double-clubs. The following are the chief types, with measurements, length y breadth, in millimetres :—

(1) Double-clubs with a very long constriction and with almost hemispherical ends. The warts are almost smooth; they are openly disposed and arranged almost in whorls: 0·068 × 0·034; 0·061 × 0·03; 0·057 × 0·027.

(2) Elongated double-clubs passing to double-spindles. There is a very distinct constriction; and the ends are markedly conical. The warts are not closely set, and are almost smooth: 0·114 × 0·023; 0·103 × 0·023; 0·095 × 0·027; 0·095 × 0·023.

Irregular forms, crosses, and scales from the tentacles also occur.

Locality.—O'Neil Peak, N.W., ¼ W. 9⅓ miles; 90 fathoms. Bottom, broken shell.

To show the varied appearance of the verrucae, we have included here three figures of specimens of *Scirpearia flagellum* in the Monaco Museum. (See figs. 58, 59, and 60.)

XXII. **Scirpearia thomsoni**, n. sp., figs. 61–63.

Juncella elongata Thomson and Henderson, xl., p. 81, Pl. I., fig. 10; Pl. IX., fig. 17.

We have no hesitation in establishing this new species for a specimen which was originally referred to the species *Juncella elongata* by Thomson and Henderson, who were compelled to base their diagnosis on the very inadequate description of this species which was available at the time of publication of the Indian Ocean Deep Sea Alcyonaria Report. At that time the spicules of *Scirpearia elongata* (*Juncella elongata*) were unknown; but an investigation of the spicules of an old specimen in the Museum of the Royal College of Surgeons, and the consequent resuscitation of that old but imperfectly known species has caused the necessity of removing the present specimen.

The colony shows several very characteristic features: for example, (1) the nature of the branching, (2) the marked rigidity of the colony, (3) the nature of the verrucae; but most of all the distinctive character of the spicules, which mark it off as a very definite and new species.

The specimen is 22 cm. in height, and is branched approximately in one plane. The branching is almost dichotomous; and the silhouette of the axis (fig. 61) gives the essential features. On the whole, the colony is very rigid, owing to the very densely calcareous nature of the axis. The coenenchyma is moderately thin, but densely spiculose; the general colour of the colony is salmon-pink.

"The axis is calcareous, rigid, and brittle; it is slightly oval in section; but in the younger portions it becomes quite cylindrical, and tapers till it is thread-like. It shows a very white core surrounded by a brownish cortex."

The polyps are disposed in two longitudinal series on opposite faces, each of which consists of from two to four irregularly alternating rows. The verrucae are low and truncate; when retracted there is a deep depression in the centre which is directed slightly upwards. This gives a very characteristic appearance (fig. 62). They are about 0·4 mm. in height and 1·5 mm. in diameter at the base.

The spicules are extremely characteristic, and quite unlike those of any other species (fig. 63). They consist of the following types, with measurements, length by breadth, in mm.

(*a*) Double-clubs with almost hemispherical heads, and with a relatively long constriction. On either side of the constriction the large warts are arranged in a whorl, while beyond this there is a very warty hub which gives the whole head a very irregular outline: 0·08 × 0·04; 0·07 × 0·035.

(*b*) Smaller double-clubs in which the whorl is not so pronounced: 0·07 × 0·46; 0·07 × 0·042.

(*c*) A peculiar type, which approximate to capstans with terminal warty projections: 0·08 × 0·04; 0·07 × 0·021.

(*d*) Elongated double-clubs with a long, narrow constriction, with the inner warts arranged approximately in a whorl, and with more or less elongated and irregularly warted hubs: 0·114 × 0·053; 0·114 × 0·046; 0·095 × 0·05.

(*e*) Double-spindles (some of these approach spindles). The ends are almost conical, and are variously covered with very irregular warts which give the whole a very ragged outline: 0·125 × 0·038, 0·11 × 0·03; 0·1 × 0·027.

Locality.—Bay of Bengal, 88 fathoms.

XXIII. **Scirpearia alba** (Thomson and Henderson), figs. 64 and 65.

Scirpearella alba Thomson and Henderson, xl., p. 82, Pl. IX., fig. 15.

This species was established for three long, incomplete specimens, of a white colour, 28, 411, and 408 mm. in length, with a corresponding diameter at the lower end of 1·75, 2·3, and 1·75 mm.

Two of the colonies are unbranched; but the largest branches at a distance of 251 mm. from the lower end.

The axis is cylindrical, hard, brittle, and very calcareous, but becomes very flexible and filiform near the tip. It is marked by a number of grooves which run up for a short distance, and also by a number of small protuberances.

The stem is oval in section, with a groove on the two flattened surfaces faintly marked in two of the specimens.

The verrucae occur *in a single row on each side of the stem*, those of one row alternating with those of the other. They are low and truncated (0·45 mm. in height), laterally compressed, with spreading basis (fig. 64).

The diameter is 1·4 mm. at the base and 0·65 mm. at the apex.

The coenenchyma is moderately thick.

The spicules of this species (fig. 65) are extremely characteristic. They consist essentially of double-clubs, which are almost as broad as long, and have a very short but extremely thick median constriction.

Their ends are almost hemispherical, and are covered with abundant rugose warts. There are also a few elongated narrow double-clubs, with more openly-warted heads, and with a longer constriction. Some of these approximate to spindles. Small, apparently developmental, forms and a few crosses also occur.[1]

The following are typical measurements of the chief types, length by breadth, in mm.:—

(*a*) Short thick double-clubs: 0·15 × 0·17; 0·15 × 0·095; 0·13 × 0·11; 0·13 × 0·095.

(*b*) Slender double-clubs: 0·15 × 0·02; 0·13 × 0·08; 0·09 × 0·03.

(*c*) Irregular or developmental forms: 0·057 × 0·02.

Locality.—Bay of Bengal, 88 fathoms.

Specific Diagnosis.

Colony simple or slightly branched, long and filiform; axis cylindrical, calcareous, and grooved; coenenchyma moderately thick; *verrucae in a single row on each side of the stem*; spicules consist essentially of short, thick double-clubs almost as long as broad and with a very narrow constriction; the ends are almost hemispherical, and are covered with densely rugose warts.

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[1] The large spindles described from the type specimen of the species are undoubtedly extrinsic.

XXIV. **Scirpearia aurantiaca** (Thomson and Henderson), figs. 66–68.

Scirpearella aurantiaca, Thomson and Henderson, xxxix., p. 311, Pl. IV., fig. 7, Pl. V., fig. 15.
Scirpearella sp., Thomson and Henderson, xxxix., p. 312.
Scirpearella divisa, Thomson and Henderson, xxxix., p. 312, Pl. VI., fig. 8.
Scirpearella aurantiaca, Thomson and Russell, xliii., p. 163, Pl. VIII., figs. 4, 6, and 9.

This species was established by Thomson and Henderson for several portions of colonies from Ceylon.

The colony is slightly branched. The axis is cylindrical in shape, very calcareous, and marked by two or three slight winding grooves in the lower portions. The general colour of the branches is yellowish-white

The verrucae occur on all sides of the branches. They are conical in shape, truncated at the tip, 2 mm. in maximum height, and 1·5 mm. in basal diameter. In colour they resemble the stem in the lower part; but the tip is orange-yellow, thus standing out against the general colour of the branches. The edges of the oral end curve inwards, and all stages, from an opening with an eight-lobed margin to a simple pore-like opening, and finally to a completely closed tip, may be seen. The polyps are all completely withdrawn into the coenenchyma.

The coenenchyma is granular in texture and only of medium thickness. It is practically composed of spindles and double-clubs.

The spicules are small in size, and measure, length by breadth, in millimetres :—

(1) Spindles: 0·06 × 0·03; 0·08 × 0·02; 0·085 × 0·03.

(2) Double-clubs: 0·055 × 0·03; 0·07 × 0·04; 0·06 × 0·04.

Locality.—Deep water outside pearl-banks, Gulf of Manaar.

Scirpearella sp., Thomson and Henderson.

We would also refer the specimen described in *op. cit.*, p. 312, to this species. It consisted of a damaged colony, broken in four pieces, attaining a total length of 48 cm. The base is present, but the tip of the colony has been lost. The main stem, after a distance of 4 cm., gives rise to a branch which has been broken off at its point of origin: a second branch arises after another 12 cm.; it is 11 cm. in length. The diameter of the main stem is 2·5 mm.; about the middle of the colony it is 1·5 mm.

The coenenchyma is finely granular, and is about 0·5 mm. in thickness throughout the entire length.

The general colour of the colony is brick-red; but the anthocodiae are white.

The base of the colony and the main stem for a short distance are devoid of verrucae, but in the polyp-bearing region they appear to occur all round the stem in rows, and so simulate a spiral arrangement. Closer examination, however, reveals two distinct longitudinal sinuous bare tracts. There are about four irregular rows in each of the polyp-bearing regions in the older parts; but in the branch, which is present, there are only two rows; while near the tip there is only one. The verrucae are small and comparatively distant. In the older part of the stem they are cylindrical, stand perpendicularly, and are about 1 mm. in height and 0·5 mm. in diameter; but in the branch they are more retracted, and almost dome-like. When partially retracted the apex is flattened, and has a distinct eight-rayed structure.

The canal system is typical; the two main canals are not much larger than the others, but are quite distinct. The axis is cylindrical, and is composed of concentric laminae; it is densely calcareous, hard yet flexible. The surface is deeply grooved, especially in the lower part. This is due to the large size of the canals of the inner longitudinal series.

Locality.—Ceylon Sea.

Scirpearella divisa.—We have examined the spicules of this species, and can find no reason for separating it from *S. aurantiaca.* The type-specimen consisted of a fragment of a reddish-orange colony with four branches, 7 cm. in height and about 2 mm. in diameter. The verrucae are very low and gently rounded; towards the end of the highest branch, where they are closely crowded and very distinct, the arrangement appears to be in four rows with a suggestion of a spiral; in the older parts the verrucae are very inconspicuous, not close together, and somewhat irregularly disposed.

The coenenchyma is finely granular, almost smooth to the naked eye, The axis is very calcareous, light yellow in colour, with ten shallow grooves on the part examined. It is about 1·4 mm. in diameter out of a total branch diameter of 2 mm.

The spicules of this species are very characteristic. They consist of:—

(*a*) Double-clubs with hemispherical heads in which the warts are arranged concentrically; the constriction is very short: 0·0684 × 0·049; 0·065 × 0·038; 0·053 × 0·03.

(*b*) Double-clubs, slender with elongated ends, tending to double-spindles: 0·084 × 0·019; 0·076 × 0·029; 0·076 × 0·023.

(*c*) Spindles—warty: 0·095 × 0·027; 0·095 × 0·02; 0·087 × 0·015.

In addition to these there are often forms which are intermediate between types (*a*) and (*b*); but these cannot be regarded as constituting a distinct type.

As we have already pointed out, the branching, as shown in this specimen, is not of a character of sufficient value for specific determination. We would therefore suggest merging it into the older species *S. aurantiaca*.

Locality.—Ceylon Sea.

In the Littoral Collection of the Indian Museum, Calcutta, there is a very long, simple, flagelliform colony which has unfortunately been broken into five pieces. The attachment is broken off, but very near the base, as is evident from the absence of verrucae at the present basal portion. The total length of the colony is over 112 cm. The diameter near the base (without verrucae) is 3 mm.; about midway it is 2 mm., while near the tip it is 1 mm.; so that the tapering is very slight.

The coenenchyma is very smooth, and is about 0·5 mm. in thickness throughout the entire length of the colony.

The general colour is brick-red; but the anthocodiae are white. Near the base of the colony there are no verrucae; but after a short distance they appear as if distributed all over the coenenchyma, and so simulate a spiral arrangement; a distinct trace of two bare longitudinal spaces is, however, clearly discernible; these tend to disappear towards the tip of the colony, owing to its extreme slenderness and the interlocking of the verrucae. There are five rows near the base in each polyp-bearing tract; but these gradually diminish to two near the tip. The verrucae are small and relatively distant. Near the base they have the form of short cylinders (fig. 66); but are often flattened, owing to the collapse of the thin walls; they are about 1·25 mm. in height, and 0·75 mm. in diameter, and stand almost perpendicularly. Towards the tip, however, they are smaller, more retracted, and appear as small domes directed slightly upwards (fig. 67).

The two main canals, corresponding to the two bare tracts, are clearly visible in a cross-section. The other canals of the inner series are relatively large.

The axis is cylindrical, densely calcareous, and very brittle. It tapers in a more marked degree than the colony itself. The colour of the lower part is brown, but the core is white. There are deep longitudinal depressions on the surface. The laminae are very thick, and may be seen with the naked eye, in spite of the small diameter of the axis.

The spicules (fig. 68) are quite typical of the species.

Locality.—Laccadives, 30–50 fms.

XXV.—**Scirpearia furcata.** Figs. 69–91.

Scirpearia furcata	Hickson, xv., p. 822; figs. 8 and 9.
Scirpearia furcata	var. (?) Hickson xv., p. 822.
Scirpearella indica	Hickson, xv., p. 822; fig. 10.
Scirpearia sp. (?)	Thomson and Henderson, xxxix., p. 313, Pl. IV. fig. 1; Pl. v., fig. 16.
Scirpearella sp. B.	Thomson and Henderson, xxxix., p. 312.
Juncella elongata	(Val.) Hickson, x., p. 821.
Scirpearella aurantiaca	Th. & Russell, p. 163.

Perhaps no species in the whole family shows so great variability or has given so much trouble as the one now under consideration. Hickson formed two new species on fragments from the Maldives, and referred one to Scirpearia, the other to Scirpearella. At the same time he hesitatingly referred some fragments to the species *Juncella elongata*. Thomson and Henderson, in the Ceylon Alcyonaria Report, refrained from naming some fragments which did not seem to agree with any of the formerly described species. They referred one to the genus Scirpearia as *Scirpearia sp.* (?), the other to Scirpearella as *Scirpearella sp. B.*, and in so doing give the following note:—

"Our impression is that the elongated forms of Scirpearella, Juncella, and the like, so monotonous in general appearance, so perplexingly different when one gets beneath the surface, are subject to great variability."

Before proceeding to differentiate the reasons upon which I have merged all these species under the earliest name it might be well to give a short description of the different specimens. Professor Hickson has very kindly sent me small portions of his *Scirpearella indica* and *Juncella elongata*, as well as the type specimen of *Scirpearia furcata* figured in his report. Professor Thomson has also placed pieces of the Ceylon specimens at my disposal. This has been of immense service to me, as only by means of a critical examination of these and other specimens to be described later, could a thorough specific determination be arrived at.

Scirpearia sp. (?) Thomson and Henderson.

A beautiful colony, 41 cm. in length. The base has been broken off, but probably not far from the present base. The main stem, after a distance of 4 cm., bifurcates, and gives origin to two long, whip-like branches; these are almost equal in length. The diameter of the main stem is 2·5 mm., that of the branches at their origin 2 mm., and near the tip 1·5 mm. There is thus only a very gradual tapering.

The coenenchyma has a very arenaceous surface, and is moderately thin.

The general colour of the colony is reddish orange; but the verrucae are distinctly red.

The polyps are disposed in two longitudinal series, each consisting of two or three transverse rows, and separated by two distinct bare tracts (fig. 69). There is no flattening of the branches, nor is there any sign of a longitudinal depression. The verrucae are low and slightly dome-like.

The axis is slender, tapering only slightly, and is deeply grooved. It is composed of concentric laminae, and is densely calcareous; the diameter at the base is 1·5 mm., but it is hair-like at the tip.

Localities.—Ceylon Seas.

Scirpearia furcata Hickson.

This species was established for two fragments from the Maldives. The larger was 90 mm. long. Both exhibited an orange-red-coloured coenenchyma, with dark red dome-shaped verrucae, closely crowded, but separated into two groups by broad, spirally directed, bare tracts. The more delicate specimen had a single branch which was bifurcated at its extremity. (See xv., fig. 8.)

Localities.—S. Nilandu, 25 fathoms; N., Male, 20 fathoms.

Scirpearia furcata var. (?) Hickson.

A specimen 200 mm. long, slightly branched, and differing from the type. It is more delicate in build, has less prominent verrucae, and the colour is not so much a pure red, but is tinged with orange.

Locality.—N. Nilandu (Maldives), 24 fathoms.

Superficially, these different specimens are hardly distinguishable. The forked specimen of *S. furcata* and the type specimen of *S. sp.* (?) are identical in colour and in the distribution and nature of the verrucae; but the branches in the former are short; while in the latter they are long and whip-like. The other specimens of *S. furcata* and the type specimen of *S. furcata var.* (?) seem, however, to form intermediate links. Let us now consider the specimens referred to *Scirpearella.*

Scirpearella indica Hickson.

This species was established by Hickson for several specimens from the Maldives with the following characteristics:—

All are unbranched. The diameter of the specimens varies very little, and is in all about 3·5 to 4 mm.; the apex is blunt. The verrucae vary considerably. In one specimen they are pointed and about 1 mm. in height at the base of the other, they are broader and less prominent. In places they have an appearance like "a shallow ledge that reminds one of the edible nests of the swallow (*Collocalia*)," similar to that described by Wright and Studer for *S. profunda.* The verrucae are arranged in six or seven slightly spiral rows.

The colour varies in the different specimens. In one the coenenchyma is white, but the tips of the verrucae are red. In another the verrucae are white throughout; but there are streaks of pink along the coenenchyma running irregularly and uniting at the base to give the coenenchyma a general pale red colour. Other specimens are entirely white.

Locality.—S. Nilandu (Maldives), west passage of Atoll, 30 fathoms.

Scirpearella sp. B. Thomson and Henderson.

A somewhat damaged colony, which has unfortunately been broken in five pieces. The base is complete, but a short piece at the tip has been lost. The total height is 28 cm.; the diameter near the base is 3·5 mm.; but near the present tip it is 1·5 mm. At a distance of 20 cm. from the base there is a distinct angular bend; it is difficult to say whether this is the origin of a branch or a growth consequent on fracture.

The coenenchyma is extremely thin and finely arenaceous. The general colour is pale-pink or salmon-pink; but the verrucae are white, and streaks of the same colour permeate the coenenchyma.

The polyps are apparently distributed all over the colony; but close examination reveals two indistinct, sinuous longitudinal bare tracts. The verrucae are low domes, and scarcely project beyond the coenenchyma (fig. 70).

Owing to the extreme thinness of the coenenchyma, the canal system is very ill-defined.

The axis is very calcareous, hard, and, in the younger parts, brittle. It is composed of very thick concentric laminae; the surface is faintly and irregularly marked by grooves.

Locality.—Ceylon Seas.

As was the case with the two species already discussed, the two now described are identical on superficial examination. Let us now proceed to investigate in what respects the two groups differ.

furcata-group.	*indica*-group.
The verrucae are separated into two longitudinal series by two very distinct bare tracts.	The verrucae are separated into two longitudinal series by indistinct bare tracts which may even disappear near the base.
There are two or three longitudinal rows in each series.	The verrucae appear as if distributed in five to seven slightly spiral rows.
The verrucae are low and dome-like.	The verrucae may be (1) long and pointed, (2) projecting ledges, (3) low and dome-like, (4), almost level with the coenenchyma.

Thus we see that, although superficially they may present very different appearances, when we investigate the various characters nothing of specific moment can be found to obtain. The question of "five to seven slightly spiral rows" resolves itself into two series of two to four rows in which the bare tracts are hardly distinguishable.

Juncella elongata (Val.) Hickson, xv., p. 821.

Hickson referred some fragments to this species, but expressed doubt as to the identification. He gave the following notes:—One specimen (in three pieces) was 315 mm. in length. The total diameter was 3·5 mm., and the axis 2 mm. in the middle region. Nearer the base the coenenchyma is relatively thin or very thin, and nearer the apex much thicker. The colour of the coenenchyma is pale pink and the verrucae are throughout shallow domes, white in colour. The verrucae are separated by distinct bare tracts into two longitudinal series. In the portion I examined there were six to seven rows in each series. Other specimens were pale red and orange-red in colour. In the latter, which was 230 mm. in length, the verrucae were scattered and prominent towards the distal end, but there is an almost smooth coenenchyma near the base (fig. 71).

The spicules are double-clubs, warted spindles, and a few more elongated spindles, with fewer tubercles arranged in regular rows. The warted spindles and double-clubs vary in length from 0·08 to 0·085 mm. Some of the pointed spindles are 0·1 mm in length. There is evidently a good deal of variation in the shape of the spindles (fig. 72).

The colour, the prominence of the verrucae, and the definiteness of pronounced tracts free from verrucae, are also characters in which the species shows much variation.

Locality.—S. Nilandu, 25 to 30 fathoms (Maldives) Hulule, Male Atoll, 25 to 30 fathoms (Maldives).

Note.—In one specimen Hickson says clubs similar to those in *J. juncea* occur: but this probably belonged to that species.

In the Littoral Alcyonaria Collection of the Indian Museum there is a portion, 35 cm., in length, of what has evidently been a long flagelliform colony; both the basal and terminal parts are wanting.

The coenenchyma is granular and moderately thick. The diameter is almost constant throughout the part under examination; it is about 4 mm., while that of the axis is 2 mm. The general colour of the colony is orange-red, but the anthocodiae are white.

The polyps are disposed in two longitudinal series separated by two narrow bare strips which become more indistinct, but still visible, towards the tip (fig. 73). These are spirally twisted; but this is, no doubt, due to a general torsion of the colony. In each series the polyps appear in rows diverging from the bare tracts; this gives a very marked spiral arrangement, but this is also due to torsion. Transversely four or five is a common number in each series. The verrucae are sub-cylindrical and closely adpressed to the stem; the outer insertion is lower than the inner. They are about 1·5 mm. in height and 0·75 mm. in diameter at the base. When retracted they are sub-conical, and have eight converging lips (fig. 74).

The canal system is very definite and typical; the two main longitudinal canals are extremely large.

The axis is yellow in colour, and markedly calcareous; the surface is apparently smooth; it tapers only slightly in the portion preserved.

Locality.—Off Table Island, Cocos Group, Andamans, 15–35 fathoms.

When we take into consideration the fact that the great majority of these forms are fragmentary, and also the slight basis on which the genera Juncella, Scirpearia, and Scirpearella were formerly differentiated, there is small cause for wonder that the various specimens were referred to one or other of these genera on account of differences which we hope to show are not specific, but only different manifestations assumed by extremely plastic organisms.

We have made a very exhaustive study of the spicules in all the forms of which descriptions have been given; and although these show certain deviations, nevertheless they may be grouped into a number of more or less definite types.

Fig. 75 gives a very good representation of the different types and deviations therefrom in the case of the spicules in the Indian Museum specimen. Fig. 72 of the spicules of Hickson's *Juncella elongata* has also been added, and a comparison of these two groups should at once indicate the affinities of these two apparently different forms. A similar comparison might be made with regard to the others with a like result.

If, then, the character of spiculation can be regarded as specific, we should be compelled to unite all these extremely divergent forms into one very variable species. This procedure may, at first sight, seem rather drastic, as, it may be argued, the different variations occurred not in each specimen but in different specimens.

They distinctly show a range of variation which cannot be easily comprehended within an individual colony.

We are, however, fortunately in the possession of a large colony which has the same characteristic spiculation, and which does actually show a range of variation as great as, if not greater than, that recorded for the individual portions hitherto described.

We therefore propose to give a fairly exhaustive account of this colony, and regard it as the type of the species in its emended form.

A beautiful colony of an orange-red colour 52 cm. in height and about 16 cm. in breadth. It is largely branched, approximately in one plane, and in a manner similar to that in *Juncella gemmacea*. It is complete to the very base; but some of the branches have been broken off. These are nearly all preserved, however; and it is possible to piece them together so as to get an idea of the nature of the colony as a whole when living (fig. 76).

The main stem has a diameter of 4·5 mm. at the base and 3·5 mm. at a height of 100 mm. where it has been broken off.

The first branch arises at a distance of 18 mm. from the base; it is 3 mm. in diameter at its point of origin, and tapers gradually to a point; it is 145 mm. in length. The second arises after another 33 mm., and attains a length of 445 mm.; it is 4 mm. in diameter at its origin, and gives rise to a secondary branch 375 mm. long after a distance of 82 mm.; the diameter of the latter is 3 mm. at its point of origin. A third primary branch comes off at a distance of 95 mm. from the base, and is 3 mm. in diameter near its origin; it is 430 mm. in length, and tapers gradually to a conical point.

The coenenchyma is thin and finely granular; it is of a pale yellow colour, but the verrucae are red. Near the base long streaks of red extend longitudinally from the verrucae and interlock, giving a peculiar tessellated pattern (cf. the type specimen of *Scirpearella sp. B.*). This feature may be seen in other parts of the colony.

The polyps are disposed on the branches in two longitudinal series, separated by two distinct bare tracts, which may be more irregular or even altogether absent.

Near the base the verrucae are only slightly elevated, and in many cases hardly project beyond the coenenchyma (fig. 77).

Near the origin of the second primary branch there are 3–5 longitudinal rows in each series; the verrucae are low and dome-like, or in some cases like bluntly truncate cones, having an eight-rayed structure at the summit (fig. 78).

About midway on the third primary branch there are 4–5 longitudinal rows in each series; the verrucae are sub-cylindrical and closely adpressed to the stem (fig. 79).

Towards the tips of the branches the number of rows of polyps in each series diminishes to two and eventually to one; the verrucae are sub-cylindrical or in some cases dome-like (fig. 80).

Thus we see that this specimen exhibits all the variation phases which are represented in the various specimens previously discussed.

The canal system is typical; the two large main canals corresponding to the two bare tracts are very pronounced.

The axis is cylindrical, calcareous, and made up of concentric laminae. It tapers gradually from the base upwards, and is fairly flexible. The coenenchyma is thus of an almost uniform thickness throughout. The surface of the axis is marked by longitudinal striae, the number of which varies in the different parts of the colony. The following are the chief types of spicules (fig. 81), with their measurements, length by breadth, in mm :—

(*a*) Small double-clubs with a narrow constriction, and with openly warted ends: 0·076 × 0·038; 0·068 × 0·046; 0·068 × 0·034.

(*b*) Smaller double-clubs with comparatively few warts on the ends: 0·065 × 0·034; 0·061 × 0·03; 0·057 × 0·038.

(*c*) Smaller double-clubs with the ends more densely covered with smaller warts: 0·046 × 0·023; 0·042 × 0·019; 0·038 × 0·015.

(*d*) Elongated double-clubs with openly warted ends: 0·08 × 0·023; 0·068 × 0·031.

(*e*) Elongated double-clubs with closely warted ends: 0·072 × 0·03; 0·068 × 0·027; 0·065 × 0·023.

(*f*) Narrower double-clubs, simulating spindles: 0·076 × 0·019; 0·072 × 0·023; 0·065 × 0·019.

Locality.—Providence Island, 29 fathoms.

In the Cape Collection there is a large number of colonies which are extremely diverse in external appearance, but all of which have essentially the same spiculation. It is absolutely impossible to differentiate these from *S. furcata*; so that I have decided to include them in this species and give a few notes on each specimen, with special reference to the variations.

In addition to the more mature colonies, there are a few undoubtedly young forms, the largest of which is only 50 cm., and the smallest 8·5 cm. in length. All are of a creamy-white colour, and form a striking annectent series, showing the various " types " of verrucae which are undoubtedly only different stages in retraction (fig. 82).

Locality.—Hood Point, N., 5½ miles, 42 fathoms. Bottom: sand and shells.

We shall commence with those forms in which the verrucae are very small, and gradually pass to those in which they are more expanded, and show that a series exists connecting the most extreme types.

A beautiful, simple colony of a pale orange colour. It is 17 cm. in length. The base is broken off and the tip is dome-like.

The coenenchyma is moderately thick, and is finely granular. The polyps are distributed over the whole of the coenenchyma; in some parts they appear as if in spirals, but they are in reality in longitudinal rows, the members of which irregularly alternate. Four of these rows may be seen from one aspect. The verrucae are extremely small, and are sunk into pits in the coenenchyma, so as to be almost level with it (fig. 83). The members of one longitudinal series are separated by distances about three to four times the length of the verrucae. The verrucae themselves are somewhat cylindrical, and have a distinctly eight-rayed summit. There is not the slightest trace of a bare tract.

The canal system is, however, typical. The two large main canals are quite prominent in a cross-section. This reminds one of the type of *Juncella juncea* with non-projecting verrucae.

The axis is lamellar, densely calcareous, and very hard; the surface is indefinitely marked by longitudinal striations.

Locality.—Off and east of Cape Morgan, 36 fathoms. Bottom: stones.

A long, simple, flagelliform colony, 50 cm. in length. The diameter near the base is 5 mm.; near the tip it is 4 mm. The coenenchyma is thick, being slightly over 1 mm. throughout. The general colour of the colony is a dull orange-red.

The polyps are distributed in two longitudinal series separated by two narrow bare tracts; there are four to seven alternating rows in each series. The verrucae are small and are closely adpressed to the coenenchyma, being sunk in pits so as to be almost level with it. They are very much retracted, however, and there is every reason to believe that when expanded they would be more than double their present length (fig. 84).

The members of one row irregularly alternate with those of the adjacent row.

The canal system is well developed, and is clearly seen in the thick coenenchyma; the two main canals are very large.

The axis is flexible, but very hard and densely calcareous; it is about 2·5 mm. in diameter near the base. The surface is marked by distinct longitudinal striae.

Locality.—Umhlangakulu River mouth, N.-W. by N., 7½ miles; 50 fathoms. Bottom: sand, shell, and sponge fragments.

An almost complete colony, 24 cm. in length, of which only the base is wanting. This specimen is extremely interesting, as it shows to what extent the polyps may be extruded in this species.

The diameter of the stem is 4 mm. near the base, but diminishes gradually to 3 mm. near the tip. The coenenchyma is thick; the general colour of the colony is pale yellow; but the tips of the verrucae and the anthocodiae are white.

The present specimen agrees in detail with the last, except in the nature of the verrucae (cf. figs. 84 and 85).

Locality.—Off and east of Cape Morgan, 36 fms. Bottom: stones.

A beautiful, complete, simple colony, 22·5 cm. in length; the coenenchyma is moderately thick and densely granular; the general colour is a bright orange-yellow; but the tips of the verrucae and the anthocodiae are white, and there are also white streaks throughout the coenenchyma.

The polyps are distributed in two lateral, longitudinal series; the bare median tracts are fairly well defined. The number of rows in each series varies from two to four. The verrucae are sub-cylindrical, directed upwards, and adpressed to the stem (fig. 86). The members of two adjacent rows alternate with one another so that the tip of one verruca is on a level with the base of the next higher in the adjacent row. The verrucae are about 1·25 mm. in height and 0·75 mm. in diameter. Near the base they are much smaller, more distant, and a few are even sunk into pits in the coenenchyma. The anthocodiae are white; the tentacles are short, but have a dense aboral armature.

The canal system is typical and well developed; the two main canals are easily seen when a piece of the coenenchyma is detached.

The axis is slender, flexible, but very calcareous; the surface is marked by longitudinal striae.

Locality.—Umhloti River mouth, N. by W. half W., 8⅓ miles, 43 fms. Bottom: sand, shells, and hard ground.

A small, complete colony, 15·5 cm. in height; is almost identical with the last specimen.

The following differences may be noted :—

(1) The colour is almost brick-red.

(2) The verrucae are slightly smaller and are more adpressed to the coenenchyma. (Both these differences are probably due to greater retraction and to the fact that the colony itself is smaller.)

Locality.—Umhloti River mouth, N. by W. half W., 8⅓ miles, 40 fms. Bottom: sand, shells, and hard ground.

In the Littoral Collection of the Indian Museum there are four filiform colonies which have the characteristic spiculation of *S. furcata*, to which species we have therefore assigned them. They differ considerably in external appearance, so that the following notes and figures (figs. 88 and 90) give some idea of the fertility of variation. Let us commence with those in which the verrucae are most contracted.

A long, simple filiform colony, 82 cm. in length, and having a maximum diameter of 2·5 mm. The coenenchyma is finely granular, and only 0·25 mm. in thickness near the base. The colour of the colony is a pale orange-yellow; but the tips of the polyps are reddish.

The verrucae are small and wart-like; when retracted they are sunk into the coenenchyma, and show an octoradiate structure (figs. 88*a* and 88*b*). The polyps are disposed in two longitudinal series, with two or three transverse, irregular rows in each series. No polyps occur on the lower basal part of the colony. The polyp-bearing areas are separated by two bare tracts, in one of which there is a distinct furrow, caused by the collapse of one of the main canals; the position of the other main canal is clearly visible owing to the extreme thinness of coenenchyma.

The verrucae are about 1 mm. in diameter.

The canal system is well marked and is quite typical of the group. The canals themselves are all very large.

The axis is cylindrical, dark brown at the base, where it is about 1·5 mm. in diameter; and pale yellow in the upper portion, where it is hair-like in fineness. The surface is marked by indistinct longitudinal furrows and ridges. Fig. 89 shows the chief types of spicules.

Locality.—Off Malabar Coast, 36 fms.

A small, complete, simple colony, 27 cm. in length, from the Andamans, also occurs in the Indian Museum Littoral Collection. It is of a creamy-white colour, and is almost uniform in thickness throughout; it agrees in detail with the last specimen from the Malabar Coast, except that each transverse row has only one polyp or occasionally two polyps. The axis is of a straw colour throughout.

The spicules are identical with those described for the other specimens.

Locality.—Andamans.

Two slender colonies, of a creamy-white colour, with projecting wart-like verrucae. The smaller colony is complete, and is 39 cm. in length; it is 2·25 mm. in diameter near the base (without verrucae), and about the middle of the colony; the basal portion which is present is 47 cm. in length. The diameter at the base is 2·75 mm., while at the broken end it is 4 mm.

The coenenchyma is granular, and moderately thin; it is creamy-white in colour.

Polyps do not occur for a considerable distance from the base; thereafter they are separated into two longitudinal series by two sinuous depressions (fig. 90*b*); the two series approach so closely together as to appear as if merged into one, covering the whole of the coenenchyma, especially towards the middle of the colony. The verrucae are low, broad, and mound-like; they are sometimes 2·5 mm. in diameter at the base. Towards the base (fig. 90*a*) they are almost level with the coenenchyma; while near the tip they are often sunk into depressions in the coenenchyma (fig. 90*c*). The opening is circular, sometimes elongated, and has eight lips around it, giving a very definite pattern.

The canal system is typical; the two main canals are large. The axis is brown at the base, but yellow in the younger part; it is composed of concentric laminae, and is markedly calcareous. There are definite longitudinal striae, especially in the older part. Fig. 91 shows the predominant spicular types.

Locality.—Off Malabar Coast, 36 fms.

Amongst the Alcyonaria collected by the writer in the Mergui Archipelago, Burma, there are six specimens which undoubtedly belong to this species. Five of these are long and flagelliform, and represent a series in development; they are very slender, and taper only slightly from base to apex. The following measurements will serve to illustrate the most salient features:—

Specimen.	Total length of colony.	Diameter of colony at base.	Diameter of colony midway.	Diameter of axis at base.	Colour.
I.	27 cm.	1·75 mm.	1·5 mm.	1 mm.	Creamy-white, but yellowish towards base.
II.	42 cm.	3 mm.	2·5 mm.	1·25 mm.	Creamy-white
III.	61 cm.	3·75 mm.	3 mm.	2 mm.	Pale creamy-white.
IV.	86 cm.	2·75 mm.	2·75 mm.	2 mm.	Creamy-white.
V.	117 cm.	4·5 mm.	3·25 mm.	3 mm.	Dull white.

The coenenchyma is very thin, as may be seen from the above measurements; it is finely granular and very compact.

The mode of distribution of the polyps is very pronounced. Two of the specimens, (namely, I. and IV.) bear the disk of attachment, so that in these the arrangement may be studied from the base. The lower portion, for a considerable distance, is devoid of polyps; in the polyp-bearing region of the colony the verrucae are distinctly separated into two series by two longitudinal bare spaces, whose position is sometimes indicated by depressions, This is especially marked towards the tip; but the depressions are continued very visibly along the non-polyp-bearing basal portion of the coenenchyma.

The number of verrucae in a transverse row in each of the two series varies according to the position in the colony. Towards the middle of the colony as many as six may occur; but this number decreases both towards the base and the apex, in each of which two or even one is the common number. Young forms occur scattered throughout the other verrucae, and the distribution is then very difficult to determine.

The verrucae are very minute and wart-like; when retracted, they are slightly sunk into the coenenchyma, and present a distinct eight-rayed figure which simulates a pseudo-operculum. In some cases they protrude slightly, and give the surface of the colony a faintly undulating appearance.

The axis is composed of concentric laminae, and is markedly calcareous; the surface varies in colour from black, through brown to pale yellow, according to its age. It tapers only very slightly.

The canal system is well developed; even in these slender specimens a cross-section, when viewed with a hand-lens, reveals the two longitudinal series. The part of the coenenchyma between these two series is very small compared with the outer non-canal-bearing part. The two main canals are extremely large in proportion to the others; and to this is due the very obvious longitudinal depressions even in the non-polyp-bearing part.

Locality.—Mergui Archipelago, Burma.

Scirpearia furcata var. **robusta.** Figs. 92–96.

We have examined two characteristic colonies, one from the Indian Museum Littoral Collection and one from the Mergui Collection. These exhibit certain differences from the other specimens of *furcata*, but for the present we would consider them as a variety of *furcata.*

The colony in the Indian Museum Littoral Collection is complete with its basis of attachment; it is 20 cm. in height and 3 cm. in breadth, and consists of a main stem from which a branch of 6·5 cm. in length arises at a distance of 6 cm. from the base (fig. 92). A second branch arose 1 cm. from the first; but this has been broken at the point of origin. The diameter of the main stem near the base is 4 mm.; near the tip it is 3·5 mm. The two branches seem to arise in planes perpendicular to one another. The stem and branch are cylindrical.

The coenenchyma proper is finely granular and thin, never attaining a thickness of over 1 mm., but about 0·5 mm. near the base. Near the tip of the main stem it has been rubbed off.

The general colour of the colony is brick-red.

On superficial examination the polyps appear to be distributed over the whole of the coenenchyma: but a minute inspection reveals a disposition in two longitudinal series separated by a sinuous line in the lower portion: this is more marked in the upper half and in the branch where a distinct depression is visible. No polyps occur on the basal 1·5 cm.

The verrucae are large and dome-like; they are about 2 mm. in diameter and 1·25 mm. in height. There is a trace of an eight-rayed structure at the summit (fig. 93). They vary very little in the different parts of the colony.

The canal system is typical; the two large main canals are very distinct.

The axis is cylindrical, very calcareous, and gives great rigidity to the colony; it is composed of concentric laminae. The colour varies from brown in the lower portion to pale yellow near the tip. The diameter near the base is over 3 mm.; it does not taper very markedly until it approaches the tip. The surface is marked by indistinct longitudinal striae.

The spicules (fig. 94) consist of double-clubs and elongated double-spindles, which in some cases approached the spindle type.

The following are the chief types, with measurements, length by breadth, in millimetres:—

(*a*) Double-clubs with a short constriction and with the warts somewhat regularly disposed: 0·08 × 0·04; 0·073 × 0·046; 0·07 × 0·042.

(*b*) Smaller double-clubs with the warts nearest to the constriction arranged in a whorl: 0·06 × 0·034; 0·045 × 0·025.

(*c*) Elongated double-spindles with irregular disposed warts: 0·1 × 0·035; 0·095 × 0·03; 0·09 × 0·03; 0·08 × 0·025.

(*d*) Spindles (like type (*c*), but with no constriction): 0·09 × 0·025; 0·08 × 0·02.

Types (*c*) and (*d*) are more abundant in the verrucae. Very characteristic is the occurrence of a large number of conically shaped elongated double-clubs and spindles.

Locality.—Andamans.

Another very characteristic, complete, simple colony, 17 cm. in length. occurs in the Mergui Collection. Externally it recalls the projecting-verrucae type of *Juncella juncea*; but the nature of the spiculation precludes this possibility. The disk of attachment is present. The diameter at the base, without verrucae, is 2 mm.; it increases in thickness very markedly.

so that near the middle of the colony it is 5·5 mm. (including verrucae); from this position to the tip it decreases, so that midway it is only 3·5 mm., while the apex itself is distinctly pointed (fig. 95).

The coenenchyma is finely granular, and, except near the base and towards the tip, it is very thick. About the middle of the colony, where the diameter of the axis is 0·75 mm., the coenenchyma is 2 mm. in thickness.

The colour of the colony is creamy-white.

The verrucae are dome-like; but the oral opening is directed slightly upwards; they are about 1 mm. in height and 1 mm. in diameter at the base. The colour is markedly flattened throughout its entire length; on each of the two flattened surfaces there is a very deep groove; these separate the polyps into two longitudinal series. In each series there is a varying number of polyps; near the base there are four transverse rows; towards the middle of the colony there are five; while from this point the number diminishes, so that near the apex there is a single row in each series. Young forms occur amongst these, however, and break the fundamental symmetry.

The canal system is well marked; the two main canals corresponding to the two longitudinal grooves are very large; in this and other respects it is characteristic of the group.

The axis is very slender; at the base it is only slightly over 1 mm. in diameter; from this it tapers gradually to an almost hair-like fineness at the tip. It is black in colour near the base, but passes through pale brown to yellow near the apex.

The spicules (fig. 96) are almost identical with those in the previous specimen, both in types and measurements.

Locality.—Mergui Archipelago, Burma.

XXVI. **Scirpearia andamanensis** n. sp. Figs. 97–101.

This new species is established for a very distinctive specimen in the Littoral Collection in the Indian Museum.

The colony is 17 cm. in height and 9 cm. in maximum breadth; it is laxly branched in one plane. The branches arise in an irregular and sub-alternate manner, and are considerably elongated. The basis of attachment is broken off at what is evidently a short distance from the actual base. The colony is shown complete in fig. 97.)

The stem and branches are cylindrical, and taper very slightly. The coenenchyma is about 1 mm. in thickness; and this is almost constant throughout the colony, being slightly thinner in the older portions. The surface is finely granular.

The general colour of the colony is ochreous-yellow; but the tips of the verrucae and the anthocodiae are white.

The polyps are distributed in two longitudinal series situated laterally—that is, on the aspects perpendicular to the plane of ramification. In each series there are from three to four irregular rows. The two bare spaces are quite distinct, and only here and there are median depressions to be seen.

The verrucae vary considerably according to the stage of retraction. When expanded they are mammilliform, are directed upwards, and adpressed to the coenenchyma. This is well seen near the tips of some of the smaller branches where the coenenchyma is relatively thicker and where they are depressed into the coenenchyma (fig. 98). When partially retracted they are wart-like or sometimes like short truncated cones standing perpendicular to the coenenchyma (fig. 99). When still further retracted they appear as small rounded projections or may be even sunk beneath the surface of the coenenchyma (fig. 100).

In all stages an eight-rayed figure is discernible. They are about 1 mm. in diameter, and may attain a height of over 1 mm.

Two large main canals corresponding in position to the bare tracts are plainly visible in a cross-section. The small canals are very numerous owing to the large number of the polyps in a transverse row.

The axis is cylindrical and calcareous. It is about 3 mm. in diameter at the base, but gradually tapers to an almost hair-like fineness. It is composed of concentric laminae. The surface is greenish-brown in colour, but towards the centre it is whiter owing to the greater amount of calcareous matter; there are indistinct longitudinal striae.

The spicules (fig. 101) are pale yellow or colourless; they consist of the following types, of which the measurements in millimetres are given:—

(*a*) Large double-clubs, with almost hemispherical ends, and a very short median constriction: 0·07 × 0·035; 0·07 × 0·03; 0·065 × 0·04; 0·06 × 0·04.

(*b*) Smaller double-clubs with more openly warted heads and a longer constriction: 0·045 × 0·03.

(*c*) Elongated double-clubs with comparatively few irregularly distributed warts: 0·08 × 0·023; 0·08 × 0·02; 0·06 × 0·015.

(*d*) Spindles (these may be modifications of type (*c*) in which the constriction is not visible): 0·09 × 0·02.

Locality.—Andamans.

XXVII. **Scirpearia ramosa** n. sp. Figs. 102–104.

In the Littoral Collection of the Indian Museum there occurs a very beautiful and characteristic branched colony for which it has been necessary to establish a new species. The mode of branching, the nature of the verrucae, and the distinctive character of the spicules, are all features of great importance. The colony is complete with its basis of attachment; it is 14 cm. in height and about 9·5 cm. in maximum breadth, and is branched irregularly in one plane. The majority of the branches arise at nearly right angles; they are long, and may ascend for a considerable distance without giving rise to finer twigs. They vary very little in diameter throughout their entire length (fig. 102). They are flattened in the plane of ramification, so that a cross-section is elliptical. The diameter of the main stem is 2·5 mm., but some of the branches are 3 mm. in their longer and about 2 mm. in their shorter diameter.

The coenenchyma has a very granular surface; it is 1 mm. in thickness towards the tip of the branch, but considerably less in the older parts where the axis is thicker.

The colour of the colony in spirit is yellowish-red; but the verrucae are of a more decided reddish tint, and streaks of red pass indefinitely from them, and gradually merge into the general tone of the coenenchyma. When dry the whole colony is almost ochreous yellow.

The polyps occur on the branches, but not on the main stem; they are distributed in two distinct series on the sides, or non-flattened aspects, of the branches, but occasionally they encroach on the flattened surfaces. There are thus two very distinct bare longitudinal zones.

The verrucae have the appearance of very low truncated cones, and are almost crater-like; they hardly project beyond the coenenchyma. This is due to their great contractility, as is evident from the shrunken appearance. They are about 0·5 mm. in height and 2 mm. in diameter at the summit. The oral opening is very large; it is circular in outline, and the eight retracted tentacles apparently form a pseudo-operculum (fig. 103).

The canal-system is typical of the group: the two main canals are very large, and correspond to the bare tracts. On several of the branches there is a distinct longitudinal furrow indicating their exact position.

The axis is cylindrical, and is composed of definite concentric laminae; a cross-section shows lines radiating from the centre to the circumference. The outer more horny portion is brown in colour, but the more calcareous central part is white. The surface is marked by longitudinal ridges and furrows, the number of which varies according to the portion of the colony examined. Two of the furrows, larger and deeper than the others, correspond in position to the two large main canals.

The spicules consist essentially of double-clubs; but these may be elongated and narrow, and with so short a constriction as to appear like warty spindles. The warts are large and close-set. The spicules are either pale yellow or colourless. In the coenenchyma there are only double-clubs, with warty, hemispherical heads, and a short constriction. The following measurements, in millimetres, are typical:—

0·07 × 0·05; 0·07 × 0·045.
0·05 × 0·03; 0·04 × 0·025.

The spicules of the polyps are, on the whole, longer and narrower than those of the coenenchyma. They are

(1) Double-clubs, with warty, slightly elongated heads, and with a short constriction: 0·09 × 0·02; 0·08 × 0·02; 0·06 × 0·025.
(2) Thicker double-clubs, more like those of the coenenchyma: 0·08 × 0·035.
(3) Warty spindles (occasionally a constriction is discernible): 0·07 × 0·02.

Locality.—Andamans, 20 fms.

Specific Diagnosis.

Colony branched in one plane; most of the branches arise almost perpendicularly, but soon turn upwards; they are flattened in the plane of ramification, vary very little in thickness throughout their entire length, and terminate bluntly. The polyps are distributed for the most part on the non-flattened aspects of the branches, and stand perpendicularly; the verrucae, when retracted, have the form of low, truncated cones, and may even appear almost level with the coenenchyma. The oral opening is closed by the inturned tentacles, which thus form a pseudo-operculum. The spicules consist essentially of (1) broad double-clubs, with a short constriction and almost hemispherical ends; (2) elongated, broad double-clubs, with *very rounded ends*, and with the same character as the previous type; and (3) longer and narrower double-clubs, which may approximate double-spindles, and eventually spindles.

XXVIII. **Scirpearia ceylonensis** n. sp. Figs. 105-107.

Among the Alcyonaria collected by Professor Herdman in Ceylon is a beautiful branched specimen which was not described in the general report. It has been found necessary to establish a new species to include it.

The total height of the colony is 31 cm.; it consists of a main stem 30 cm. in height, from which four branches arise, all on one side. The first arises at a point 4 cm. from the base; and the others after 2·5, 3, and 10 cm. consecutively. The lowest branch is broken, and is 13 cm. in length, but was evidently much longer; the others are 5·5, 10, and 15 cm. respectively (fig. 105).

The main stem after the origin of the first branch and all the branches are markedly flattened in the plane of ramification.

The diameter of the main stem near the base is 2 mm., and its greatest breadth in the flattened portion 3 mm. The branches vary considerably in thickness. The colour of the colony is a pale orange-yellow; but the verrucae are more reddish. The coenenchyma has a very granular surface; it is nearly 1 mm. in thickness in the branches, but thinner in the older parts, where the axis is proportionately larger.

The polyps occur on the branches and also on the main stem, except on the portion below the origin of the first branch; they are distributed in two longitudinal series on the sides of the branches; the flattened aspect is broad, and quite devoid of polyps. In each series this is a single row; but overcrowding or the interposition of young forms sometimes obliterates the symmetry (fig. 106).

The verrucae, when retracted, are low, truncated cones, and often show very distinct wrinkling: they project very little beyond the coenenchyma. Many of the anthocodiae are only partially withdrawn; and the infolded tentacles appear to form a cone: on further retraction their bases form a horizontal pseudo-operculum, and the verrucae present a very shrunken appearance. The tentacles are eventually quite covered up by the inturned sides of the verrucae.

The canal system is typical and well defined; the two main canals, corresponding in position to the bare tracts, are large; and a depression is sometimes visible owing to a collapse of the walls.

The axis is thin, cylindrical, composed of concentric laminae, and markedly calcareous. It is yellow in colour; and the surface is striated, two grooves slightly larger than the others being seen in some places.

The spicules (fig. 107) consist of the following types, with measurements, length by breadth, in millimetres.

(*a*) Double-clubs, with a short constriction and with almost hemispherical heads, very irregular in outline, covered with few large warts: 0·08 × 0·042; 0·076 × 0·046; 0·076 × 0·42.

(*b*) Elongated double-clubs, with rounded ends, and openly-warted: 0·08 × 0·038; 0·08 × 0·034.

(*c*) More elongated double-clubs, merging into double-spindles. The warts on these are sometimes disposed in whorls: 0·084 × 0·027; 0·082 × 0·03; 0·082 × 0·026.

From these measurements it will be seen that there is very little difference in the lengths of the various types, but that the breadths diminish proportionately more than the lengths. Intermediate forms also occur.

Locality.—Off Galle, Ceylon.

XXIX.—**Scirpearia maculata.** Figs. 108 and 109.

Ellisella maculata Studer, xxxiv., p. 629, Taf. iv., fig. 27 (*a*, *b*, and *c*).
Ellisella maculata (pars) Wright and Studer, l., p. 160, Pl. XXXIV., fig. 9.
Ellisella calamus Studer, xxxiv., p. 660, Taf. v., fig. 28 (*a*, *b*, *c*, *d*, and *e*).
Ellisella calamus Ridley, xxxiii., p. 348.

It is with considerable hesitation that we still recognize this species as distinct. It has been impossible, however, to examine the type specimen of the species; but we have seen a Banda specimen in the British Museum, of which Professor Bell has sent me a photograph (fig. 108). The other specimen, from the Torres Straits, described in the "Challenger" Report, has proved, on examination of the spicules, to be *Juncella gemmacea*.

There can be no doubt, however, that *Ellisella calamus* is the same as *Ellisella maculata*, since in spiculation they are identical, and the macroscopic characters on which they are separated are only variational differences. This will be evident from the following description. Studer, in describing *E. maculata* says:—

The stem is cylindrical, forked, divided into only a few long cylindrical branches. The colony is 5 cm. in height; the diameter of the stem is 5 mm., that of a branch 3 mm. One of the branches is 13 cm. in length.

The stem and branches are covered with verrucae, which hardly project; these occur laterally, on the thicker branches, in several rows, leaving a narrow, shallow median space, which disappears in the twigs. The verrucae have a circular opening. The spicules are (1) double-clubs, 0·095 mm. in length; and (2) a few warty spindles, 0·084 mm. long.

The colour of the coenenchyma is orange-red; the verrucae are dark red.

Locality.—Mermaid Straits, North-West Australia, 50 fms.

In separating *E. calamus* from *E. maculata* he gives the following diagnosis of the former:—

Simple, rod-like, cylindrical stem. The length of the largest specimen is 80 cm. The maximum diameter is 2 mm. The axis is horny and calcareous, with alternate horny and limy rings, flexible, yellowish. The cortex is fairly thick. The verrucae project as pointed cones only in the upper portion. They occur on the sides of the stem in quincunx, in several rows, leaving a narrow, shallow, smooth space, which gradually becomes narrower till it disappears in the terminal portion.

The spicules are like those of *maculata*, namely, spiny double-clubs and spindles (0·06).

Locality.—Mermaid Straits, 50 fms.

Ridley (xxxiii., p. 348), in identifying a specimen in the "Alert" Collection with *E. calamus*, gives the following notes:—

A specimen 9 inches (225 cm.) long; incomplete. The colour is dark brick-red. The fusiform spicules were almost twice as long as those of Studer's specimen. He says nothing of the dimensions of the double-clubs.

Locality.—Port Denison, Queensland, 4 fms.

The following notes from the "Challenger" specimen in the British Museum (fig. 108) may be of interest:—The fragment is 50 mm. in length, and has a diameter varying from 3·5 mm. at the base and 2 mm. near the tip. The coenenchyma is about 1 mm. in thickness throughout; the canal system is typical of the group, and there are two distinct main canals which define two longitudinal bare spaces, although Wright and Studer refer to only "a very narrow median groove."

The polyps are disposed in two longitudinal series; but a torsion of the whole colony has resulted in a false spiral appearance. The verrucae are small and dome-like; some are adpressed to the stem; while others are almost retracted within the coenenchyma.

The axis is of the typical Juncellid structure.

Wright and Studer thus define the spicules, of which the chief types are shown in fig. 109:—

"The spicules consist of (1) salmon-coloured spindles, 0·12 × 0·04 mm.; 0·08 × 0·02 mm. (2) sherry-coloured double-clubs: 0·1 × 0·06 mm.; 0·06 × 0·04 mm. (3) Needles: 0·06 × 0·02 mm.

Locality.—Banda Islands.

Note.—Fig. 110 of the Torres Straits specimen of *Juncella gemmacea*, which was originally described as *Ellisella maculata*, has been added here to illustrate convergence in the group, and show how futile it is to attempt to separate Juncellids into genera without an examination of the spicules.

XXX. **Scirpearia quadrilineata** n. sp. Figs. 111–113.

It has been found necessary to establish this new species to include a very distinctive specimen in which the most predominant feature is the presence of *four* main longitudinal canals, and the consequent distribution of the verrucae in *four* longitudinal series.

The colony is complete, simple, and flagelliform; the basis of attachment is conical, covered with coenenchyma, and spread over a piece of rock. The total height of the colony is 35 cm.; the diameter at the base is 4·5 mm.; near the tip it is 2 mm.

A very noticeable feature in the general appearance of the colony is the fact that it is markedly square in section.

The coenenchyma is thin; near the base it is 0·75 mm. in thickness; but near the tip it approaches 1 mm. Around the periphery of the axis there is a system of longitudinal canals, of which *four* are markedly larger than the others; these are arranged symmetrically, equidistant from one another, and thus forming the corners of a square (fig. 111). No outer system of longitudinal canals was visible; but the coenenchyma is so thin that these may be easily overlooked. It is extremely difficult to cut through the coenenchyma without damaging it, so that it is quite possible that these are present.

The polyps are disposed in a very characteristic fashion. They are grouped in *four* definite longitudinal series, separated by four bare spaces which correspond in position to the four main canals (fig. 112). Each series consists of a single row; but near the middle of the colony they are somewhat crowded, and give an appearance of two rows, due in great part to displacement.

Near the base and towards the tip they are more openly arranged, but always in four series.

The verrucae are low and dome-like, and have a maximum height of 0·5 mm. Towards the tip of the colony and near the base they tend to become almost level with the coenenchyma; while the extreme basal portion is quite destitute of polyps. When partially closed they show a very distinct eight-rayed figure. The anthocodiae are very small, and are all retracted within the verrucae.

The axis is made up of concentric laminae; it is extremely limy and very hard; the colour of the outside is brown, but the core is white; the surface is marked by faint longitudinal striae. Near the base the diameter is 3 mm.; but towards the tip it becomes almost hair-like and less limy.

The spicules are quite distinctive. We have figured six types (fig. 113).

(*a*) Double-clubs with very densely warted and regular heads; the constriction is very short; and the warts are symmetrically arranged: 0·06 × 0·05; 0·076 × 0·049; 0·076 × 0·046.

(*b*) Smaller double-clubs, with a longer constriction, with more open heads, and with the warts less symmetrically arranged: 0·06 × 0·034; 0·05 × ·031; 0·049 × 0·027.

(*c*) Elongated double-clubs, tending towards double-spindles, with rounded blunt ends: 0·091 × 0·038; 0·087 × 0·034; 0·083 × 0·034.

(*d*) Elongated double-spindles, with pointed ends, and with a definite constriction: 0·118 × 0·034; 0·114 × 0·31; 0·114 × 0·023; 0·103 × 0·023.

(*e*) Long spindles with a hint of constriction: 0·125 × 0·23; 0·114 × 0·031.

(*f*) Shorter spindles also with a hint of constriction: 0·095 × 0·019; 0·087 × 0·015; 0·016 × 0·023.

We have little hesitation in defining (*a*), (*b*), and (*c*) as distinct types; but it is just possible that (*f*) might develop into (*e*) or (*d*) according as increase with growth was greater in length or in breadth. So many of each kind occur, however, that we feel justified in defining them as separate for the present, at any rate, until more is known with regard to their growth.

The colour of the coenenchyma is a bright orange-red—but the tips of the verrucae are more reddish.

Locality.—Laccadives, 30–40 fathoms.

Diagnosis, colony simple; spicules contain double-clubs and double-spindles, with transitions to spindles. The coenenchyma is thin, and contains *four* main longitudinal canals. The verrucae are disposed in *four* definite longitudinal series, separated by four bare tracts, which correspond in position to the four main canals. The colony is markedly square in section.

XXXI. **Genus Nicella** emend.

(A) *Discussion of the Genus.*

This genus was established by Gray in 1870 (Cat. Lith. Brit. Mus., p. 40) in the following terms:—

Coral fan-like, in one plane, branched; branches forked, rather diverging. Bark smooth, brown. Polyp cells cylindrical, truncated, diverging from the stem at nearly right angles; mouth open. Axis calcareous, white solid.

To this genus he refers a specimen under the name *Nicella mauritiana*, and gives as a synonym his previous *Scirpearia dichotoma* (P.Z.S., 1859, 481–2).

Ridley (xxix., p. 150) identified a specimen from Mauritius under the name *Nicella dichotoma*, and made the following observation on the spicules: "There is a dense cortical layer of small double-heads and a subjacent layer of longer densely tuberculate spindles, having a bare median space more or less clearly indicated."

Wright and Studer, with these facts as a basis, give the following diagnosis:—

"The colony is upright, branched, with a thin coenenchyma and protruding verrucae, which arise perpendicularly, and appear to be terminally truncated. The polyps arise from either side of the stem and branches, leaving a middle space free. The spicules form a cortical layer of small double-clubs and an internal layer of long densely warted spindles."

The following species have been from time to time referred to this genus:—

N. dichotoma (Gray).
N. mauritiana (Gray).
N. laxa Whitelegge.
N. flabellata (Whitelegge).
N. reticulata Thomson and Simpson.
N. pustulosa Thomson and Simpson.

An examination of the type-specimen of *Scirpearella moniliforme* Wright and Studer, in the Collection of the British Museum, has revealed the fact that this species should be included in the genus Nicella. Thomson and Henderson also referred *Verrucella flabellata* Whitelegge to this genus, so that the generic diagnosis has been emended to include these forms.

Thomson and Simpson (xli., p. 267) referred a specimen in the Littoral Collection of the Indian Museum to this genus under the name *Nicella pustulosa,* with the following reservation:—

"It is with some hesitation that we refer this type to the genus Nicella. It is a matter of no small difficulty to distinguish between Nicella, Gorgonella, and Verrucella. . . .

"Our specimens approach Nicella in several respects, though agreeing with none of the described species; and as the positive characters of the other genera are absent, we feel justified in making a new species to include these forms."

The present study of this genus has, however, convinced me that the presence of the abnormally large spindles is a character which cannot be overlooked; so that, while still acknowledging the specific rank of the specimens under consideration, I would suggest their withdrawal from the genus Nicella, but until a revision of the species of Verrucella and Gorgonella has been made I would not hazard an opinion on their generic position. With regard to the spicules of this group, we also made the following observation:— "Distinctions based on spicules alone are very unsatisfactory in this group (Gorgonella and Verrucella), because the spiculation varies at different levels; and transition forms are so numerous and varied that it is sometimes almost impossible to distinguish between double-spheres, double-stars, and double-clubs, each in turn passing gradually to double-spindles. In Verrucella . . . there are double-stars; in Gorgonella . . . double-spheres occur."

As I have elsewhere pointed out, I doubt very much the validity of these two genera, on the present spicular distinction, but await a revision of the known species for a solution of the difficulty.

(B) *Classification of the Species with emended Diagnoses.*

On this basis four species may be recognized, and are included in this report. These are:—

N. dichotoma Gray.
N. flabellata (Whitelegge).
N. reticulata Thomson and Simpson.
N. moniliforme (Wright and Studer).

The following short specific diagnoses may prove useful:—

Nicella flabellata.

The colony is branched in one plane; the smaller branches tend to arise from one side of the larger. The coenenchyma is moderately thin, and often presents a ridged appearance due to segregations of spicules. The polyps are disposed in two longitudinal series: in the younger part they occur in a sinuous row on either side of the branch; but in the older portions they are more numerous and may encroach slightly on the median bare spaces. The verrucae vary in shape and size according to the stage of retraction; when expanded they are prominent, and show an eight-rayed figure at the summit; when retracted they appear as low conical warts, and there is no trace of an octo-radiate structure. The axis is composed of concentric laminae; and the surface is marked by longitudinal striae.

The spicules consist of (1) small double-clubs, (2) small double-wheels, (3) elongated double-clubs, (4) long, massive, bluntly terminating double-spindles, (5) long, slender simple-spindles. (See fig. 115.)

Nicella reticulata.

Colony branched in one plane, with abundant anastomosis; the branches and twigs are very slender, so that the colony is extremely reticulate and flabelliform. The coenenchyma is thin and finely granular. The polyps are disposed mainly in two longitudinal series; but deviations from this type occur, owing in some cases to overcrowding, in others to the anastomosis. The verrucae are usually low and dome-like. The spicules consist of (1) small double-clubs and elongated double-clubs, and (2) long double-spindles and simple-spindles. These two sets are quite distinct; but the spindles are not so disproportionate in length to the double-clubs as in most other species.

Nicella moniliforme.

Colony simple or feebly branched, slender, filiform, and of almost uniform diameter throughout; polyps disposed in two longitudinal series, near the tip in one row, but in the older parts in two or more indefinite rows in each series. The spicules are very characteristic. They include small double-clubs and elongated slender double-clubs: also spindles of two kinds (1) *long, slender, spiny* spindles, and (2) *long, thick, densely warted* spindles. The spindles are sometimes more than twice as long as the typical double-clubs. (See figs. 117 and 118.)

XXXII. **Nicella dichotoma** Gray. Fig. 114.

Scirpearia dichotoma Gray, xi., p. 481.

Nicella mauritiana (Gray), xii., p. 40, fig. 12. non *Nicella mauritiana* Studer.

Nicella dichotoma Ridley, xxix., p. 130.

Nicella dichotoma Thomson and Russell, xliii., p. 161, Pl. VII., figs. 1 and 5.

Nicella laxa Whitelegge, xlix., p. 319, Pl. XVII., figs. 30-33.

This species was established by Gray in 1859 under the name of *Scirpearia dichotoma*. He defined it thus:—"Coral fan-like, in a single plane, irregularly dichotomous. Cells cylindrical, elongated, truncated, in a row on each side of the branches, sub-alternate." *Locality.*—Mauritius. In 1870 he formed another species, *Nicella mauritiana*, while he gave as a synonym *Scirpearia dichotoma*. Since this new species is the same as the older *dichotoma*, it was unnecessary to give it a new name, although he referred it to a new genus, so that the newer name must give way to the older. The description of *Nicella mauritiana* is as follows:—

"Coral fan-like, dichotomously branched; stem cylindrical, longitudinally striated; bark thin, pale brown; cells elongate, cylindrical, longer than the diameter of the stem, ascending, truncated at the tip, placed rather irregularly, sub-alternate (rarely sub-opposite) on each side of the stem and branches; axis pale greyish-brown." *Locality.*—Mauritius.

Ridley in 1882 re-identified the species, and described some specimens from Mauritius, giving some positive, additional characters. One of his specimens was 340 mm. in height, and 240 mm. in maximum diameter. He says:—"The shape of the verrucae varies considerably according as to whether they are open or closed; in the former condition they are rectangular at the apex, while in the latter they appear conical with rounded apices. The basal diameter may vary from 1·25 mm. to 2·25 mm. when closed. The spicules consist of a dense cortical layer of small double-heads and a subjacent layer of longer densely tuberculate spindles having a bare median space more or less strongly indicated. The colour is variable, (1) ochreous yellow to a dull flesh colour, (2) dirty white."

In 1897 Whitelegge established a new species under the name *Nicella laxa* with the following characters:—The colony is feebly branched; the branching is lateral and in one plane. The axis is laminate and calcareous. The coenenchyma is thin, and when viewed with a lens presents a series of minute ridges, forming a network of raised lines, which are lighter in colour and consist of double-club spicules. The polyps are confined to the sides of the stem and branches in a single row on each side. The verrucae are large, alternate, and stand nearly at right angles; they are divided at the summit into eight lobes. The spicules consist of (1) short double-clubs with smooth or warty tubercles: 0·1 × 0·05 mm.; 0·07 × 0·03 mm.; 0·05 × 0·02 mm.; (2) fusiform spindles with rather obtusely pointed ends and a spiny tuberculated surface: 0·25 × 0·06 mm.; 0·2 × 0·05 mm.; 0·1 × 0·03 mm. Many of both kinds are a little flattened. The colour is a light mouse-grey.

He says:—"This species differs from *N. dichotoma* by its smaller and more distant polyps and by its lax method of branching."

We have already seen that neither of these two characters is of much taxonomic importance; and, taking into consideration Ridley's observations on the size of verrucae in different stages of retraction, we do not feel justified in ranking this as a distinct species. At the same time Gray gives a very good figure of his *N. mauritiana*, and the branching there is almost identical with that figured by Whitelegge. In Gray's figure also the distribution of the polyps varies in different parts of the colony, so that while in some branches they are more closely packed, in others they are quite as distant as in Whitelegge's figure. The spicules are identical with those described by Ridley; and the network of ridges described by Whitelegge, though not given in Gray's description, are unmistakably present in his figure. We therefore see no reason for ranking *N. laxa* as a separate species.

Thomson and Russell, 1909 (xliii., p. 161, Plate VII., figs. 1 and 5) describe some specimens as follows:—

Several colonies of chestnut-brown to umber-brown colour. The largest is

20 cm. in height by 8 cm. in maximum breadth, and consists of a main stem, with lateral branches, which are again repeatedly branched. For the most part the branching is in one plane; but this is not rigorously adhered to. On the main stem of one of the larger specimens there is a curious gall-like swelling from which branches arise on all sides.

The stem is 4 mm. in thickness at its base, and gradually tapers to 2 mm. at the ends of the branches. The axis is light brown in colour, and very calcareous. On the surface of the general coenenchyma, and on the verrucae there are irregular wavy longitudinal ridges, producing a characteristic bark-like appearance. Under the low-power microscope the texture seems finely arenaceous.

The verrucae are very prominent, rising more or less perpendicularly to a height of 2 mm. They occur on all sides of the stem; but in the upper parts of the branches a bilateral arrangement is well defined. At the apex of the verrucae there is an indication of eight lobes, from which the tentacles here and there project.

Another specimen, the basal part of a large colony, branches in a somewhat irregular fashion, and not rigidly in one plane. The verrucae are much less bilateral, especially near the base of the colony. Examination of the spicules shows that this may be referred to *N. dichotoma.*

Locality.—Salomon A, 65 fathoms; Salomon B, 60–120 fathoms.

XXXIII. **Nicella flabellata** (Whitelegge). Fig. 115.

Verrucella flabellata Whitelegge, xlix., p. 319, Plate XVII., figs. 34–37.
Nicella flabellata Thomson and Henderson, xl., p. 80.

This species was established by Whitelegge for a specimen from Funafuti, but was then included in the genus Verrucella. Thomson and Henderson, in identifying a specimen from the Indian Ocean with this species, concluded that it should really be referred to the genus Nicella; and in this we thoroughly agree. The spiculation is quite distinctively Nicellid in character; and, as these authors point out, the actual shape of the verrucae matters little in a generic diagnosis. As a matter of fact, the nature of the verrucae, as shown in the figure given by Whitelegge, is intermediate between that in *N. dichotoma* and the Indian Ocean specimen.

The notes following may serve to indicate the chief specific characteristic.

The colony is branched in one plane; the branches show a tendency to arise from one side. The axis is densely calcareous and is striated. A noteworthy feature is the presence of two distinct grooves corresponding in position to the two main canals.

The polyps occur in a sinuous row on each side of the younger branches; on the stem and on the older portions of the branches they are more numerous, and encroach on the two bare, flattened surfaces, always leaving a slight median depression free. Those on opposite sides alternate. The verrucae may be slightly prominent or may appear as low conical warts. When partially retracted, they show an eight-rayed figure; but when fully withdrawn, this is not evident. An average height may be taken as 1 mm.

The coenenchyma is of medium thickness, and may have ridges on the surface. The canal system is the typical Juncellid.

The spicules are essentially of two types, viz., small double-clubs and long thick double-spindles. The double-spindles are about four times as long as the small double-clubs. There are, however, in addition to these two types:—(1) some small double-wheels, with elongated warty hubs; (2) elongated double-clubs; (3) long slender spindles with practically no constriction. Very small short rods and spiny spindles occur in the tentacles.

The colour of the Funafuti specimen was yellowish-white; that of the Indian Museum specimen was ochreous yellow and brownish-white.

XXXIV.—**Nicella reticulata** Thomson and Simpson. Fig. 116.

Nicella reticulata Thomson and Simpson, xli., p. 266, Plate IV., fig. 5; Plate VIII., fig. 12.

This species was established by Thomson and Simpson (xli., p. 266) for specimens in the Indian Museum Littoral Collection. We have considered it advisable, however, to recapitulate the original description for the sake of completeness. A typical colony measures 27 cm. in height by 16 cm. in maximum breadth, and is attached by a very much broadened expansion. It consists of a main stem, only 2 cm. long, and measuring 4·5 mm. in diameter. At the distal end of the main stem four branches arise, two sub-opposite and two at slightly different levels, but all very close together. These diverge at varying angles, the two lower being almost horizontal, the other two also in the same plane of ramification. These ramify irregularly in one plane and anastomose freely, forming a large, almost semicircular, flabelliform mass, with very irregular meshes.

The coenenchyma is thin and compact, and presents a glistening arenaceous appearance. The colouring is very peculiar, being generally reddish-brown in the lower part of the colony, but gradually merging into slaty grey in the upper parts. Patches of grey appear throughout the red in some of the colonies, and *vice versa*; while one colony from the Laccadives is almost uniformly of a brick-red colour. The surface bears longitudinal furrows, which are sinuous, and sometimes almost spirally twisted; one being generally deeper than the others. These extend into the secondary branches, and even into one side of the twigs, the number diminishing with the size of the branches.

The axis is very calcareous and cylindrical in form. It is composed of concentric laminae, and has an almost olive-green colour at the base, gradually merging into a pale yellow in the smaller branches.

The polyps are disposed essentially in two longitudinal series; but deviations occur in several places, due sometimes to the anastomosis and sometimes to overcrowding. They are chiefly lateral on the main stem or primary branches; in the secondary branches they are arranged almost all round. On the finer branches and twigs they occur for the most part on two sides; but this rule is broken occasionally by the occurrence of polyps on all the four sides. The verrucae are dome-like, but slightly flattened on the twigs. They are separated by intervals of about 1 mm. in the branches; but their bases touch on the branchlets and give an undulating appearance. They measure about 0·5 mm. in height and 1 mm. in diameter. When the verruca closes over the retracted polyp, an eight-rayed star is formed by the eight lobes of the wall. The anthocodiae are very minute and are completely retractile; the spicules are arranged transversely on the tentacles.

The spicules of the coenenchyma consist of small double-clubs, elongated double-clubs, double-spindles, and simple-spindles. The double-spindles and simple-spindles in this species are not so markedly disproportionate as in most other species; but their distinctive character justifies their inclusion in the genus Nicella.

The following are a few of the more common types, with measurements in millimetres:—

(*a*) Double-clubs, with smooth warts:

0·05 × 0·04; constriction 0·02 broad × 0·008 long.
0·048 × 0·04 „ 0·02 „ × 0·005 „

(*b*) Elongated double-clubs, with fewer and more irregular warts:

0·06 × 0·04; constriction 0·03 broad × 0·01 long.
0·048 × 0·035 „ 0·02 „ × 0·012 „

(*c*) Spindles with round warts, and double spindles, having a smooth part in the middle:

0·09 × 0·025; smooth part, 0·02 long.
0·085 × 0·028 „ „ 0·018 „

(*d*) Minute crosses, with a very distinct cross, 0·04 × 0·04.

(*e*) Minute irregular crosses, elongated along one diagonal, with distinct cross, 0·05 × 0·03.

Those of the tentacles are short, warty rods: 0·05 × 0·015; 0·06 × 0·015; 0·6 × 0·015.

Localities.—Persian Gulf, 48–49 fms. Laccadives, 30–50 fms.

XXXV.—**Nicella moniliforme** emend. Figs. 117 and 118.

Scirpearella moniliforme Wright and Studer, p. 156, Pl. xxxiv., fig. 8.
non. *Gorgonia moniliforme* Lamx., xxv., p. 420.
nec. *Scirpearella moniliforme* Thomson and Henderson, xl., p. 82.
nec. *Scirpearia moniliformis* Gray xii., p. 39.

This species, as established by Wright and Studer in the "Challenger" Report, is a very distinctive one, based chiefly on the character of the spiculation.

The colony may be simple or feebly branched; the branched type-specimen was 505 mm. in length; and the branch arose at a distance of 215 mm. from the base; one of the unbranched forms was 325 mm. in length. The colonies are very slender and do not vary much in diameter throughout the entire length. The coenenchyma is thin and coarsely granular.

"The axis is very deeply grooved; ten grooves can be very easily counted on the older portion of the axis; but these diminish to two at the apex. These ridges show through the coenenchyma as linear furrows."

The polyps are arranged on the stem, the lower portion in four irregular rows; towards the apex they are alternate and arranged on either side of the stem; while for the first 60 mm. of the stem, counting from the basal disk, they are absent. They are retractile within the well-marked but shallow verrucae; these latter measure at their base 1 mm. An occasional verruca will be found larger and more elevated than the rest, measuring 1·5 mm. in diameter and the same in height; these generally are to be found near the summit of the axis."

The disposition of the verrucae is in two longitudinal series; and the two bare tracts are marked by distinct furrows larger than the others. Unfortunately Wright and Studer give no figure of the colony itself; and, as the figure of spicules is somewhat mis-leading, we have thought it advisable to add to this memoir two figures from the type-specimen in the British Museum (figs. 117 *a*, *b*, and *c*).

The colour in spirit is white.

The nature of the spicules in this species and also their relative proportions are very striking, and mark it off as distinct. The following four types can easily be identified:—(*a*) long, comparatively slender spindles, covered with coarse spines or small warts; (*b*) long, thick spindles, very densely warted; (*c*) slender double-clubs, with elongated conical ends, and with the constriction more or less marked; (*d*) *small* double-clubs, with almost hemispherical ends and with a definite smooth constriction: aberrant forms, such as crosses, (*e*) also occur. There are small needles in the anthocodiae.

The following measurements, length by breadth in millimetres, will give the relative proportions of these different types (see fig. 118):—

(*a*) Spindles—long, thin spiny or with small warts: 0·2 × 0·034; 0·15 × 0·026; 0·13 × 0·02.

(*b*) Spindles—long, thick and densely warted: 0·15 × 0·046; 0·13 × 0·042.

(*c*) Double-clubs—slender, with elongated ends, and with the constriction more or less markedly defined: 0·11 × 0·045; 0·099 × 0·043; 0·087 × 0·03; 0·065 × 0·025.

(*d*) Double-clubs—with massive ends, and with a distinct, short, smooth constriction: 0·072 × 0·042; 0·072 × 0·038; 0·057 × 0·038.

(*e*) Crosses—0·16 × 0·11; 0·12 × 0·12.

(*f*) Needles—small (in anthocodiae): 0·06 × 0·011; 0·04 × 0·02.

Locality—Amboina: 100 fathoms.

XXXVI. BATHYMETRICAL DISTRIBUTION.

The whole group is essentially littoral in its distribution. The great majority of the specimens hitherto described have been dredged within the hundred-fathom line; in fact, the only records outside this range are from (1) "Challenger" Station 232, known as the *Hyalonema*-ground off Japan, 345 fathoms; (2) "Challenger" Station 177 off the New Hebrides, 130 fathoms; (3) a dredging made by the "Investigator," off the Andamans in 124 fathoms; and (4) off the Azores, 150 and 200 fathoms.

At the first of these *Juncella racemosa* and *Scirpearia profunda* were obtained, at the second *Scirpearia profunda*, at the third only *Juncella racemosa*, and at the fourth only *Scirpearia flagellum*.

Consequently these are the only three species which can lay claim to deep-sea forms; and it is interesting that all the records of these species are from over 100 fathoms, and also that each has been found in distant localities over this depth. At the same time it is not improbable that these specimens occurred in deep water at the edge of an almost vertical reef, and that these were merely "escapes" from the reef.

Such records are not unknown; and the writer has experienced similar occurrences in the deep water off the almost perpendicular reefs on the east coast of Africa.

Nicella moniliforme is recorded from one hundred fathoms, and the only other records from over fifty fathoms are *Scirpearia thomsoni* and *Scirpearia alba*, both from 88 fathoms. The following table will give at a glance the chief records for each of the species in this report:—

SPECIES.	DEPTHS IN FATHOMS FROM WHICH RECORDED.
Junceella juncea,	0·10; 4; 7–11; 15–35; 25–30; 45; 50.
Junceella gemmacea,	0–8; 4; 8; 11; 19; 12–20; 32.
Junceella racemosa,	120; 345.
Junceella trilineata,	34.
Scirpearia profunda,	130; 345.
Scirpearia hicksoni,	36.
Scirpearia verrucosa,	50.
Scirpearia anomala,	?
Scirpearia pectinata,	3–4; 12; 30.
Scirpearia elongata,	
Scirpearia flagellum,	90; 150; 200; 60–120.
Scirpearia thomsoni,	88.
Scirpearia alba,	88.
Scirpearia aurantiaca,	30–50; 60–130; 120; 150; 130.
Scirpearia furcata,	15. 20 . . . . . . 30–40; 50–78.
Scirpearia andamanensis,	?
Scirpearia ramosa,	20.
Scirpearia ceylonensis,	?
Scirpearia maculata,	?
Scirpearia quadrilineata,	30–50.
Nicella dichotoma,	? 60–120.
Nicella flabellata,	45.
Nicella reticulata,	30-50; 48-49.
Nicella moniliforme,	100.

It is quite probable, however, that when more in-shore-work is carried on in tropical seas records will be abundant from water of much less depth than that at present given. Ridley in referring to the depths at which *Junceella gemmacea* occurs gives "between tide-marks," and, as has been already pointed out in the "Biological Note," it is no uncommon occurrence on the scattered coral reefs of the Mergui Archipelago to see at low spring tide huge colonies of *J. gemmacea* and *J. juncea* as well as *Melitodes* and other Alcyonaria swaying to and fro in the air.

XXXVII. Geographical Distribution.

The great importance of the Geographical Distribution of even a small group of animals, but especially those whose early life is pelagic and whose adult life is sedentary, is becoming more and more evident. Such knowledge, combined with systematic oceanographical observations, may eventually help to solve many problems that at present are a source of great perplexity to the biologist.

It is premature to attempt such a distribution of Juncellids; but in view of the fact that in this memoir a general survey of the group, so far as it is known, has been given, and as the references to localities, especially in the case of the older species, are extremely scattered, the following summary may serve as a basis for a more detailed study when further records are forthcoming.

Although doubt may exist as to the specific determination of those species added as an appendix to the genus Juncella, it may be useful to include them here, inasmuch as they are in all probability Juncellids.

It has been considered inadvisable with the limited records at our disposal to draw any conclusions as to the dispersal of these organisms, as to their origin as a part of a littoral fauna, or as to the probability of their being originally indigenous in certain areas.

Distribution of the Juncella-group of Gorgonellids.

The Juncella-group of Gorgonellids occurs both in the Atlantic and Pacific waters, but almost entirely within the Tropics of Cancer and Capricorn, and also chiefly in the Pacific Ocean. The extreme records North and South are "Off Japan" and "Off Cape Colony." The following are the chief centres:—(1) Red Sea, (2) Persian Gulf, (3) Laccadives, (4) Maldives, (5) West Coast of India, (6) Ceylon, (7) Andamans, (8) Mergui, (9) Bourbon, (10) Mauritius, (11) Cape Colony, (12) East Indies, (13) Japan, (14) East Coast of Australia, (15) West Coast of Florida and in the Atlantic, (16) East Coast of Central America, (17) N.-E. of South America, (18) Azores, (19) Mediterranean Sea.

Genus Juncella.

This is the most widely distributed genus in the group, and is almost entirely a Pacific Ocean form.

Genus Scirpearia.

This genus is entirely restricted, with the exception of *S. flagellum*, so far as the present records show, to the Pacific Ocean.

Genus Nicella.

This genus is entirely restricted to the Pacific Ocean.

Let us now illustrate "associations of species" in different localities.

(*a*) Laccadives, . .	*S. aurantiaca, S. quadrilineata,* and *N. reticulata.*
(*b*) Maldives, . . .	*J. juncea, S. furcata.*
(*c*) Ceylon, . . .	*J. gemmacea, J. trilineata, S. aurantiaca, S. ceylonensis, S. furcata.*
(*d*) Andamans, . .	*J. juncea, J. racemosa. S. hicksoni, S. verrucosa, S. anomala, S. andamanensis, S. ramosa.*
(*e*) Mergui, . . .	*J. juncea, J. gemmacea, S. furcata.*
(*f*) N.-E. Australia, . .	*J. juncea, J. gemmacea.*
(*g*) Bourbon-Mauritius, .	*J. juncea, J. gemmacea, N. dichotoma.*
(*h*) Cape of Good Hope, .	*S. flagellum, S. furcata.*

References to various large Collections of Juncellids.

"CHALLENGER" COLLECTION.

This collection was made by H.M.S. "Challenger," during her cruise round the world, 1873–76. The specimens are deposited in the British Museum, and were described by Wright and Studer in the Zoological Report of the "Challenger" Collections, vol. xxxi., pp. 153–181.

	DESCRIBED AS
Juncella juncea, ...	*Juncella juncea,* var. *alba,* p. 158.
Juncella juncea, ...	*Juncella barbadensis,* p. 159.
Juncella gemmacea, . . .	*Juncella gemmacea,* p. 158.
Juncella gemmacea, . . .	*Ellisella maculata* (pars), p. 160.
Juncella racemosa, . . .	*Juncella racemosa,* p. 159.
Scirpearia maculata, . .	*Ellisella maculata* (pars), p. 160.
Scirpearia profunda, . .	*Scirpearella profunda,* p. 155.
Scirpearia profunda, . .	*Scirpearella gracilis,* p. 156.
Scirpearia profunda, . .	*Scirpearella rubra,* p. 157.
Nicella moniliforme, . .	*Scirpearella moniliforme,* p. 156.

"ALERT" COLLECTION.

This collection was made during the Surveying Voyage of H.M.S. "Alert," during the years 1881–82. The Gorgonellids were reported on by Ridley in "The Zoological Collections" of H.M.S. "Alert," 1884, pp. 345–349.

	DESCRIBED AS
Juncella juncea, . . .	*Juncella juncea*, p. 345.
Juncella juncea, . . .	*Juncella fragilis*, p. 347.
Juncella gemmacea, . . .	*Juncella gemmacea*, p. 346.
Juncella gemmacea, . . .	*Juncella elongata*, var., p. 346.
Scirpearia pectinata, . .	*Ctenocella pectinata*, p. 348.
Scirpearia maculata, . .	*Ellisella calamus*, p. 348.

CEYLON COLLECTION.

This collection was made by Professor Herdman in the Ceylon Seas in 1904 while investigating the Pearl Fisheries of the Gulf of Manaar. The type-specimens are deposited in the British Museum, and were reported upon by Thomson and Henderson, "Ceylon Pearl Oyster Report," Royal Society, 1905. Supplementary Report, No. xx., Alcyonaria, pp. 311–315.

	DESCRIBED AS
Juncella juncea, . . .	*Juncella juncea*, p. 314.
Juncella juncea, . . .	*Juncella gemmacea*, p. 313.
Juncella juncea, . . .	*Juncella fragilis*, p. 314.
Juncella juncea, . . .	*Juncella fragilis*, var. *rubra*, p. 314.
Juncella trilineata, . . .	*Juncella trilineata*, p. 315.
Scirpearia furcata, . . .	*Scirpearia sp.* (?), p. 313.
Scirpearia furcata, . . .	*Scirpearella sp. B.*, p. 312.
Scirpearia aurantiaca, . .	*Scirpearella aurantiaca*, p. 311.
Scirpearia aurantiaca, . .	*Scirpearella divisa*, p. 312.
Scirpearia ceylonensis, . .	(*undescribed*).

MALDIVE COLLECTION. 1.

This collection was made by Mr. Stanley Gardiner in 1900, and was described by Hickson in "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," vol. ii., part iv. "The Alcyonaria of the Maldives," part iii., pp. 816–823.

	DESCRIBED AS
Juncella juncea, . . .	*Juncella juncea*, p. 820.
Juncella juncea, . . .	*Juncella flexilis*, p. 821.
Juncella juncea, . . .	*Juncella elongata*, p. 821.
Scirpearia furcata, . . .	*Scirpearia furcata*, p. 822.
Scirpearia furcata, . . .	*Scirpearia furcata*, var., p. 822.
Scirpearia furcata, . . .	*Scirpearella indica*, p. 822.
Scirpearia furcata . . .	*Juncella elongata* (Val.), p. 821.

MALDIVE COLLECTION. II. (described by Thomson and Russell, 1910).

	DESCRIBED AS
Juncella gemmacea,	*Juncella gemmacea.*
Scirpearia flagellum,	*Scirpearia flagellum.*
Scirpearia aurantiaca,	*Scirpearella aurantiaca.*
Nicella dichotoma,	*Nicella dichotoma.*

MONACO COLLECTION. I.

The collections made by the Prince of Monaco, during the scientific voyage of the yacht "Hirondelle" in the North Atlantic Ocean, in 1886–88, contain several Gorgonellids. These have been reported upon by Studer, in "Resultats des Campagnes Scientifiques du Prince de Monaco," 1901, fasc. xx., pp. 52, 53.

	DESCRIBED AS
Scirpearia flagellum,	*Scirpearia flagellum*, p. 53.
Scirpearia flagellum,	*Scirpearia ochracea*, p. 53.

INDIAN MUSEUM DEEP-SEA COLLECTION.

This Collection was made during the cruise of the old R. I. M. SS. "Investigator" in the Indian Ocean. The specimens are deposited in the Indian Museum, Calcutta, and were reported on by Thomson and Henderson, in the memoirs of the Indian Museum, Alcyonaria (1906).

	DESCRIBED AS
Juncella racemosa,	*Juncella miniacea*, p. 81.
Scirpearia profunda,	*Scirpearella moniliforme*, p. 82.
Scirpearia alba,	*Scirpearella alba*, p. 82.
Scirpearia thomsoni,	*Juncella elongata*, p. 81.
Nicella flabellata,	*Nicella flabellata*, p. 80.

INDIAN MUSEUM LITTORAL COLLECTION.

This Collection was made during the surveying cruises of the R. I. M. SS. "Investigator" in the Indian Ocean.

The type specimens are deposited in the Indian Museum, Calcutta. They were reported on by Thomson and Simpson, in the Memoirs of the Indian Museum Alcyonaria, 1909; but specific names were given only to a few;

descriptions of the others were tabulated, so that the following list will enable these to be identified.

	DESCRIBED AS
Juncella juncea, . . .	E. and F.
Juncella gemmacea, . .	O.
Juncella trilineata, . .	R.
Scirpearia pectinata, . .	M.
Scirpearia andamanensis, .	N.
Scirpearia anomala, . .	Q.
Scirpearia aurantiaca, . .	B.
Scirpearia furcata, . .	H, G, D, I.
Scirpearia furcata var. *robusta*,	P.
Scirpearia ramosa, . .	K.
Scirpearia verrucosa, . .	C.
Scirpearia hicksoni, . .	A.
Scirpearia quadrilineata, .	J.

WOOD-MASON COLLECTION.

This Collection was made by W. J. Wood-Mason in the Indian Ocean. A few of the specimens were described by Thomson and Simpson, but the majority of them were left over for incorporation in this paper. The types are deposited in the Indian Museum, Calcutta.

Juncella racemosa.
Juncella gemmacea.
Scirpearia aurantiaca.
Scirpearia furcata.
Nicella flabellata.

MERGUI COLLECTION. I.

This Collection was made by Dr. John Anderson for the trustees of the Indian Museum, Calcutta, where the specimens are deposited. They were described by Ridley in the Journal of the Linnean Society, vol. xxi., pp. 240-243.

	DESCRIBED AS
Juncella juncea, . . .	*Juncella fragilis*, var., p. 242.
Juncella gemmacea, . . .	*Juncella gemmacea*, p. 241.
Scirpearia pectinata, . .	*Ctenocella pectinata*, p. 243.

Mergui Collection. II.

This Collection was made by Simpson and Brown in the Mergui Archipelago, Burma, in the spring of 1907. The specimens are deposited in the Natural History Museum, Aberdeen University, and are reported on here for the first time.

They include the following species:—

Juncella juncea.
Juncella gemmacea.
Scirpearia pectinata.
Scirpearia furcata.
Scirpearia furcata var. *robusta.*

Australian Museum Collections.

This Collection was made by Mr. C. Hedley for the Australian Museum, where the specimens are deposited. It was reported upon by Whitelegge in the "Memoirs of the Australian Museum XII.," The Alcyonaria, Part ii. (1897 ?), pp. 318–320.

	DESCRIBED AS
Nicella dichotoma, . . .	*Nicella laxa*, p. 318.
Nicella flabellata, . . .	*Verrucella flabellata*, p. 319.

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DESCRIPTION OF PLATES.

Fig.

1. Polyp of *Scirpearia pectinata* enlarged (×25) to show structure.
2. Portion enlarged of Monaco specimen to illustrate the motility of the polyps.
3. Cross-section of a Juncellid axis to show the concentric laminae and the "ridges and depressions."
4. *a–g*. "Clubs" of *Juncella*, (*c–g*) showing characteristic variations.
5. *a* and *b*. Two kinds of double-clubs.
6. Variation forms of double-clubs.
7. Double-wheels or capstans.
8. Transition from the elongated double-club (*a*), through the double-spindle (*b*), to the simple spindle (*c*).
9. Three portions of var. *a* of *Juncella juncea* to show the disposition and nature of the polyps, (*a*) near the base of the colony, (*b*) midway, (*c*) near the tip.
10. Cross-sections of var. *b* of *J. juncea* to show the internal structure. The levels of (*a*), (*b*), and (*c*) correspond to those of fig. 9.
11. Three views of the superficial appearance of the axis in *J. juncea*. The portions shown are from the parts of the colony given in fig. 9.

Fig.

12. Portions of *J. juncea* var. b. to show the distribution and nature of the verrucae, (*a*) near the base, (*b*) midway (non-polyp-bearing aspect), (*c*) near the tip.

13. *J. juncea* var. b. Cross-sections at the three levels given in fig. 12 to show the internal structure.

14. Spicules of *J. juncea.*

15, 16, and 17. Three colonies of *Juncella gemmacea*, reduced proportionately, to show the difference in the branching at different ages.

18. Three portions of *Juncella gemmacea* enlarged ($\times 5$) to show the nature and distribution of the verrucae at different levels, (*a*) near the base, (*b*) midway (non-polyp-bearing aspect), (*c*) near the tip.

19. Transverse sections of *J. gemmacea*, at levels corresponding to those in fig. 18, to show the structure of the coenenchyma ($\times 5$).

20. *Juncella racemosa.* Portion of colony described in XLI.

21. *Juncella racemosa.* Colony enlarged ($\times 1\frac{1}{2}$).

22. Twig of *Juncella racemosa* to show disposition and nature of the verrucae.

23. Spicules of *Juncella racemosa.*

24. Terminal twig of *Juncella trilineata* to show the nature and disposition of the verrucae.

25. Transverse section of *Juncella trilineata* to show (1) the structure of the coenenchyma, (2) the three large main canals, and (3) the position of three alternating rows of verrucae.

26. Spicules of *Juncella trilineata.*

27. Spicules of *Scirpearia profunda.*

28. *Scirpearia hicksoni* n. sp. Portion near the base enlarged ($\times 4$) to show the appearance of the aspect devoid of polyps.

29. *Scirpearia hicksoni* n. sp. Portion near the base enlarged ($\times 4$) to show the nature of the verrucae on the "crowded" aspect.

30. *Scirpearia hicksoni* n. sp. Tip of colony enlarged ($\times 4$) to show the distribution and nature of the verrucae.

31. Spicules of *Scirpearia hicksoni* n. sp.

32. *Scirpearia verrucosa* n. sp. Portion enlarged ($\times 6$) to show the nature and distribution of the verrucae.

33. Spicules of the *Scirpearia verrucosa* n. sp.

Fig.

34. *Scirpearia anomala* n. sp. Three portions enlarged (×5) to show the difference in the nature and distribution of the polyps at different levels, (*a*) near base, (*b*) midway, (*c*) tip.

35. Spicules of *Scirpearia anomala* n. sp.

36–38. Silhouettes of the axis of colonies of *S. pectinata* to show different angles of origin for the branches.

39. *S. pectinata.* Silhouette of axis of a colony to show the crossing of the branches due to contraction.

40. *S. pectinata.* Silhouette of axis of a colony to show how a secondary branch may take the place of a primary.

41. Secondary development in *S. pectinata.*

42. Portion near the base of a colony of *S. pectinata* to show the distribution of the verrucae and the large canals superficially.

43. *a*, *b*, and *c*. Transverse sections of *S. pectinata* to show the structure of the coenenchyma and the disposition of the main longitudinal canals, (*a*) main stem with numerous large canals, (*b*) and (*c*) secondary branch, at different levels, with only two main canals.

44. *a* and *b*. Two views from the non-polyp-bearing aspect of a secondary branch of *S. pectinata* to show the disposition of the polyps and also their appearance when partially expanded, (*a*) about midway, (*b*) tip.

45. Spicules of *S. pectinata.*

46. Colony of *Scirpearia elongata* in the Museum of the Royal College of Surgeons, London (from a photograph supplied by Dr. Burne).

47. Spicules of the Royal College of Surgeons specimen of *Scirpearia elongata.*

48. Spicules of the British Museum specimen of *Scirpearia elongata.*

49. *Scirpearia flagellum.* Portion of Naples specimen enlarged (×6) to show the nature and distribution of the verrucae.

50. Spicules of *Scirpearia flagellum* (Naples specimen).

51. Colony (nat. size) of *Scirpearia flagellum* (Cape).

52. Portion of colony (fig. 51) to show the nature of the verrucae.

53. Longitudinal section through the portion of *Scirpearia flagellum* shown in fig. 52 to show the internal structure and the attachment of the strong retractor muscles.

54. Spicules of *Scirpearia flagellum* (fig. 51 specimen).

Fig.

55. Young colony of *Scirpearia flagellum* (nat. size) (Cape).

56. Portion of colony (fig. 55) enlarged (×12) to show the nature and distribution of the polyps.

57. Spicules of *Scirpearia flagellum* (fig. 55).

58. Portion of a Monaco specimen to show the distribution of the verrucae (×4).

59. Same as 58} different specimens.
60. Same as 58}

61. *Scirpearia thomsoni* n. sp. Silhouette of axis to show the nature of the branching.

62. *Scirpearia thomsoni* n. sp. Portion enlarged (×6) to show the disposition and nature of the verrucae.

63. Spicules of *Scirpearia thomsoni* n. sp.

64. *Scirpearia alba.* Two portions enlarged (×5) to show the nature and distribution of the verrucae at different levels, (*a*) near tip, (*b*) near the base.

65. Spicules of *Scirpearia alba.*

66. *Scirpearia aurantiaca.* Portion enlarged (×5) near the middle of the colony to show the nature of the verrucae.

67. *Scirpearia aurantiaca.* Portion enlarged (×5) near the tip of the colony to show the nature of the verrucae.

68. Spicules of *Scirpearia aurantiaca.*

69. *Scirpearia furcata.* Two views of the same portion of the type specimen of *Scirpearia* sp. (?) enlarged (×5) to show the nature and distribution of the verrucae.

70. *Scirpearia furcata.* Part of type specimen of *Scirpearella sp.* B.

71. *Scirpearia furcata.* Part of type specimen of *Juncella elongata* (Hickson).

72. *Scirpearia furcata.* Spicules of type specimen of *Juncella elongata* (Hickson).

73. *Scirpearia furcata.* Two views of the same part of a colony from the Indian Collection (×5) to show the nature and distribution of the verrucae.

74. Polyp of *Scirpearia furcata.*

75. Spicules of Indian Collection specimen of *Scirpearia furcata.*

Fig.

76. Silhouette of axis of "Providence" specimen of *Scirpearia furcata* ($\frac{2}{3}$ n. s.).

77. *Scirpearia furcata.* Small portion of main stem of "Providence" specimen to show the verrucae.

78. *Scirpearia furcata.* Two views near the base of the second primary branch of the "Providence" specimen.

79. *Scirpearia furcata.* Two views midway on the third primary branch of the "Providence" specimen.

80. *Scirpearia furcata.* Two views near the tip of the third primary branch of the "Providence" specimen.

81. Spicules of the "Providence" specimen of *Scirpearia furcata.*

82. *Scirpearia furcata.* Complete colony (nat. size) of a young specimen in the Cape Collection.

83. *Scirpearia furcata.* Portion enlarged ($\times$ 8) of a Cape specimen to show the low nature of the verrucae.

84. *Scirpearia furcata.* Portion enlarged ($\times$ 4) of a Cape specimen to show the nature of the verrucae.

85. *Scirpearia furcata.* Portion enlarged ($\times$ 5) of a Cape specimen to show the nature of the verrucae.

86. *Scirpearia furcata.* Portion enlarged ($\times$ 5) of a Cape specimen to show the distribution and nature of the verrucae.

87. Spicules of a Cape specimen of *Scirpearia furcata.*

88. *Scirpearia furcata.* Two views of a portion near the middle of a colony in the Indian Collection to show the distribution of the verrucae, (*a*) polyp-bearing aspect, (*b*) non-polyp-bearing aspect.

89. Spicules of Indian Collection specimen (Fig. 88) of *Scirpearia furcata.*

90. Three views from a specimen of *Scirpearia furcata* in the Indian Collection to show the distribution and nature of the verrucae at different levels. (*a*) near base, (*b*) midway, (*c*) tip.

91. Spicules of *Scirpearia furcata.* (Specimen fig. 90.)

92. *Scirpearia furcata*, var. *robusta.* Colony (nat. size) to show the general habit and the distribution of the verrucae.

93. *Scirpearia furcata*, var. *robusta.* Portion enlarged ($\times$ 5) near the base to show the nature of the verrucae.

94. Spicules of *Scirpearia furcata*, var. *robusta.* (Andamans specimen.)

Fig.

95. *Scirpearia furcata*, var. *robusta*. Three portions enlarged (×5) to show the proportions of the different parts and also the nature and distribution of the verrucae, (*a*) near base, (*b*) midway, (*c*) near tip.

96. Spicules of *Scirpearia furcata*, var. *robusta*. (Mergui specimen.)

97. *Scirpearia andamanensis*, n. sp. Colony (nat. size) to show the mode of branching and the general habit.

98. *Scirpearia andamanensis*, n. s. Portion near the tip of a branch enlarged (×6) to show the nature of the verrucae when slightly retracted.

99. *Scirpearia andamanensis*, n. sp. Portion of a branch enlarged (×6) to show the nature of the verrucae when partially retracted.

100. *Scirpearia andamanensis*, n. sp. Portion near the base enlarged (×6) to show the nature of the fully retracted verrucae.

101. Spicules of *Scirpearia andamanensis*, n. sp.

102. *Scirpearia ramosa*, n. sp. Colony (nat. size) to show the mode of branching and the general habit.

103. *Scirpearia ramosa*, n. sp. Portion enlarged (×6) to show the nature of the verrucae.

104. Spicules of *Scirpearia ramosa*, n. sp.

105. *Scirpearia ceylonensis*, n. sp. Colony one-half nat. size to show the mode of branching and the general habit.

106. *Scirpearia ceylonensis*, n. sp. Portion enlarged (×5) to show the disposition and nature of the verrucae.

107. Spicules of *Scirpearia ceylonensis*, n. sp.

108. "Challenger" specimen of *Scirpearia maculata* from Banda. (From a photograph supplied by Prof. Bell.)

109. Spicules of the "Challenger" specimen of *Scirpearia maculata*.

110. Fragment of *Juncella gemmacea*, originally described as *Ellisella maculata*.

111. Transverse section through *Scirpearia quadrilineata*, n. sp., to show the structure of the coenenchyma and the position of the four main canals.

112. Two portions of *Scirpearia quadrilineata*, n. sp., slightly enlarged ($\times 1\frac{1}{3}$) to show the distribution and nature of the verrucae at different levels, (*a*) near the tip, (*b*) near the base.

113. Spicules of *Scirpearia quadrilineata,* n. sp.

114. Spicules of *Nicella dichotoma.*

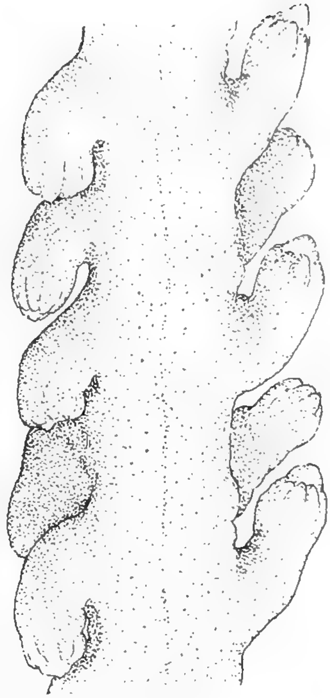
115. Spicules of *Nicella flabellata.*

116. Spicules of *Nicella reticulata.*

117. Three portions of *Nicella moniliforme,* enlarged (×5) to show the difference in the distribution and nature of the verrucae at the various levels, (*a*) near the base, (*b*) middle of the colony, (*c*) near the tip.

118. Spicules of *Nicella moniliforme.*

Fig. 1.



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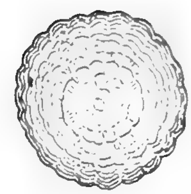

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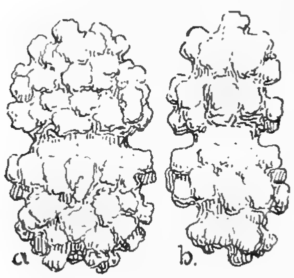

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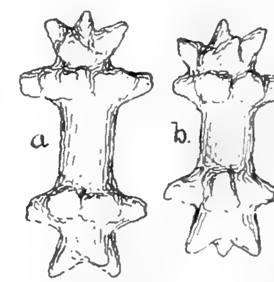
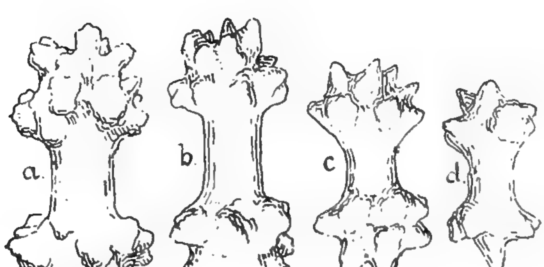


Fig. 7.

Fig. 4.



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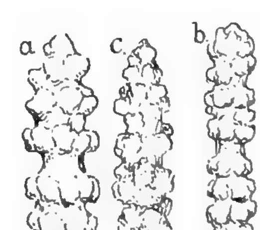
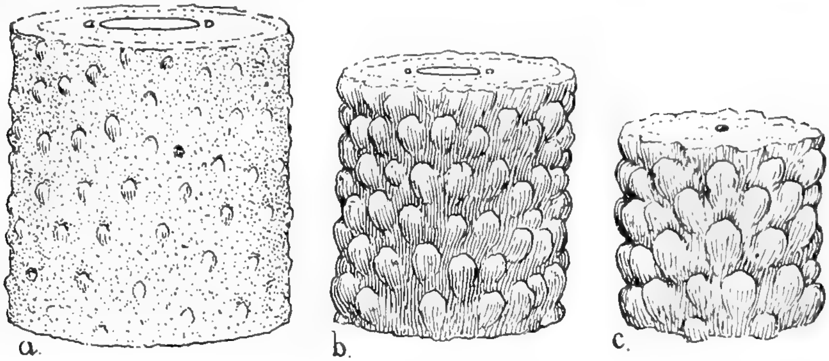


Fig. 8.

Simpson—Gorgonellidae.



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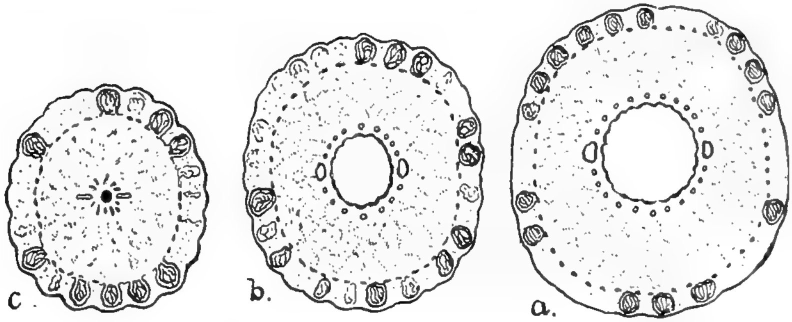

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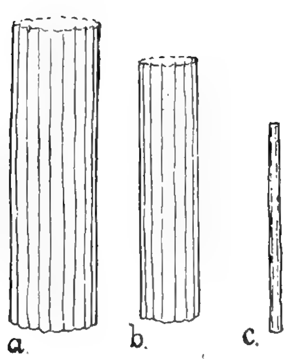

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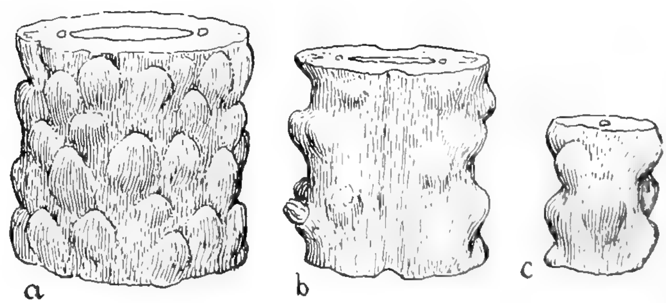

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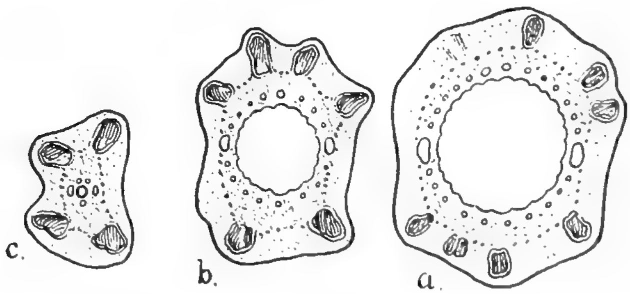

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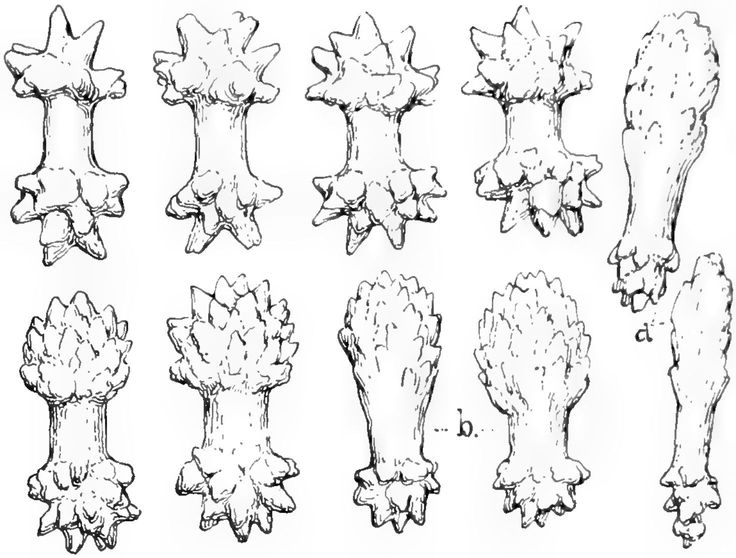
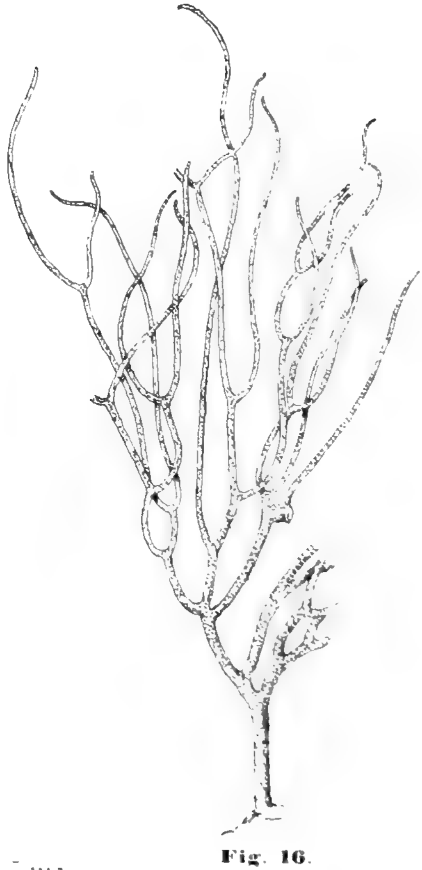


Fig. 14.

Fig. 15.



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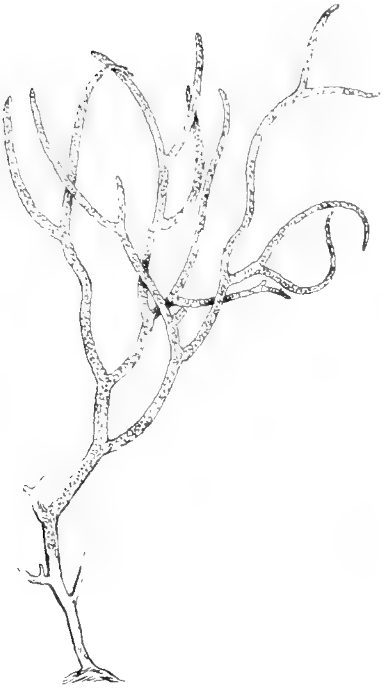

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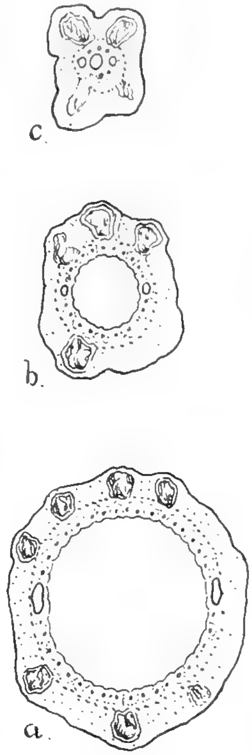

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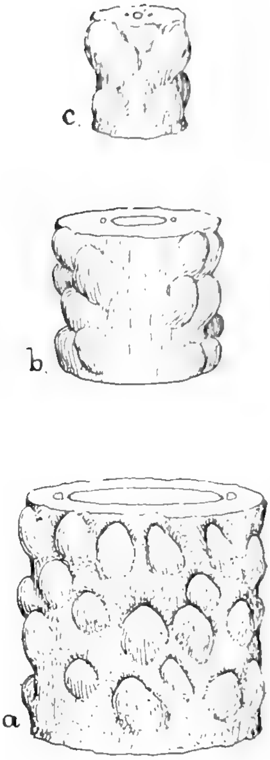

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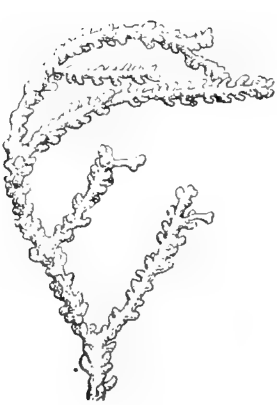
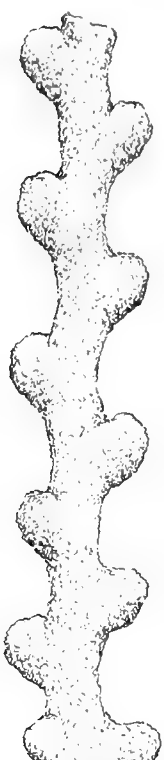


Fig. 20.

Fig. 21.



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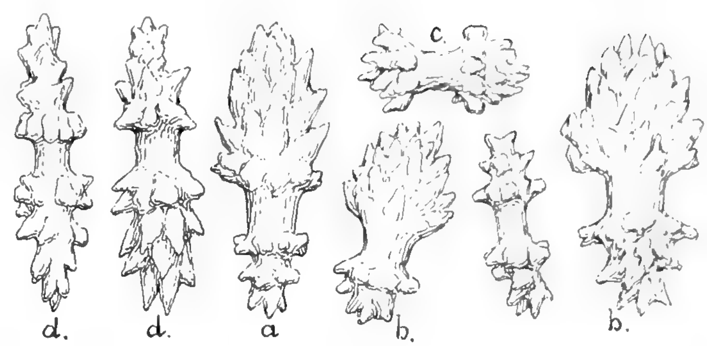
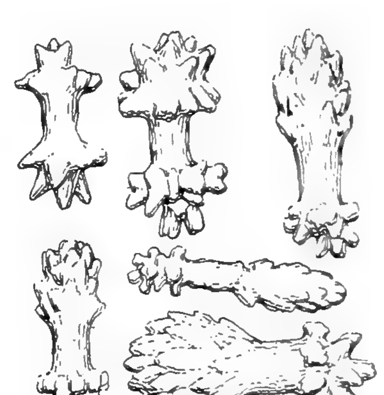


Fig. 23.

Fig. 25.



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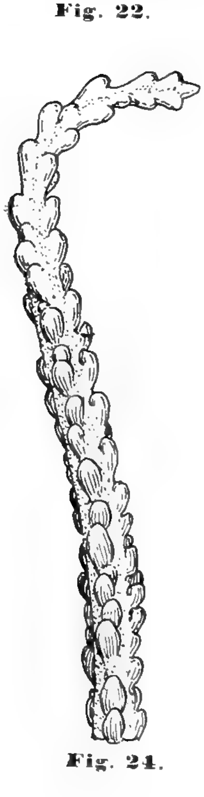

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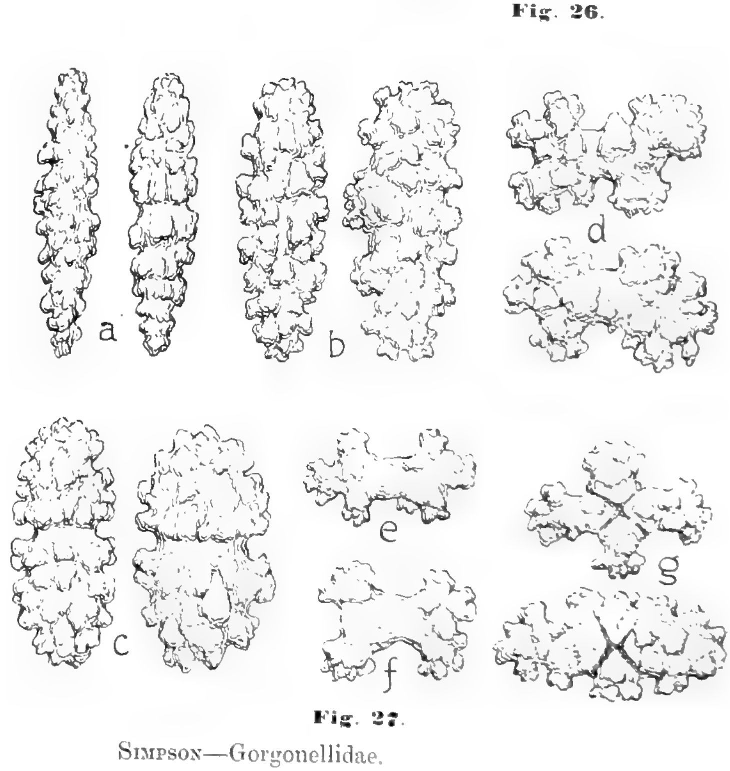

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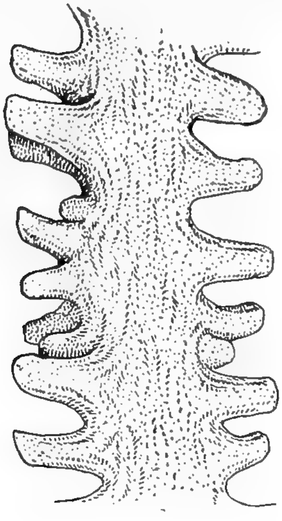

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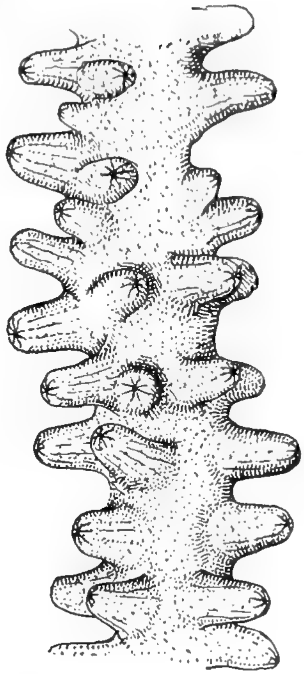

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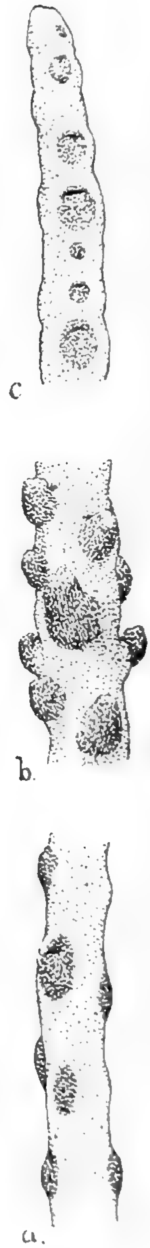

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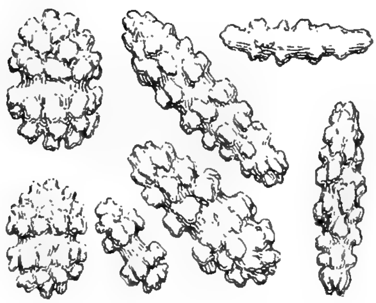

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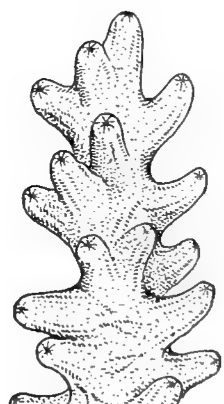

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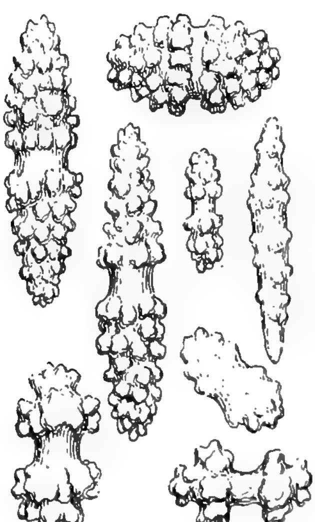
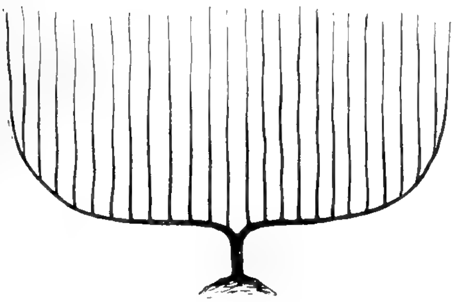


Fig. 33.

Fig 32.

Simpson—Gorgonellidae.



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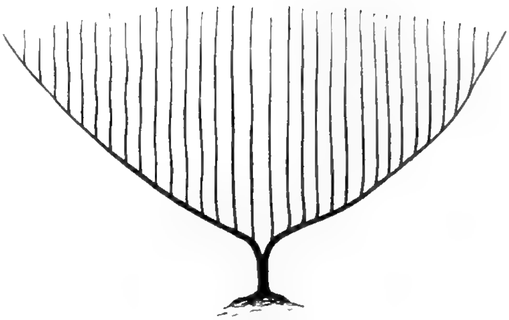
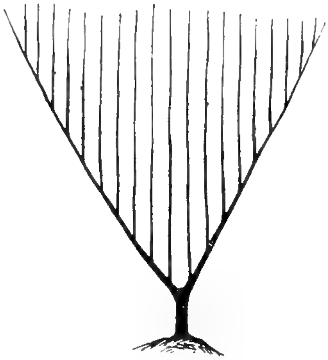


Fig 37.

Fig. 35



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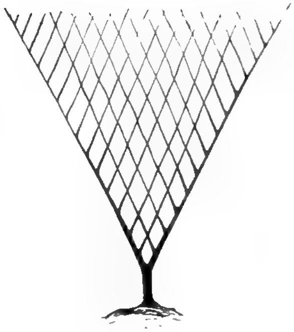

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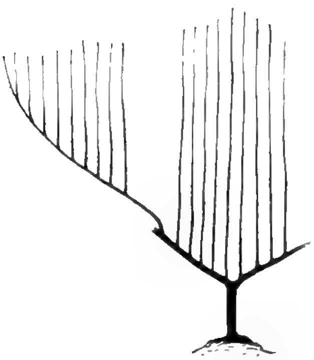

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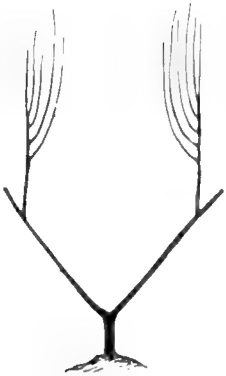

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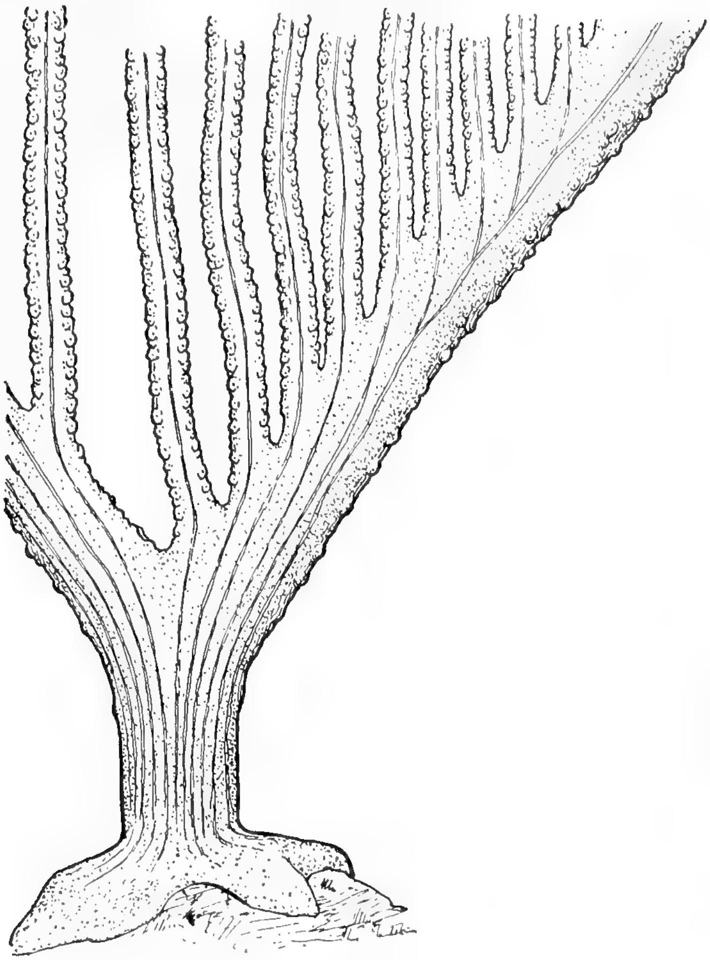


Fig. 42

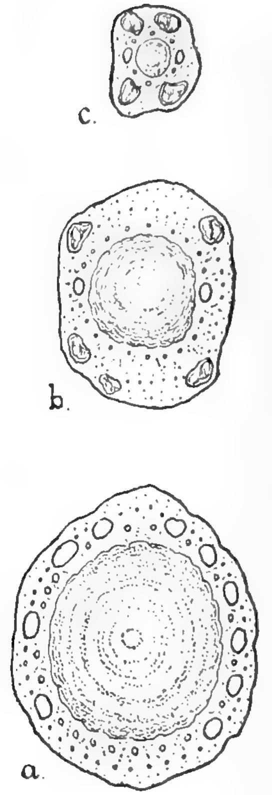
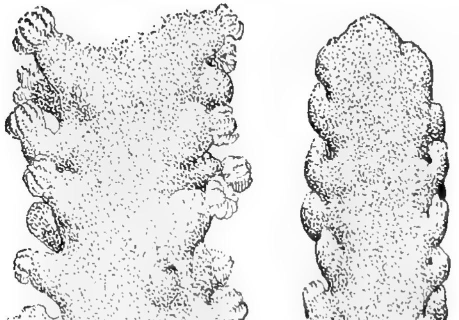


Fig. 43



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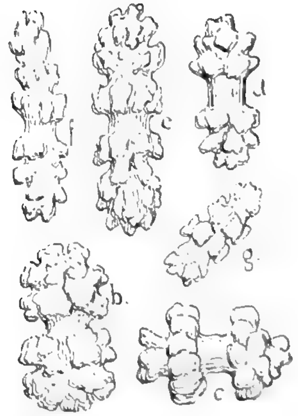
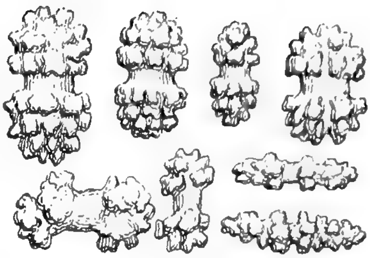


Fig. 45

Simpson—Gorgonellidae.



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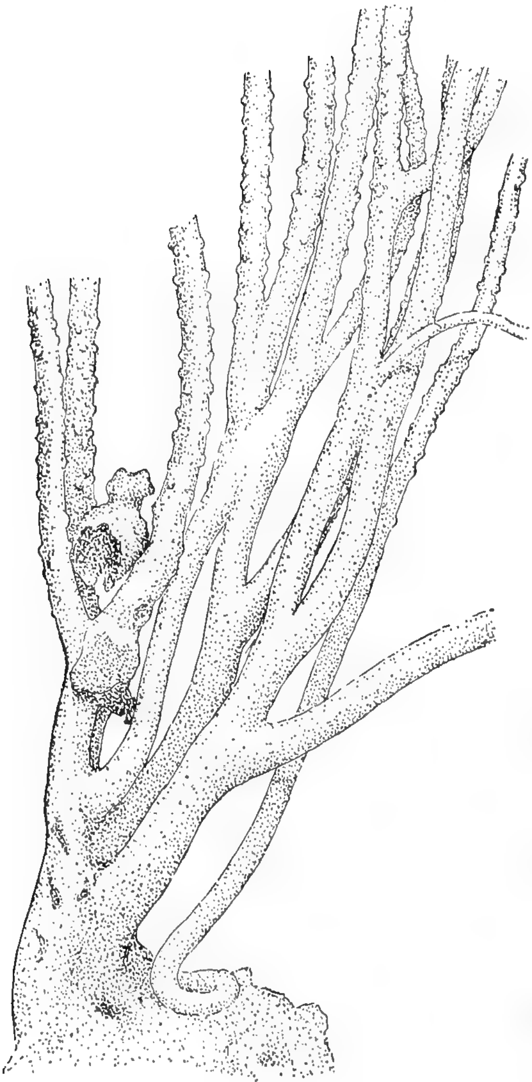


Fig. 46

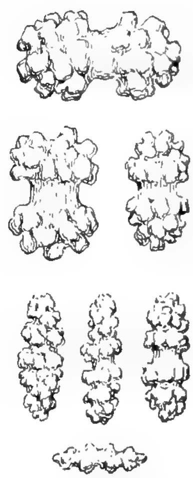
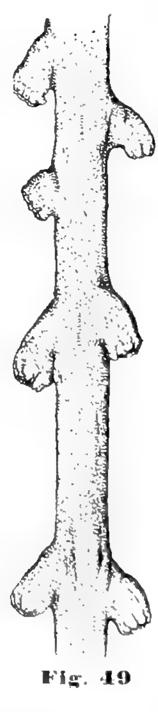


Fig. 48



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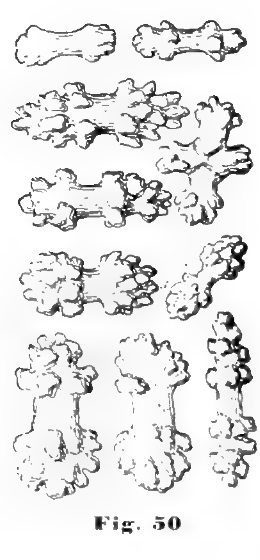

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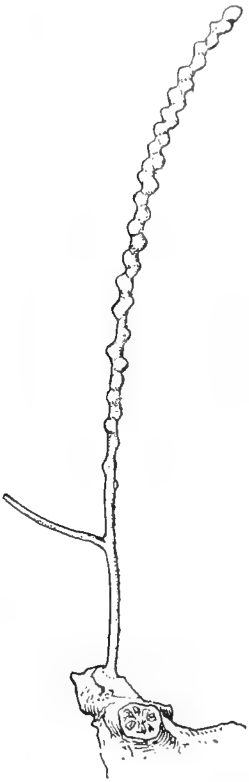

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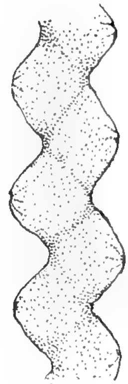

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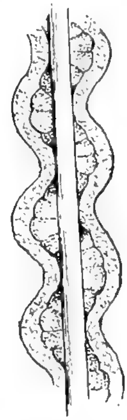

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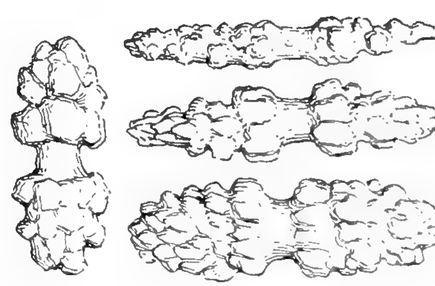

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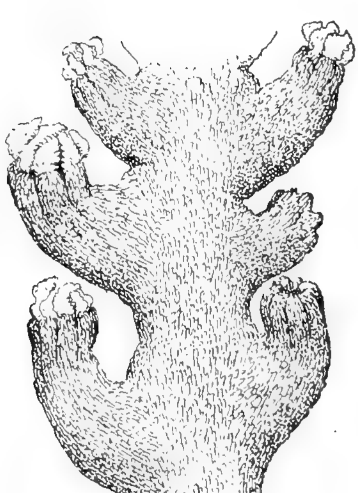

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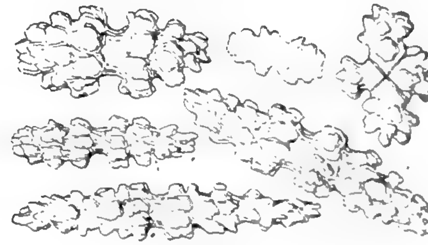

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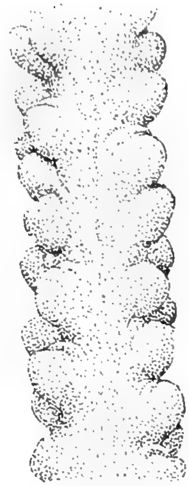

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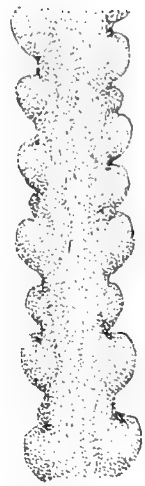

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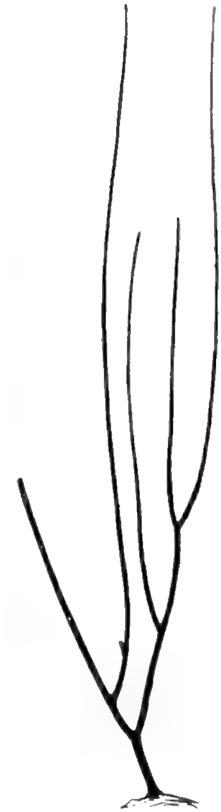

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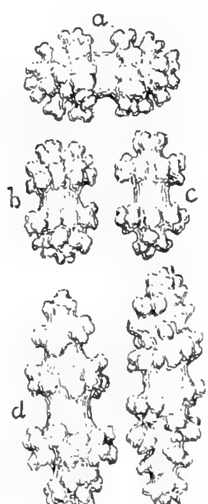

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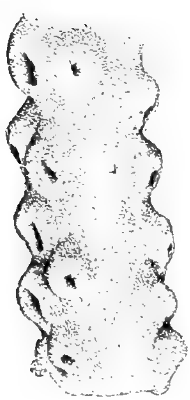

Fig. 62

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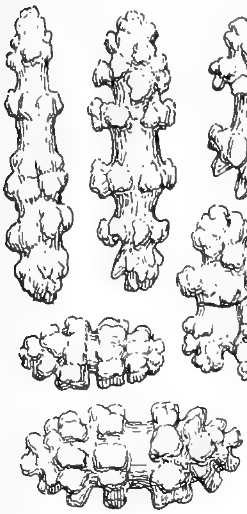

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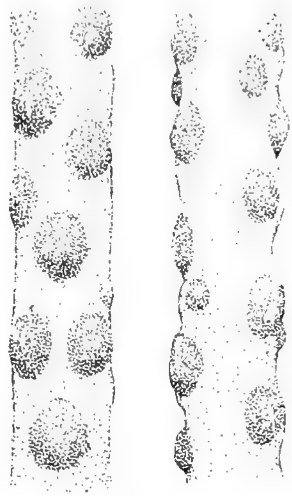
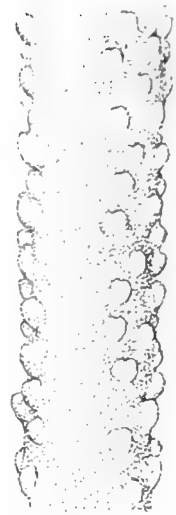


Fig. 69

Fig. 70



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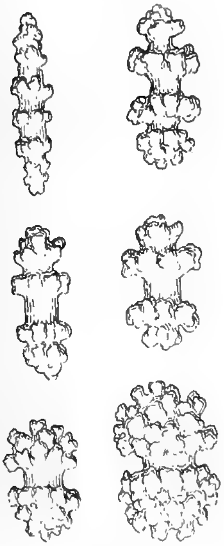

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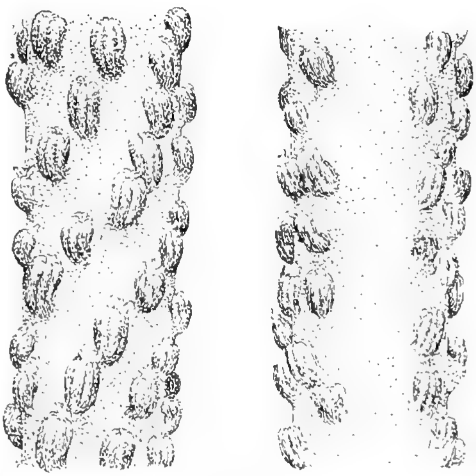

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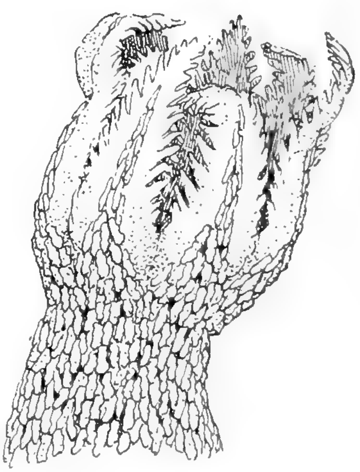

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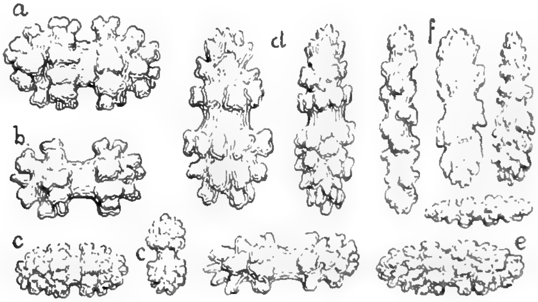
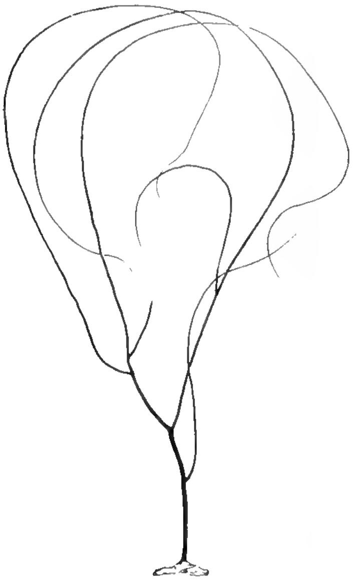


Fig. 75

Simpson—Gorgonellidae.



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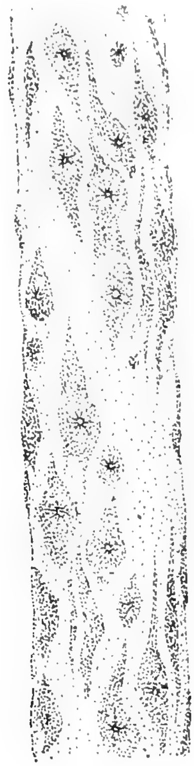

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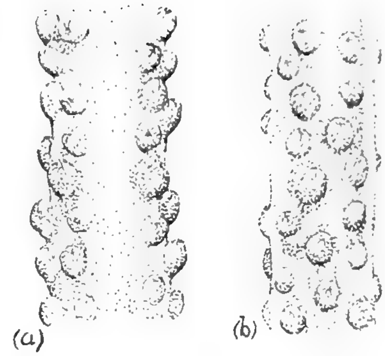

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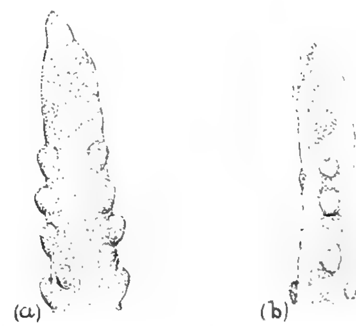

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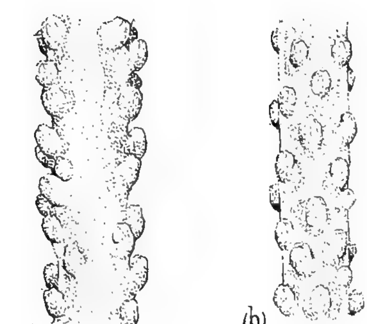

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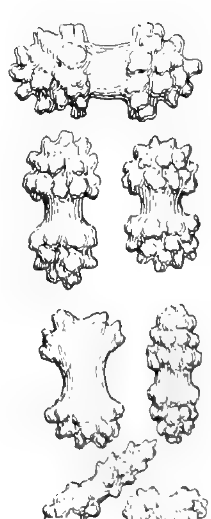
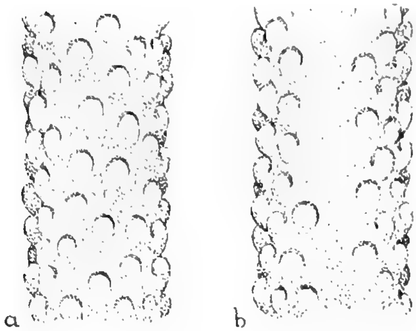


Fig. 81

Fig. 82



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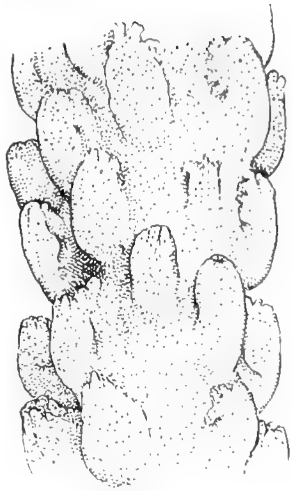

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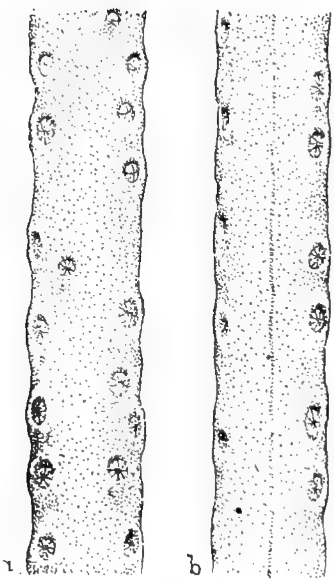

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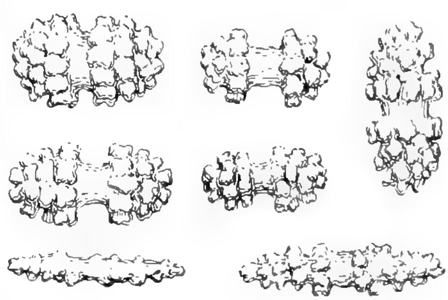

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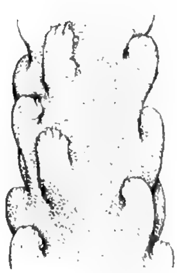

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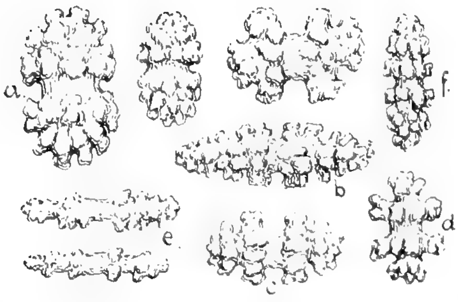

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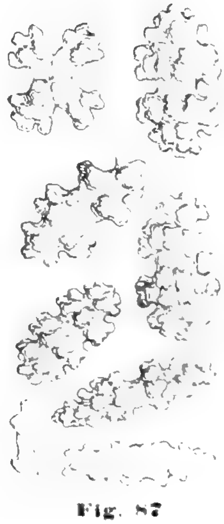


Fig. 87

Fig. 90

Simpson—Gorgonellidae.

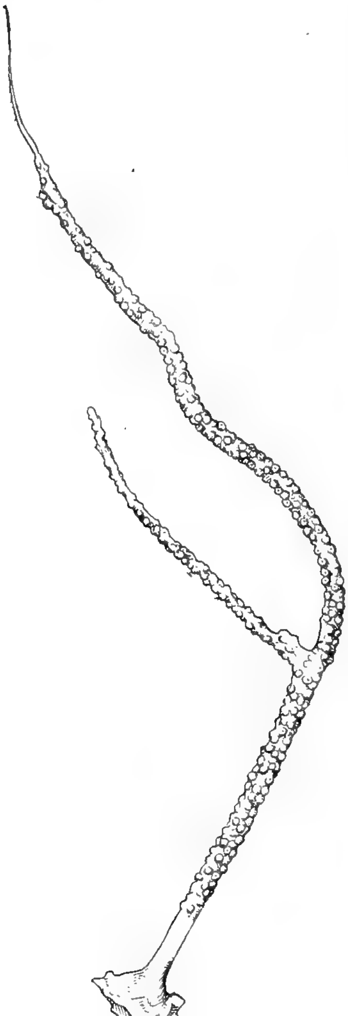
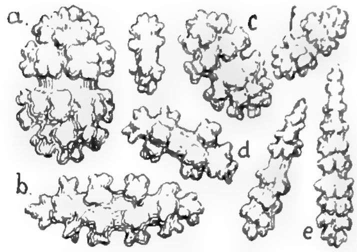


Fig. 92

Fig. 93



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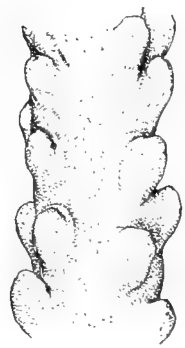

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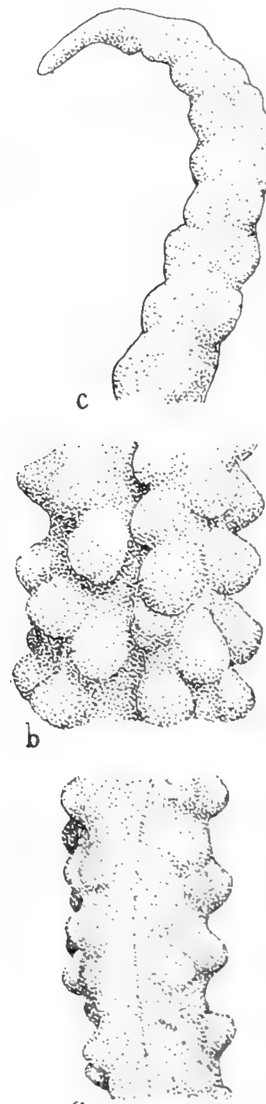

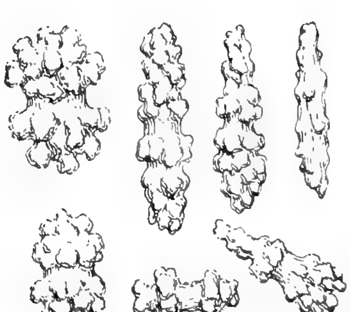

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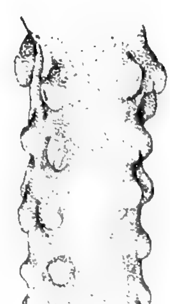
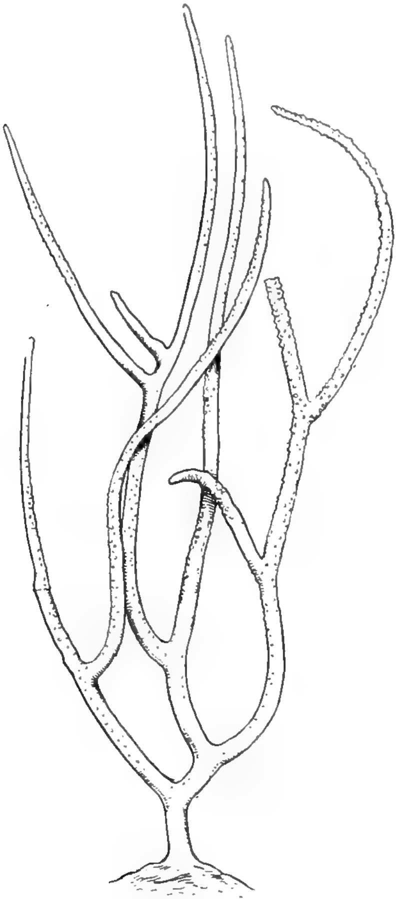


Fig. 99

Fig. 95

Simpson—Gorgonellidae.



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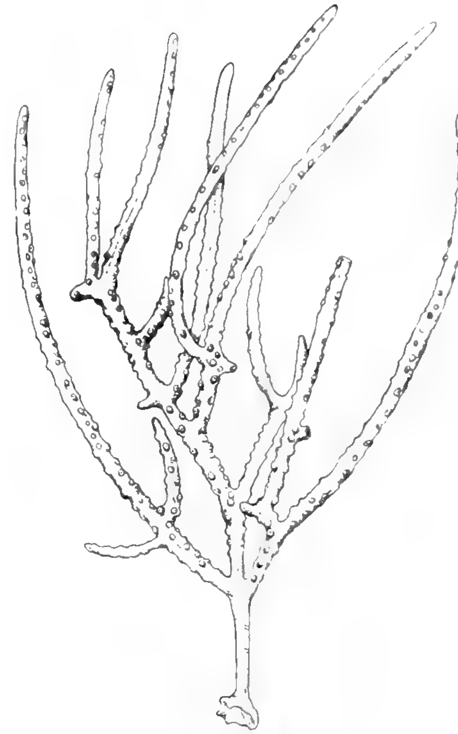
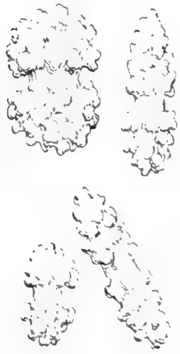


Fig. 102

Fig. 100



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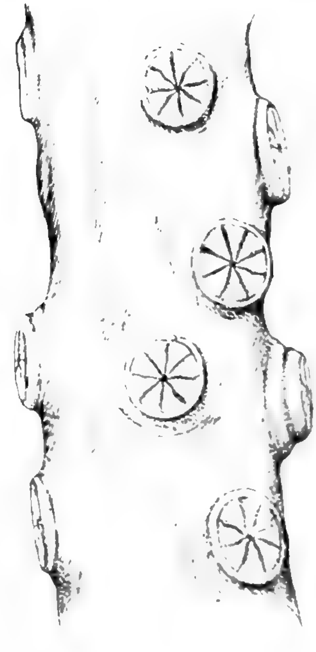

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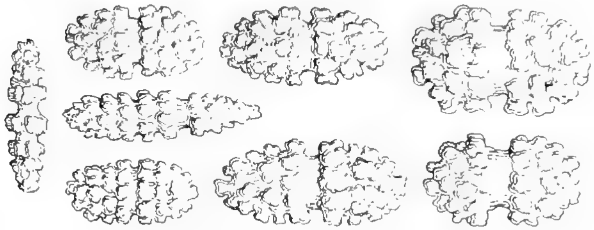

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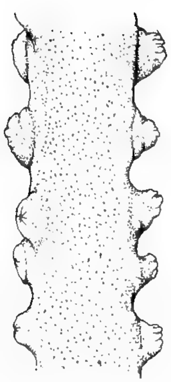

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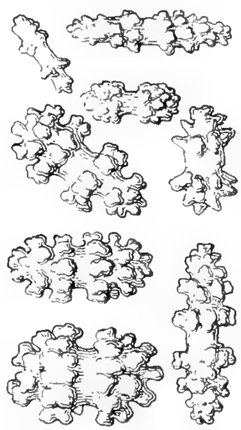


Fig. 107

Fig. 105

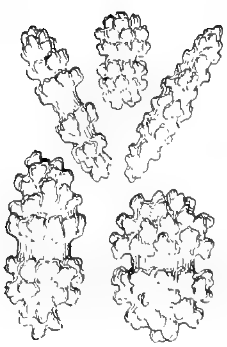


Fig. 109

Fig. 108

Simpson—Gorgonellidae.

Fig. 110

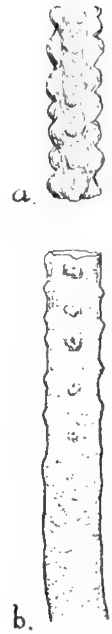
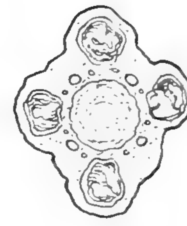


Fig. 112



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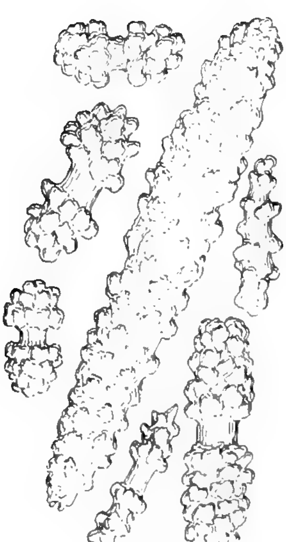

Fig. 114

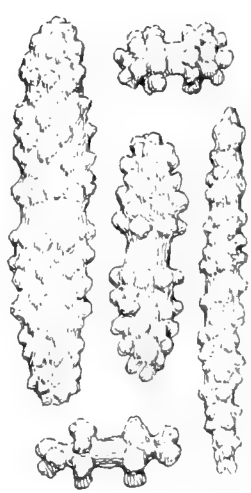

Fig. 115

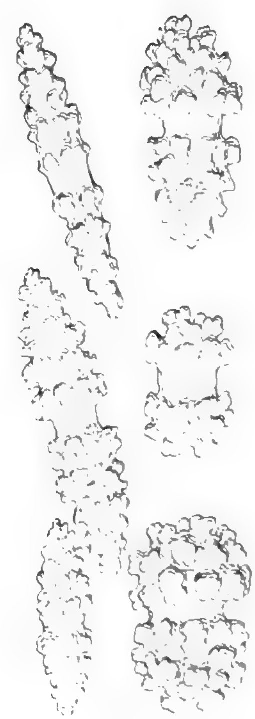

Fig. 113

Simpson—Gorgonellidae.

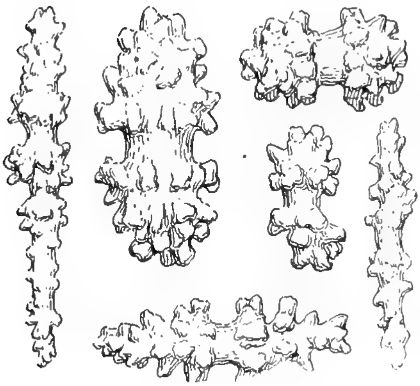

Fig. 116

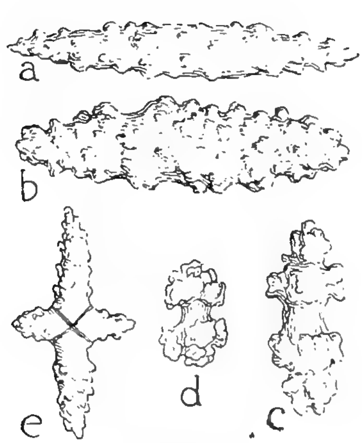

Fig. 118

Fig. 117

VIII.

ON THE CLAIM OF THE SNOWFLAKE (*LEUCOJUM AESTIVUM*) TO BE NATIVE IN IRELAND.

By MISS M. C. KNOWLES and R. A. PHILLIPS.

[COMMUNICATED BY R. LLOYD PRAEGER.]

(Plates XX.–XXII.)

Read June 13. Ordered for Publication June 15. Published July 28, 1910.

At the time the second edition of "Cybele Hibernica" was published in 1898, *Leucojum aestivum* was known to Irish botanists from the single station at Macmine Junction, Co. Wexford, where the Rev. E. S. Marshall had discovered it the year before. Messrs. Colgan and Scully therefore, considering that their knowledge of its Irish distribution was insufficient to justify its admission to the flora, relegated the plant to the appendix of that book, among the excluded species. In the following year, Mr. R. D. O'Brien recorded it from some unembanked land by the Shannon on the Clare side of the river near the Lax Weir, about two miles from Limerick city. On the strength of this additional locality, Mr. Praeger included it in his "Irish Topographical Botany," published in 1900, with a double dagger before its name, signifying "probably introduced."

Since the publication of these two books, *Leucojum aestivum* has been found in several other Irish stations. Its distribution on the Shannon, where it proves to be abundant, has been largely extended, and a good deal of information about the plant in general has accumulated. We propose to bring all this, together with the results of our own investigations, into one paper, so that botanists, having the full data before them, may be able to form an opinion as to the standing of the plant in Ireland.

It may be well at the outset to say a few words about the plant itself.

Leucojum aestivum possesses a large bulb, rooting perhaps 10 inches to a foot deep among the stools of willows and marsh reeds in swamps and ditches in the estuaries of rivers, and in marshy meadows along their banks. It also occurs in similar situations at storm-level on the shores of inland lakes and rivers. The leaves are hibernal. The flower scapes are developed, in Ireland, early in May, growing to a height of about 18 inches to 3 feet over the surface, the time of flowering lasting until the first or second week in June. Large three-valved capsules, varying in shape from pyriform to globose, and each containing several fertile shiny black seeds, follow the flowering. As the capsules ripen, the scape and leaves fall and soon decay, or are perhaps devoured by the snails and slugs that frequent these marshy places; so that it is almost impossible to distinguish the plant out of the flowering season. The capsules split open when ripe, and the seeds, which are quite buoyant, are carried off by the floods and spring-tides, and distributed here and there among the reeds and bushes that fringe the creeks and river-margins, there to germinate and grow.

It is the view of some botanists that *Leucojum aestivum* has possibly been introduced into the British Islands by man—that it may have been planted, or may have escaped from hypothetical gardens—a view for which no positive evidence seems to exist. We do not intend to try to disprove this; that would be to try to prove a negative; but we propose to show that the habitat and distribution of the plant on the continent of Europe, where it is admitted to be native, agree with its occurrences in England and Ireland, and that in its principal stations in both these countries, its abundance, its associates, the situations it affects, and the general conditions under which it grows, are such as to preclude all idea of its being an introduced plant.

The accompanying map (Plate XX.) has been prepared to show the distribution of *Leucojum aestivum* in Europe. In making it, we have consulted all available continental floras in the National Library of Ireland and elsewhere in Dublin. We have also examined the specimens in the Herbariums at Kew, British Museum, Manchester Museum, Trinity College, Dublin, and the National Museum of Ireland. A glance at this map will show that the plant occurs in almost every country in Europe. It is found in the Crimea, in the estuary of the Danube, in marshes and wet places in Roumania, Servia, Bosnia, and Slavonia, countries through which the Danube flows; it occurs also on the islands of this river in the kingdom of Hungary, and in wet places in Upper and Lower Austria. In Turkey it grows in Macedonia and Thrace, bordering the Aegean Sea, the Sea of Marmora, and the Black Sea. It is rare in Greece, being mentioned only, so far as we can find, from swamps and wet marshes in Euboea and on the island of Scopola. It is abundant in the low-lying regions of Dalmatia, Croatia, and Carniola. In "Die Vegetationsverhältnisse der illyrischen Länder," 1901, Dr. G. R. Beck von Mannagetta gives a very interesting account of the habitat of the plant in the countries bordering the eastern shores of the Adriatic. All along the coast in the estuary of the Narenta and other rivers there are extensive marshes, which extend inland for some distance, gradually passing from salt-water swamps into fresh-water ones. Here and there are large open stretches of water and deep pools. On the surface of these, where the brackish and fresh waters intermingle, float the Yellow and White Water-lilies, Limnanthemum, Potamogetons, and other plants not found in the salt-water swamps. The edges of these pools are fringed with impenetrable stretches of reed vegetation formed of *Scirpus lacustris, S. maritimus, Eleocharis palustris, Cladium Mariscus*, Typha, &c., the flowering element of this uniform association being formed by the Snowflake (*Leucojum aestivum*), the Yellow Iris (*Iris Pseudacorus*) and the Flowering Rush (*Butomus umbellatus*).

In Italy the plant is recorded from wet places and marshy meadows in the neighbourhood of the Gulf of Venice, on the banks of the River Po, and it is said to be common in similar situations in the northern part of the peninsula, especially on the shores of Lakes Maggiore, Como, and Garda. It is also found in inundated swamps along the course of the River Arno. In Switzerland it has been found in wet meadows at Yverdon, Lake Neuchâtel, and at Nidau at the north end of Lake Bienne. In southern France it occurs in ditches, marshes, and wet meadows along the Mediterranean from Nice to the Pyrenees, in Provence, in Languedoc, and in Roussillon. In western France it occurs in the estuary of the Gironde, and is abundant in the province of Tarn-et-Garonne. In northern France it is very common in two provinces drained by the Loire, viz. Loire-et-Cher and Sarthe. It is recorded from Belgium and Holland by Nyman in his "Conspectus." We have seen specimens from Malines; and Messrs. Krelage and Son of Haarlem, to whom we are indebted for specimens of the Dutch cultivated *Leucojum aestivum*, write that "*L. aestivum* is also a wild growing plant in Holland." In Germany it grows in Pflaz and Lothringen, in wet meadows of Westphalia, on the banks of the Lower Rhine above Speyer; it is found at Hamburg on the estuary of the Elbe, and is abundant in many places about Lübeck. Some of the German floras are doubtful about the standing of the plant in Germany, as it has been under cultivation for a long time in that country; but we can find no direct evidence to show that it is an escape. It also grows in Denmark on the island of Fünen and other places.

The extra-European countries in which *Leucojum aestivum* has been found are Asia Minor (the entire north) and Persia. In Asia Minor it is found in the tracts of country bordering on the Black Sea and the Sea of Marmora. It is also recorded from the Transcaucasian provinces. In Persia it occurs in the north of the province of Ghilian, which lies along the shores of the Caspian Sea.

Thus we see the plant has a continuous distribution from the Caspian Sea to the Bay of Biscay and the North Sea; that it grows chiefly along the banks of the larger rivers, such as the Dnieper, Danube, Po, Rhone, Garonne, Loire, Rhine, Elbe, &c., and on the margins of large lakes; that it is a plant frequenting a uniform habitat—namely, either fresh-water swamps in estuarine lands which are occasionally overflowed by the tide, or the flooded margins of lakes and rivers.

In England *Leucojum aestivum* grows under similar conditions. Certainly it was in such a situation that its discoverer, Curtis, found it, as will be seen from the following account taken from the "Flora Londinensis," vol. v., published 1788:—"*Leucojum aestivum* is found *undoubtedly wild* betwixt *Greenwich* and *Woolwich*, about half a mile below the former, close by the Thames side, just above high-water mark, growing (where no garden, in all probability, could ever have existed) with *Arundo Phragmites, Caltha palustris, Oenanthe crocata*, and *Angelica sylvestris*:—PROFESSOR JACQUIN, who figures it in the *Flora Austriaca*, and SCOPOLI, in his *Flora Carniolica*, describe it as growing in similar situations; their words are, '*Crescit in pratis udis et sub palustribus.*' It has also been found in the *Isle of Dogs*, which is the opposite shore." He goes on to say: "How so ornamental a plant, growing in so public a place, could have escaped the prying eyes of the many Botanists who have resided in London for such a length of time seems strange. For my own part, I am perfectly satisfied of its being a native of our island, and have no doubt but it will be found in many other parts of it."

That *Leucojum aestivum* has been overlooked for so long in these islands does not seem surprising when we remember that it flowers early in the season, and that the situations in which it grows are wet, unpleasant, and often inaccessible at that time of the year; also that botanists were wont to delay their expeditions to such places until the sun was high in the skies at the end of June or the beginning of July. When the rank grasses and reeds of the river-swamps have developed, it is quite impossible to recognize the plant. We ourselves have experienced the greatest difficulty in finding marked clumps.

Curtis's prediction was fulfilled; for in Watson's "New Botanist's Guide," published 1837, we find the Snowflake recorded from "Kent, Suffolk, Bucks, Berks, Oxford, Warwick, Westmorland, Durham, Northumberland (?)." In the local floras more particulars are given about the habitats of the plant. In Kent it is "river-sides and adjacent marshes"; in Oxfordshire, "moist meadows and marshes near rivers," "osier holts and shady places by the Thames side"; in Sussex, "wet meadows"; in Dorset, "wet meadows and ditches"; in Middlesex, "wet marshes and rivers"; in Northumberland, "a mill dam near Heaton"; in Westmorland, "a small island in the river about three miles south of Kendal"; in South Devon, "a willow plot near Totnes"—

always the same kind of situation. There is a specimen from the Devonshire station in the Herbarium of the National Museum, Dublin, labelled, "Semi-tidal marsh, Totnes, Devon. June, 1876. Ex. Herb. Th. Chandlee." The plant is supposed to be extinct in the Northumberland and Westmorland stations. We have, however, recently seen a specimen from a Westmorland locality—viz., the mouth of the Rothay where it flows into Windermere—collected in 1894.

The earlier English botanists were divided in their opinion as to whether *Leucojum aestivum* should be regarded as native. Curtis, the discoverer, as we have seen, was satisfied on this point. Watson, however, called it a denizen—that is, a plant "At present maintaining its habitats as if a native species, without direct aid of man, but liable to some suspicion of having been originally introduced by human agency, whether by design or accident"; and he gives Aconitum, Chelidonium, Saponaria, Myrrhis, and Buxus as examples of what he means by denizens.

Most of the botanists of Watson's day were influenced by his views on this question. The trend of opinion nowadays, however, especially among those who have studied the plant *in situ*, would seem to be in favour of considering *Leucojum aestivum* native in England. E. S. Marshall holds that it is native both on the Thames and in Ireland. Druce considers it native in Oxfordshire. Hind records it as native in Suffolk. Dunn, in his "Alien Flora of Britain," says, "As its undoubtedly native range includes Northern Continental Europe, it may be considered as a rare native in Britain also." Sowerby in "English Botany," after mentioning that it is apparently native by the Thames, adds that in its typical form it is less often met with in cultivation than *L. Hermandezii*, which has smaller flowers, and frequently does duty for *L. aestivum* in Botanic Gardens. We also found this to be the case, and have seen *L. pulchellum* (L. Hermandezii) labelled *L. aestivum* in more than one Botanic Garden.

On this point, as the two plants are so similar in general appearance, and so easily confused, it may be well to say a few words about the differences between them. We went very carefully into this matter during the last two seasons, examining and comparing hundreds of fresh specimens from the Continent, from England, and from Ireland. (We would here gratefully acknowledge the assistance we received from the Keeper of the Kew Herbarium in making out the distinguishing characters of the two species.) We found that the edges of the scape in *L. pulchellum* are quite entire, whereas in *L. aestivum* they are characterized by what appear to be rough translucent teeth. These are easily seen when the plant is held up to the light. We were much puzzled by these teeth, as we could find no reference to them in any of the descriptions of *L. aestivum*; and as they were very pronounced on all our Irish specimens, we were at first inclined to think that perhaps our plant might be a variety. However, we found the same character in fresh specimens of *L. aestivum* both from the Continent and from England; and a reference to it, pointed out to us by Dr. Stapf, will be found in R. A. Salisbury's "Paradisus Londinensis" (1806–7), tab. 74, where in describing *L. p[illegible]* Salisbury says—"Peduncle . . . very entire at the edges, not [illegible] and crenulated as in L. aestivum." Of these crenulations Dr. Stapf further says—"Mr. Boodle has pointed out to me that the translucent white edge of the scape of L. aestivum is due to the epidermis running out beyond the green parenchyma, whilst in L. pulchellum this is not the case."

In *L. [illegible]* the spathe is broader, and the style is longer and stouter, [illegible] and the colour of the spot is paler (greenish-yellow) than in *L. pulchellum*. There are other differences between the two species. For [illegible] the angles of the young fruit in *L. aestivum* are more obscure and [illegible] than in those of *L. p[illegible]*. But the two chief characters to be [illegible] distinguishing the plants are those of the scape and the style. W[illegible] side by side the difference between the two species is [illegible] *L. [illegible]* being smaller in all its parts, its leaves narrower [illegible] green and more glossy. Its scapes are more slender, and bear [illegible] very rarely four flowers which are much smaller, and are usually produced three or four weeks earlier than those of *L. aestivum*.

We found *L. pulchellum* more frequently grown in Irish gardens than *L. aestivum*; yet *L. pulchellum* has not been found in wild situations in Ireland. Dunn, in his "Alien Flora of Britain," says of *L. pulchellum*—"Grown in English [illegible] occasionally observed as an escape"; but he mentions [illegible] and we have been unable to find records [illegible] or hear of any herbarium specimens from [illegible]. The Keeper of the Kew Herbarium, to whom we wrote on [illegible] our material, I find we have only a few specimens of L. pulchellum, and they are all from gardens."

H[illegible] the plant's habitat and distribution in Europe and England, let us turn to Ireland.

As already stated, *Leucojum aestivum* was first recorded for this country by the Rev. E. S. Marshall, who early in June, 1897, found it in a swamp by the river Slaney, near Macmine Junction, Co. Wexford. Mr. Marshall counted 60–80 fine specimens in flower or fruit, and saw nothing in the surroundings to make him doubt its being indigenous.

On the 29th May, 1909, we visited this locality, and found the plant plentiful as described by Mr. Marshall, and the habitat quite typical (as shown in Dr. Fogerty's photographs, Plate XXI., figs. 1 & 2)—an extensive brackish marsh covered with Phragmites, *Carex riparia, Cladium Mariscus,* and other truly native estuarine plants. The only garden near the place is that connected with the castle on the opposite side of the railway line. This we searched, and found no trace of Leucojum in cultivation there, nor was the plant known to the proprietor or his gardener.

In the "Journal of Botany" for October, 1908, Mr. Marshall reiterates his opinion that *Leucojum aestivum* is native in Ireland, and cites Miss Knowles as agreeing with him. In the same note he states that the plant has been found over a wide area in Connaught, which remark is rather misleading, as Co. Clare, to which he evidently refers, though west of the Shannon, belongs to Munster.

The next discovery of the Snowflake in Ireland was made by Mr. R. D. O'Brien, who in 1897 found it growing in the meadows and among willows at Parteen, Co. Clare, from the railway bridge to the Lax Weir, about two miles north of Limerick; and up the creek at Whitehall as far as the tide goes. The following spring Mr. O'Brien got it on the Limerick shore above the railway bridge, and since then its known range along the Shannon has been greatly extended. It occurs among the willows on the bank of the Abbey River, and on King's Island. These stations are all above Limerick. Below the city it is found here and there among the rushes on the south bank of the river, from below the docks to the mouth of the Ballynaclough River, where it is exceedingly abundant; also sparingly along the marshy banks of that stream for half a mile towards Ballinacurra. On the north bank of the Shannon we have seen it far out on the muddy shore at Coonagh Creek. Further down, the Shannon has not yet been explored; but so far we see that it occurs in almost every suitable spot along a stretch of six miles. Further west, on the Maigue, an important tributary of the Shannon, it grows among willows near Adare, and also in quantity on unembanked land by the Greanagh River from Curragh Bridge to where it joins the Maigue.

The accompanying photographs (Plate XXII., figs. 1 & 2), taken by Dr. George Fogerty, give an excellent idea of the plant in its natural habitat on the flat banks of the Ballynaclough estuary, where it grows most luxuriantly; thousands of individual plants and small clumps, and several large clumps, measuring 4 and 5 feet across, are scattered over an area of several acres, associated with *Caltha palustris, Cochlearia anglica, Lychnis Flos-cuculi, Oenanthe crocata, Angelica sylvestris, Myosotis palustris, Aster Tripolium, Rumex crispus, Orchis incarnata, Eleocharis palustris, Scirpus lacustris, Carex riparia, C. paludosa,* Phragmites, and other species characteristic of such situations.

During the month of May, the Snowflake is a most conspicuous object in this station, but after that it is completely hidden by the dense growth of Phragmites, which reaches 10 to 12 feet in height: and we have found on penetrating this jungle early in July, in order to obtain some fruiting specimens, that although we had collected the plant here in flower a month before, it was only after a long and troublesome search that even the largest clumps could be located.

In these Shannon marshes *Scirpus triqueter*, which in England is found only in the Thames and Arun rivers, and on the Continent has a distribution somewhat similar to that of Leucojum, finds its only Irish habitat. And here also, as well as in the marshes of the rivers Barrow, Nore, and Suir, the rare little brackish-water mollusk *Paludestrina confusa*, confined elsewhere to the Thames and a few other estuaries in the south of England, and some of the rivers of the Mediterranean region, is exceedingly abundant.

For many miles the land on each side of the Shannon is enclosed between high embankments, inside which Leucojum has not been found, probably because the marshes having been reclaimed for the cultivation of pasture grasses and other crops, all the suitable habitats have disappeared. The margins of the creeks flowing to the Shannon, where it should be found, are closely grazed by young stock. On this subject Mr. O'Brien says that it seems to be one of the conditions of the plant's existence that it should come within the wash of the spring tides; and in the "Limerick Field Club Journal," 1905, he aptly writes: "Its true habitat is round the bushy creeks and lagoons at the verges of the tidal marshes—refuges that have been almost abolished by the embankment of the riverain lands, and by ploughing the corcass for corn."

In May, 1900, Mr. F. Nicholson sent specimens of *Leucojum aestivum* to Mr. Praeger from Killarry Bog, about one mile from Waterford, and reported that it had been known here for nearly forty years. Mr. Nicholson informs us it was first gathered here in 1869. We visited this station on the 30th of May, 1909, but were unsuccessful in our search for the plant. This season, on the 16th of May, Mr. Phillips made another search, and found one large clump. It was growing in a very wet place, and he had to wade to secure a specimen. More plants would no doubt have been seen by Mr. Phillips if he had not been pressed for time; for Mrs. White of Westmount, Waterford, writes that she and her son went to look for *Leucojum aestivum* in this marsh on the 15th May, and found it abundant. Mrs. White says: "We found a great quantity not where we found it before, but well into the marsh, and greatly hidden by the grass stems—several large patches, each about a square yard and hundreds of blooms, so it is really very plentiful. The place it grows in is often completely under water, but happened to be moderately dry at the time we found it. It was in full bloom—only a comparatively few unopened buds, and a good many faded flowers." The spring of 1909 was an early one, and no doubt the plant was out of flower when we looked for it here on the 30th of May; at any rate four people, all well acquainted with the appearance and habitat of the plant—ourselves, Miss McArdle, and Dr. George Fogerty—spent a whole morning searching the swamp without finding any trace of it. This unsuccessful search shows, we think, how very easily the plant may be overlooked, and also how little reliance can sometimes be placed on negative evidence.

The Kilbarry station is an extensive marsh covered with Phragmites and other exclusively native plants. It is drained by a tributary of the Suir. During high spring-tides this stream (locally known as John's Pill) overflows its banks, flooding large tracts of marshy ground. Thus the conditions of habitat here agree with those existing in the Slaney and Shannon stations. *Paludestrina confusa*, which accompanies *Leucojum aestivum* in the Shannon, is abundant here also.

The Snowflake has also been found by the Clodagh River, another tidal tributary of the Suir. We were unable to visit this station; but the Rev. W. W. Flemyng, the finder, kindly sent us some blooms of the plant from bulbs in his garden, brought in there from the wild station; and they are the true *Leucojum aestivum*. Other cases of the transfer of this species from marsh to garden have come under our notice. Mr. Flemyng says there is not much of the plant in this station; that it was growing beside the river, though its roots were not actually in the water; and that the ordinary plants that grow in such situations were associated with it.

Early in 1909 we were informed of another station, discovered in 1897 by Mrs. White, of Clonageera, Queen's County. Under the direction of Mr. White we visited this locality in May last, and found that it is a large swamp by the river Erkina, near its junction with the Nore, about half a mile below the village of Durrow. Here again the plant is abundant in the midst of perfectly natural surroundings; for, though the river is not tidal, the marsh, at all times very wet, is during floods completely inundated. Its associates in this place are all native plants. Among them we noticed *Ranunculus Lingua, Caltha palustris, Angelica sylvestris, Menyanthes trifoliata, Mentha hirsuta, Sparganium simplex, S. ramosum, Typha latifolia, Scirpus lacustris*; various sedges, including *Carex stricta* and *C. riparia; Phalaris arundinacea, Phragmites communis*, &c. On inquiry we found that the Leucojum was known here for at least forty years. Being so near the village, there are flower and vegetable gardens in the vicinity; but on searching those nearest to the swamp we failed to find the Snowflake in any of them, and Mr. White has since informed us that the plant is unknown in any of the gardens in the district. Among the mollusca of this marsh we have taken the very rare little land snail *Vertigo moulinsiana*, found elsewhere in Ireland only by the river Barrow; in England confined to a few of the southern counties; and on the Continent, like *Leucojum aestivum*, widely distributed through the southern and western countries.

In 1905 a large patch of *Leucojum aestivum* was discovered by Mr. R. W. Bingham in a bog a few miles from Dungannon, Co. Tyrone. This statement was published in "Additions to Irish Topographical Botany for 1905" (Irish Naturalist, 1906, p. 60); and Mr. Praeger, who has seen the place, informs us that the plant grows in a spot that must have been on the shore of Lough Neagh before it was contracted by the Bann Drainage Works.

In the Irish Naturalist, 1906, Mr. W. J. C. Tomlinson reports the occurrence of *Leucojum aestivum* in a boggy wood which borders the Lough Neagh shore between the water's edge and the Deer Park wall, about two miles from Antrim town. It was growing about the centre of the wood, which consists of alder, birch, and willow, with a dense undergrowth. Associated with the Leucojum were *Caltha palustris*, *Ranunculus Flammula*, *Orchis mascula*, and *Scilla nutans*. There were only a few plants of the Snowflake, which, from Mr. Tomlinson's account, seems to be, in common with many other rare marsh species of Lough Neagh district, failing on account of drainage.

Leucojum aestivum has also been recorded from damp meadows at Lisgoole, Co. Fermanagh, in Mr. Praeger's "Flora of the West of Ireland," p. 192.

As habitats for *Leucojum aestivum*, the Tyrone and Antrim stations, being so far removed from tidal influence, seem at first sight to be abnormal; but both are in the neighbourhood of Lough Neagh, and we have already shown that the plant is native on the shores of large lakes in Italy and Switzerland. Moreover, we must remember that the flora of Lough Neagh includes several maritime or sub-maritime plants not usually in Ireland found inland—for instance, *Viola Curtisii*, *Spergularia rupestris*, *Scirpus maritimus*, *S. Tabernaemontani*, &c.

To sum up the results of our investigations, we have shown that *Leucojum aestivum* is distributed throughout most of the principal river-systems of southern and western Europe; that in England it has a wide range on the southern rivers under exactly similar conditions; and that in Ireland it occurs spontaneously and abundantly in at least three of the principal river-systems of the south, with surroundings and associates that in no way differ from those prevailing on the Continent, where its standing as a native has never been questioned. In the garden *Leucojum aestivum* can only maintain itself in the cultivated border; in our experience if planted in the grass it dies. Several people have told us that they have lost the plant in this way; so that we think it is much more likely that the Snowflake, like *Saxifraga umbrosa*, the Foxglove, the Welsh Poppy, and many other beautiful-flowered plants, has been brought from its native haunts into the garden than that it has escaped and become established in so many widely separated localities. Its congener, *L. pulchellum*, seems to have been more widely distributed in cultivation; yet, so far as we can find, it seems never to have escaped or to have naturalized itself. We, therefore, see no reason for looking on *Leucojum aestivum* as an alien in England and Ireland, which, though now separated, were at one time a western continuation of the Continent.

In conclusion, we would like to thank all those who so kindly supplied us with fresh specimens, both from gardens and from wild situations; Mr. R. D. O'Brien and Mr. Praeger for many helpful suggestions; and Dr. George Fogerty for the excellent photographs of the plant which illustrate the paper.

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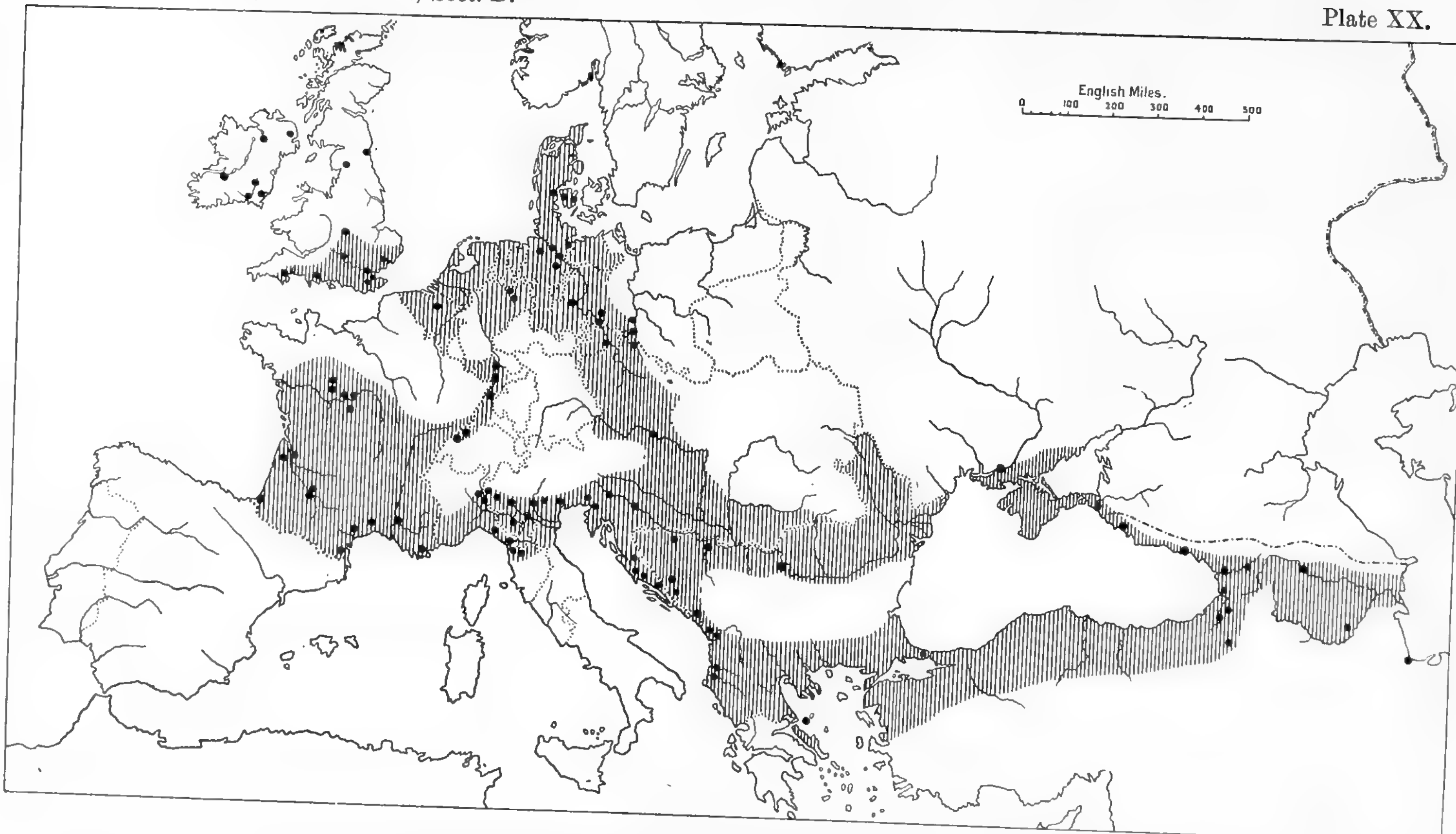

Distribution of Leucojum aestivum.

The black dots show definite recorded stations; the shading shows areas from which it is recorded.

Knowles and Phillips—Leucojum aestivum in Ireland.

FIG. 1.—Macmine, Co. Wexford—General View.

FIG. 2.—Macmine, Co. Wexford.

KNOWLES AND PHILLIPS—LEUCOJUM AESTIVUM IN IRELAND.

Fig. 1.—Ballinacurra, Co. Limerick.

Fig. 2.—Ballinacurra, Co. Limerick.

Knowles and Phillips—Leucojum aestivum in Ireland.

PROCEEDINGS

OF THE

ROYAL IRISH ACADEMY

VOLUME XXVIII

SECTION C.—ARCHÆOLOGY, LINGUISTIC, AND LITERATURE.

DUBLIN: HODGES, FIGGIS, & CO., LTD.
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CONTENTS

SECTION C.—ARCHÆOLOGY, LINGUISTIC, AND LITERATURE.

ERRATA.

SECTION C.

Page 113, ll. 14, 24, *for* HARTOLFA *read* HARTOLFE
Page 113, l. 29, and foot-note, *for* A *read* B
Page 164, l. 4 from bottom, *for* Ce *read* Cl
Page 198, l. 5, *for* rebuilt *read* built

PROCEEDINGS

OF

THE ROYAL IRISH ACADEMY

PAPERS READ BEFORE THE ACADEMY

I.

A STUDY OF THE FORT OF DUN AENGUSA IN INISHMORE, ARAN ISLES, GALWAY BAY: ITS PLAN, GROWTH, AND RECORDS.

By THOMAS JOHNSON WESTROPP, M.A.

(Plates I.–III.)

[Read December 13. Ordered for publication December 15, 1909. Published February 17, 1910.]

Sections:

1. Legendary Origin.
2. Problems of the Legend.
3. The Plan.
4. Records of its Features.
5. The Fort in 1909.

Appendices:

A. Bibliography and Views.
B. Unpublished Descriptions before 1880.
C. Published Accounts to 1880.

Of all the early forts of Ireland we may say that only one has appealed to the imagination, and even to the affection, of the nation, as a building, and become, with most antiquaries, the type and symbol of the countless similar structures, all subordinate to it in interest. At Emania and Tara it is the sentiment and tradition, not the remains, that so appeal; but at Dun Aengusa the site and the building affect even the coolest mind as no blaze of mythic or historic association could do. It is easy to see how this pre-eminence arose. Many of us still remember the sense of almost inaccessible remoteness that attached to "the Aras of the Sea." All who have visited the spot feel the "repellent attraction" of the gigantic precipice and the swirling abyss over which the fort is so airily poised. Then there is the pathos—no less of the legend that made it the refuge of a doomed and hunted race than of its own inevitable destruction—that invested the broken grey walls on the farthest edge of the old world. The facts that the fort had attracted the notice of the learned for over two hundred years, while its compeers lay undescribed till the middle of the last century; and that on the revival of sound archaeology it was studied and most impressively described by some of our greatest scholars—Petrie, O'Donovan, Ferguson, and Dunraven—all told in its favour. None other of the forts—not Tara, Emania, or the Grianan of Aileach—was so honoured.

It needs justification to bring forward a paper on it at present. May I, as one of the few who noted and sketched it over thirty years ago, ere its restoration, bring before the Royal Irish Academy an attempt to record its architectural history and its present condition? No one, I believe, has as yet described it in detail since its far too thorough "restoration" in 1884, or endeavoured to decide what of its present features are ancient, what warrant there may have been for the restored work, or what the remains have to tell to scientific antiquaries. In all this there seems, not only an excuse, but a necessity, for another essay; so I may venture to give the results of work done in 1878, and many subsequent occasions, without incurring invidious comparisons with great predecessors in the same field of study. In this spirit I lay these notes before the members of the Academy.

1.—Legendary Origin of the Fort.

We must commence with an oft-told tale—that of "the sons of Umór." In the revival of Irish nationalism under King Brian, before that great monarch's tragic death in 1014, his bard, Mac Liag, is said to have versified a legend, probably derived from a far remoter past. The period was one of restoration; law and order, arts and learning, forts, churches, and towers were being restored everywhere; and, among other matters, an attempt was made to recover all that survived the dark and destructive ninth century; and in these compilations of "tribal lays" and historic poems lies most of our knowledge of the "beginnings" of the Dalcassian realm. These beginnings were obscure beside the mythic glory that rested on Tara, Eman, or Rathcroghan; but the Dal gCais (descendants of the banshee-wooer Oilioll Olum and the Corca-modruad sprung from Fergus Mac Roigh and the great Queen Maeve) must have longed to hear what befell their ancestry "in the beginning," and now they no longer lacked a bard. The legend that centres at Dun Aenghus related to the period before the tribe of Fergus settled on the hills of Burren over three centuries before Lughad, Conall, and Enna, the conquering Dalcassian Princess, on the edge of recorded history (A.D. 380–400), added the southern fringe of Connacht to North Munster, from which it eventually usurped the name Thomond.

The song[1] told how a Firbolg tribe—the Sons of Umór, or Huathmór—after an exile in the Hebrides, got settlements in the Boyne Valley. Oppressed by the perennial land question—their rack-rent paid to Tara—they fled to Connacht, were befriended by its heroic queen, "Maeve of the Cattle Foray," and were settled round Clew Bay and Galway Bay about the beginning of our era.

> "They settled westward, along the pleasant coasts,
> As far as Dun Aenghusa in Ara:[2]
> . . . .
> They stationed Mil at Muirbech:
> They planted Daelach at Dail:
> Aenach constructed a 'dun' in his neighbourhood.
> . . . .
> They settled Beara at his headland:
> Irgas took possession of Ceann Boirne;
> . . . .
> Concraid obtained his just portion in the sea at Inismedhoin."

The prose of the Dind Senchus[3] tells a like tale, with a trace of independence in its account of Ennach and Bir, but otherwise closely following the poem.

"Cairpre" (it says) "imposed on the children of Umór a rent which could not be endured, so they decamped from him, with their possessions, westward to Ailill and Medb, and set up beside the sea—Oengus in Dun Aengusa, in Ara . . . Mil at Murbech Mil (perhaps at Port Murvey,[4] near the last); Daelach on Dail (Lissydeela and Ballydeely in Corcomroe, Clare); Bir at Rind Beara Sirraim (Finnavarra, Burren, Clare); and Ennach, from whom is Tech nEnnach (perhaps Doon Fort, Corcomroe) . . . Irgus at Rind Boirne (Caherdooneerish, on Black Head, Burren); . . . Conchiurn at Inis Medon (Dun Conor, Inismaan, Aran); . . . Taman at Rind Tamain" (Tawin Island, Galway). All these lay round the bay of Galway. The knights who stood securities for the Firbolgs to the King of Tara claimed the penalty, so the Huamorian warriors, Cing, Cimbi, Irgus, and Conall (son of Aenghus of Dun Aengusa), met in deadly combat the Red Branch Knights—Ross,

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[1] "Ossianic Society," vol. v., p. 287.

[2] If Keating be right, there was an earlier colony of Firbolgs in Aran, a remnant that escaped the carnage of the Battle of Moytura (ed. D. Comyn), p. 199—The Cruithnigh or Picts banished them out of these islands.

[3] "Revue Celtique," 1894, pp. 478–480.

[4] Petrie regards this as really Cill Murmhaighe—"Military Architecture," p. 68; but there was a great fortification which may have originated the chief's name. It is strange that Dun Oghil makes no mark in legend.

Conall-Cernach, Cet. and Cuchullin.[1] The Firbolgs fell, and the settlements were broken up, leaving a legend and their reputed forts—"vacuae sedes et inania arcana"—as their monument to our days.[2]

There is a curious allusion to the founder of Dun Aengusa, more concrete than his misty name, in the tale. The helmet of Briun, son of Smethra, is described thus in the "Book of Lismore"—"It was the brasier of Oengus, son of Umor, who made it, even a helmet of the pure purple of the land of the Indians, with a ball of gold above it." It had strings of beads of carbuncles, red-gold, and white bronze, in variegated stitching, and was one of the three chief fabrics of the realm of Erin.[3]

Probably the Firbolg Prince once stood with less blurred outline, for (if it indeed allude to the Aran Fort) a poem on "the taking of Dun Oengusa"[4] once existed, and its loss is probably a severe one to students of the fort. Besides these, it is barely possible that Tighernach, about 617, alludes to the place, in recording the "combustion of Dun-ainega," for the "Firbolg names" have been recast in some cases, into familiar forms, as Chonchobhair, for Conraid and Chonchiurn, and Fergus for Irgus, in the legends of 1684, and later attached to the forts of Inismaan and Burren.

Now as regards the main legend, one of its versions adds, "Thus they lived in fortresses." Which forts were meant by the bards of the tenth century? Dun Aengusa is certain. Roderic O'Flaherty, in 1684, records the legend that Dun Conor in Inishmaan was named from Conquovar ("Concraid" in the older legends); but the peasantry attributed the fort to Conor na Siudaine O Brien,[5] Prince of Thomond, who fell in battle, 1267,[6] and whose tomb is with us to this day. Caherdooneerish in Clare (as it is still called by the peasantry) was rendered "Caherdoonfergus" by the map-makers of 1839, with the sanction of O'Donovan.[7] He seems to have searched for traces of Fergus, son of Roigh, and so, probably by leading questions (the deadliest

[1] The Legend of Aonghus of Dún Aonghusa in Ara is also given in Keating's History of Ireland (Irish Texts, vol. iv., edited by D. Comyn), p. 201.

[2] Neither the late Dr. W. H. Stacpoole Westropp in 1877 and 1878, nor my late brother Ralph Hugh Westropp and I, in 1878, could find any local legend as to who was the builder or what was the history of the Doon. The same seems true of the Rev. W. Kilbride. It is a great pity that this last most favoured student of Aran seems to have only left his valuable paper on Iararna and some crude general notes in manuscript, the latter now in the collection of the Royal Irish Academy. When John O'Flaherty wrote, about 1820, Tales of Cuchullin and the Red Branch heroes as well as of Finn, Oscar, and Ossian, were recited. O'Donovan in 1839 does not seem to have found any traditions of early date.

[3] "Lives of the Saints, from the Books of Lismore" (ed. Whitley Stokes), 1890, p. xxx.

[4] "Togail Duine Oengusa"—M. D'Arbois de Jubainville's "Catalogue of the Epic Literature of Ireland," p. 244.

[5] "Dublin University Magazine," vol. xli., p. 501.

[6] So in Annals of Inisfallen and the Four Masters, but 1268 in those of Clonmacnois.

[7] Ordnance Survey Letters, Co. Clare (MS. 14, B. 23, R. I. Acad.), vol. i., p. 205.

source of error in collecting names or folk-lore), found what he so greatly desired. The peasantry, who never heard of Irgus (or "Eerish" phonetically), gave the names "Caherdooneerish" and "Doonirias,"[1] without prompting; indeed I was at the time obsessed by the name on the map, and only driven to better things by the names which Dr. Macnamara and I had collected independently at different places and on different occasions. Another place contemplated by the legends is probably Doon Fort,[2] on the ridge at the source of the Daelach, near Kilfenora. This tallies well with the "Dun" made by Ennach, and called "Tech nEnnach," "in the neighbourhood" of Daelach. From the latter the river Dail[3] (or Deely) is supposed to be named, whence the existing local names of Lissydeela Fort (which may have been the place intended by the legend-makers) and Ballydeely at the great cairn of Cairnconnaughtagh, near Ennistymon.

(2) PROBLEMS OF THE LEGEND.

That the legend has more than a shadow of a true history at the most no critical thinker can assert. The Firbolgs dwelt in only nine raths in Meath, yet they covered with colonies the islands of Clew Bay (Innse Mod), the base of Croagh Patrick (Oigle), the country round Lough Hackett (Cimbe), the east end of Galway Bay, two divisions in Burren, two in Corcomroe, one in eastern Clare for over fifty miles to the north, the west, and the south-west of Aran.[4] That such a tribe collapsed without a struggle after the death of four of its warriors is fiction indeed, but not even artistic romance. Neither the prose legends nor the poem anywhere state that Aengus built the fort now bearing his name, though the poem mentions the construction of the "Dun" of Ennach. Were we even dealing with history, we could not attribute to a short-lived tribal group the 500 forts of Aran and the alleged settlements in Clare, the 100 near Lough Hackett, and the thirty near Tawin[5]; yet such a belief was complacently held by antiquaries from 1840, till wider views arose at the close of the last century.[6] To us no type of earthen or stone fort can

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[1] Journal Royal Society of Antiquaries, Ireland, (referred to as R.S.A.I.), vol. xxxi., p. 4.

[2] *Ibid.*, vol. xxvii., p. 126.

[3] The river flowing into the sea between Lehinch and Liscannor. It should be noted, however, that there was also a river Dahilyegh near Ennis. The "Deely" is called "Tarsel Flu" (? Farset) in the map of 1610, but "Talegh" is marked beside it.

[4] Other legends made Asal son of Umor establish a settlement round Drumassall or Tory Hill, near Croom, in County Limerick.

[5] In Aran 12, over 265 in Burren, 200 in Corcomroe, and over 100 round Lough Hackett (Lough Cimbi), and 30 near Tawin Island.

[6] The Firbolgs were better known as makers of earthen forts, like Rathcroghan. This of course does not tell against their building stone forts on bare crags. Yet the very curious earthen, oval platform, on the bare summit of Aghaglinny Hill, near Caherdooneerish, 1044 feet above the sea,

be assigned to any one race or period. Nearly all these types spread across Europe from Perm, Esthonia, and Austria, to Aran; and they even occur in North America, in the great river valleys of the United States. The ring-fort was, there is every reason to believe, an instinctive idea[1] of our race in Europe, from perhaps more than twelve centuries before our era to more than twelve after its dawn. We also find circular defences among the tribes of Africa and New Zealand; and the older races of the first continent and of North America made the ring of stone, earth, or palisading. Thus children on the seashore, without study, dig the triple-ringed rath and the high mote, with its bailey; and the herdsman and labourer build dry stone rings for cattle-pens, or dig a fosse and ring-mound to fence a plantation. We see no means short of excavation to distinguish the periods and uses of our early monuments, while the stonework, anterior to the twelfth century, depends on the character of the stone or on the fancy of the builder. In face of all these considerations how the Firbolg, the Danish, or any other exclusive theory should be adopted seems amazing, though all may have elements of truth in them—often much truth, short of the exclusive assertion.

The existence of so mighty a fortress as Dun Aengusa or Dun Conor in these little islands has puzzled many. Whence came "the troops of slaves who raised them?" has been asked.[2] Now the probable explanation, in face of the evidences of modification and addition in these and other stone forts, is that their construction spread over long periods of time, perhaps at intervals, rebuilding taking place as required. As for organization and collection of materials for the ring-walls elsewhere—take the legend of the building of the Grianan of Aileach, we find the stones were drawn by horses; or those of the origin of the name "Firbolg," where masses of earth are carried in leather sacks; while the legend of Caherconree tells of the collection of pillar-stones (standing or prostrate) for its construction.[3] We need not believe in the Dagda "greyer than the grey mist," or the popular etymology, or legends, to see that even the wildest romancer set his story in

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the great earthen rath of Ballyallaban, amid the crags of Burren, and the liss of Doontorpa near it, show that earthworks in craggy regions were not unknown. The difficulty of raising the first two forts must have been very great.

[1] This has impressed several antiquaries of late, and is elaborated by Dr. Guébhard in his address, "Camps et Enceintes" at the "Congrès Préhistorique," 1907, p. 1004. This most helpful comparative study of ring-forts and motes all over Europe gives the following illustrations of Dun Aenghus:—From the cliff to the east (fig. 3); fort from the north (fig. 49); and steps and opes (fig. 57).

[2] Windele believed that he saw hammer-work at Dun Aengusa. I failed to find any; but evidence for hammer-work in the Clare forts of Ballykinvarga and Roughan on the edge of Burren and Langough in eastern Clare is well established.

[3] Dind Senchus translated in Ordnance Survey Memoirs, vol. i., p. 223; and Revue Celtique, vol. xvi., p. [illegible].

a setting of fact known to all his hearers. In more historic times our oldest law code provides for the "erecting of duns," and for "joint labour upon them"; also "for feeding the labourers who are in the fort to fortify it."[1] St. Enda, the chief saint of the very island in which Dun Aenghusa stands, dug the great fosses and mounds round Rossory Church in Fermanagh (*circa* 460). St. Mochulla and his seven converts levelled the hill-top, made walls, and dug fosses round Tulla Church in Clare, traces remaining at both places; the last works, though extensive, are stated to have been completed within a year (*circa* A.D. 610).[2] The royal rath at Clonroad, in the same county, with rings and outworks, was commenced by Donchadh Cairbreach O'Brien, Prince of Thomond, and completed (1241–1260) by his son Conor,[3] the traditional builder (?repairer) of Dun Conor, in the middle isle of Aran.[4] In fact, the collection of the stones was the main trouble; and if horses or oxen were used, this was greatly lessened.[5] Instead of "troops of slaves,"[6] it is possible that a small tribe, working a few years at a time, at intervals over a couple of centuries, could, in a place where stone so abounded, build even a fortress as vast as the Aran "Dun."

Those who have seen horses and cattle floated behind a canvas "curragh" at the Aran Isles cannot deny that large animals may have been brought to Aran in early times by means to all appearance as absurdly inadequate. The "Fairy Chariot" tells how Cuchullin carried off three cows, swimming strongly behind his "curach," through the "vast ocean,"[7] which shows that before 1106, as now, such transport was known. Also in Magradin's "Life of St. Enda," 1380, we are told of the horses of Corbanus grazing at Arduagcaorach on this very island, before 489, when King Aenghus, the grantor, died.

The question of the names of the Aran forts may be touched on in this connexion. Do they commemorate their founders, even if Mac Liag's tale be absolutely unreliable? They are anonymous except three: Dun Aenghusa, which

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[1] Seanchus Mór, vol. i., pp. 131–137.

[2] "Vita S. Fancheae," in Colgan's Acta; "Vita S. Mochullei," in Analecta Bollandiana (vol. xvii., p. 145). There are several other fort-building saints, from St. Patrick, who directed earthworks (evidently circular) to be dug at his monastery in Armagh, and St. Mochuda (or Carthage), who dug the small "liss" at Lismore, county Waterford, which, when his monastery sprang up at it, became "Lismore," the great *liss*.

[3] "Cathreim Thoirdhealbhaith."

[4] "Dublin University Magazine," vol. xii., p. 50.

[5] The "Second Battle of Moytura" (Revue Celtique, xii., p. 79), four score yoke of oxen employed to move a flat stone. For horses at the building of Grianan Aileach, see Dind Senchus, O. S. L., p. 41.

[6] Such, sometimes, were employed to build forts; a gang of apparently some thirty slaves appear in the legend of "The Battle of Magh Leana," as raising a rath at Magh Feimhin, in southern Tipperary.

[7] Journal R. S. A. I., vol. xi., consec., p. 389.

bore its name at least 900 years ago: Dun Conor, possibly Dun "Concraidh" at that time: and Dun Farvagh. John Windele (on the uncertain evidence of Comyn about 1750) states that "Fearbach" was a demon monster, and the fort a "dracontium" for its worship.[1] As to the name Aenghusa, it is a most curious coincidence, as William C. Borlase first pointed out, that a place called "Enchusa," on the coast of Holland, is described in language very suitable to the far different coast of Aran. "Natura loci munitum, maris furore objectum, quem in extremo terrae margine situm despicit." A proper name "Anchensanus" occurs in an inscription at Mayence.[2] Two theories might be advanced with regard to the name of the Dun. One that, like other great works, it was attributed to gods or heroes, "the far-famed hold, piled by the hands of giants for godlike kings of old"; for Aengus son of Dagda is said, in the "Agallamh," to have given "a fort (dun) and stronghold therein, a most excellent, spacious town (with lofty stockades" (sonnach).[3] His father, as we noted, was also a fort-builder, having built the stone fort of Grianan Aileach and the earthen Rath Brese with its "cladh."[4] The second possible theory has been already advanced by Ledwich and others, namely that Dun Aengusa was named after Aenghus, King of Cashel, about A.D. 460. It is true that "the three Aras of the sea" are named among the forts of the King of Cashel in the "Book of Rights."[5] Aenghus son of Natfraich gave the islands (or rather perhaps lands in them) to St. Enda; and a "Cashel-builder" of King Natfraich, Goll of Clochar, is named in a poem (c. A.D. 1000), and stated to have built a fort at Cashel for King Aenghus himself.[6] However, despite its plausibility, the fact that the islands lay so far away from every interest of a king of Cashel, and the name Aenghus being very common, takes away any great weight from the theory. The "Life of St. Enda" asserts that Aran, in about 480, was the residence of Corbanus the pagan king of Corcomodruad Ninuis (in north-west county Clare), who fled in superstitious terror from St. Enda. It also states that Aenghus King of Cashel knew nothing about the island. This proves at least that about 1380 the writer attributed no Aran fort to the latter prince.[7]

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[1] Windele's MS. "Iar Mumhan" (MSS. R. I. Acad., p. 709).

[2] "Dolmens of Ireland," vol. iii., p. 1129.

[3] Silva Gadelica, vol. i., p. 103; vol. ii., p. 111.

[4] "Revue Celtique," vol. xii., p. 65; also the long lines of the "Slicht Loirge an Dagdae," with his club, and perhaps the mound of Newgrange.

[5] "Book of Rights" (ed. O'Donovan), p. 91.

[6] Poem on early masons by Donnell son of Flannacan (*c.* 1000), O'Curry, "Manuscript Materials of Ancient Irish History," p. 222; Book of Leinster, p. 27*b*. As to Goll being of Clochar, it must be remembered that the wife of King Aenghus (the sister of St. Enda) had come from that place.

[7] Vita S. Endei, Colgan's "Acta SS." In its present form the "Life" dates as late as 1380,

With regard to the name, Aran maintains the primitive title "Dun," which has been elsewhere so generally replaced by "cathair" (caher). A transitional example "Doon'ahaar," or "Doon doo'haar," the Dun of the black cathair, is found; similarly the fort of "Eerish," in sight of Aran, on the shoulder of Black Head, is Caherdooneerish, and a fort near it, Caherdoonteigusha. The usage of 'caher' for 'fort' seems a rather late method, perhaps derived from the monastic forts, which again were suggested by the cognate word 'cathedra.' The Rev. Edmund Hogan, with his usual kindness, let me use his notes from the forthcoming "Onomasticon Goèdelicum." He gives "*Dún Aengusa*" from the Books of Imaine, Lecan, and Ballymote; "*Dún Aongusa*" from Keating, and Mac Firbis' Genealogies; and "*Dun-oinguso,*" *Dun-Oengus,* as Roderic O'Flaherty's "Ogygia." In "Iar Connaught," 1684, it is *Dun Engus.* "Dun Aengus" prevailed, 1790–1820, as now, among writers; but John O'Flaherty found the name to be locally Dun Aonguis in 1825, while in 1839 only one old man on Aranmore, a descendant of a Cromwellian family, remembered the true phonetic name "Dun Innees," according to O'Donovan; S. Ferguson, in 1853, gives the names "Ungust" and "Unguish,"[1] the latter evidently akin to Innees. It is given by Haverty as Dun Eanees in 1858; but had hardened to Doon Aingus in 1878, and is now usually "Dun Angus," though it might better be anglicized Doon Hennessy.

(3) THE PLAN OF DUN AENGUSA.

It is strange that, so far as we know, the plan of Dun Aengusa has never been studied to see whether it forms a consistent whole or has been modified. This task we now attempt to carry out. Any ancient building of historic times rarely fails to give proof of restoration, and this is true of the stone forts, and even of those of earth.[2] For example, earthworks at Rathmore in Kildare, Ballyvoony in Waterford, Lissadooneen in Kerry, and Lisnagree, near Broadford, in Clare, show that layers of earth (several in the first case, two in the third) were added to raise the original structure; baileys and outer rings were very probably added in many cases. In Clare, so closely bound up with Aran in legend and history, the stone forts give frequent evidence

but probably is founded on older sources, though unusually devoid of local colour. It does not even allude to the forts.

[1] Dublin University Magazine, vol. xli., p. 95. He notices the Pictish character of these names, but then (according to Keating) the Picts cleared out the Firbolgs of Aran and the islands.

[2] History coincides with the "records of the ruins." The Grianan of Aileach, in Donegal, was rebuilt in 674 and 937, and dismantled 1107; the stone fort of Kincora, in Clare, rebuilt in 1062, and was levelled in 1098. It was again rebuilt, to be finally demolished in 1112 (Chronicon Scotorum) or 1118 (Annals of the Four Masters); other cases will be recalled by antiquaries.

of rebuilding. At Moghane in Clare[1] the two cahers were built across the great lines of the older walls. Langough, near the east, has been almost rebuilt on a different plan in early times. Caherfeenagh and Cahergrillaun have been rebuilt in parts[2]; and the wall of Caherdooneerish has been at least twice rebuilt, the joints made at the three periods being very apparent in the wall.[3] The Kerry forts, too, show unequivocal signs of addition and rebuilding. After a careful study of Dun Aengusa, we believe the following views to be justifiable:—

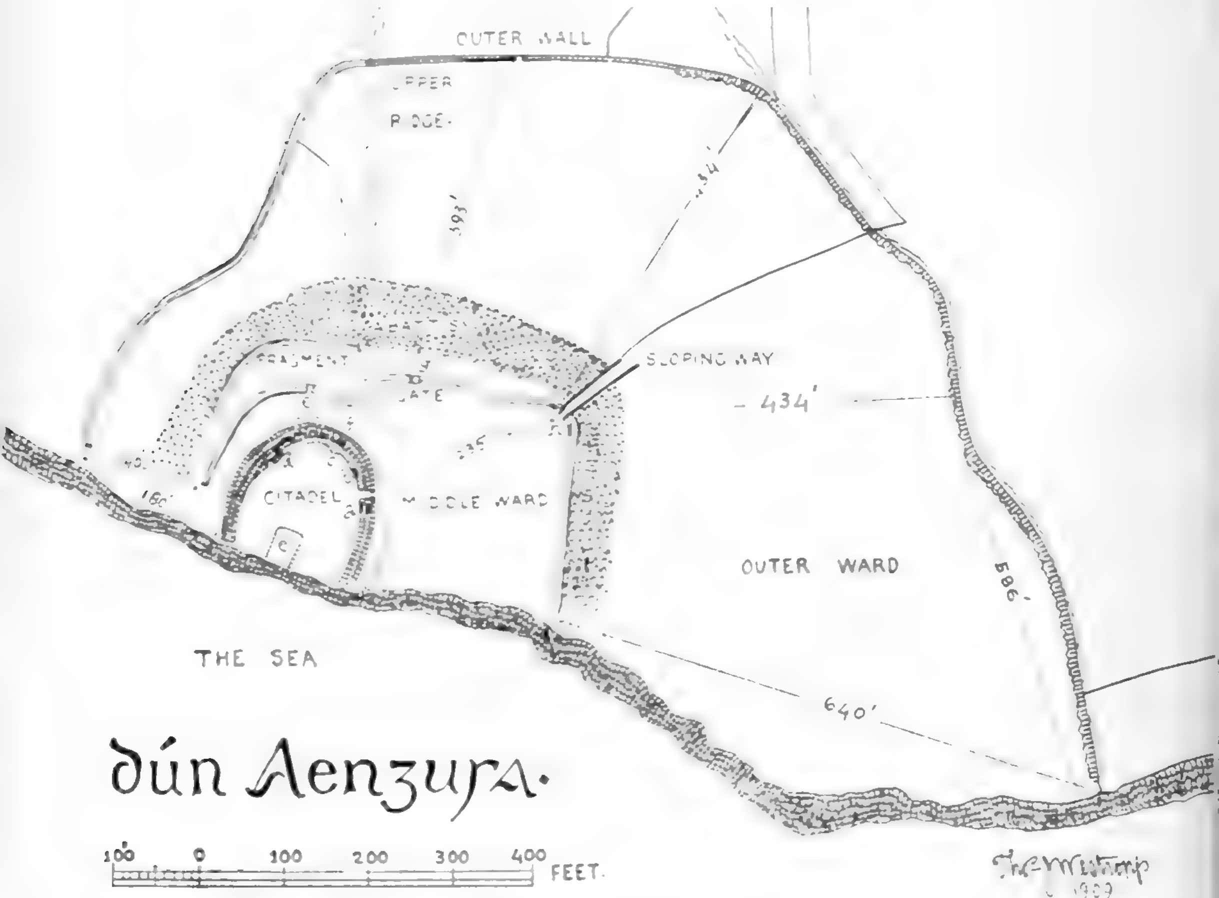

FIG. 1.—Plan of Dun Aengusa.

The Dun is usually supposed to have consisted, from the first, of three

[1] Proc. R. I. Acad., xxvii. (C), p. 221.

[2] Journal R. S. A. I., vol. xxviii., p. 364, for Cahergrillaun; vol. xxxi., p. 275, for Caherfeenagh.

[3] *Ibid.*, vol. xxxi., p. 6.

[4] Letters refer to pp. 25, 27.

oval rings into which the sea has cut for almost exactly half their extent. Such a plan is possible, warranted by the fine triple-walled hill-town of Moghane, but must not be too readily accepted. The fortress was probably at first a simple oval ring-wall, like its neighbour the Dun of Eoghanacht and many others. It was next strengthened by a second ring nearly equidistant from the first, like the forts of Dun Oghil on the same island, Furmina on Inishere, Glenquin and others in Clare. Still later, a third wall, either somewhat egg-shaped in plan or a crescent, abutting on the cliff, was built. This was regarded as final; and an elaborate abattis of close-set pillar-stones was made round it, extending to its foot, even where it crowned a steep slope. Lastly (and probably at a far later period) a large irregular space, determined to the east by a low ridge, was enclosed with another wall, defending the approach from the landing-places of Port Murvey. We do not for the moment assert whether, or how far, the sea had cut into the hill when these works were built. O'Flaherty seems to imply that the middle ring was entire, like "the bawn of a castle," in 1684; but it then stood "on the brim of a high cliff."[1] Probably the old second wall was originally entire; but this is uncertain, for the stone fort of Cahercommaun, in Clare, on the edge of the Corcomroes, has a central ring and two crescent walls.[2] It is strikingly like Dun Aengusa. The central fort is even more massive; but it overhangs a dry valley rising at both ends, so is evidently in its original condition so far as regards the plan. Another alternative is possible, namely, that (as at Dun Conor and the Clare forts of Caherlisaniska and Langough) the central fort was a ring with the outer enclosures looping in to meet its wall. We have, however, only found this looping in forts on flat fields and low ridges—never at high cliffs or slopes, or even on a low shore when there is deep water beyond it, as at the crescent fort at Cahernacalla on Ballycar Lake.[3] The crescent wall,[4] therefore, does not necessarily prove a fall of the cliff, for it is common inland in Ireland, and indeed all over central Europe and in America.

In Clare, besides Cahercommaun and Cahernacalla, with a central ring

[1] Chorographical description of "Iar Connaught" (ed. Hardiman), p. 75.

[2] A poem of Seanchan, dating about 640 (Book of Lecan, p. 17), mentions "the three mounds of walled fortresses" in Burren, Co. Clare—perhaps this (the only triple-walled) fort—as on the Burren hills, though now included in Inchiquin. It is probably the fort of Caechan Boirne, near Inchiquin Lake, named, perhaps, about 800 (certainly *ante* 1014), in the "Book of Rights." See Journal R.S.A.I., vol. xxvi., p. 153, and Proc. R.I. Acad., ser. iii., vol. vi., p. 430, for plans comparable with that of Dun Aengusa.

[3] Proc. R.I. Acad., vol. xxvii. (C), p. 227.

[4] The crescent type is so closely akin to the promontory fort that in some cases distinction cannot be drawn save by regarding the existence of a headland behind the defences. Mr. Allcroft classes them together in "Earthwork of England," chapter iii.

and one or more crescent walls, we find Caherlismacsheedy,[1] a single crescent on a cliff in Burren. The type is very common in England and Scotland, the finest and most complex specimen being the two conjoined forts of Coldingham, each with three walls. We note in England the forts of Embury Beacon, Devon, and Blackers Hill, other typical examples being the inland Scottish "Doon" of Nunmill and Errickstane.[2] In France we have many fine examples. To select a few: There is a double crescent earthwork on a spur at Caudebec, and near it a promontory fort. The camp of Bois de Rouret has two stone walls built each in two sections, as in the Irish forts. The masonry, too, is identical with that in the forts of western Ireland. At Sarran, in Cantal, a single crescent wall encloses a garth 170 feet long and 105 feet deep on the edge of an inland cliff. The fort of St. Maurice at Beaulieu (E.M.) has two crescent rings enclosing many house-sites, some of the Roman period. The ground slopes back from the inland cliff as at Dun Aengusa. Mont Milan (Côte d'Or) has also two walls; but, unlike the Irish forts, it has flanking towers believed to be of the same period as the fort. It is noteworthy that the Irish, no less in their forts than in many of their later castle courts, were entirely indifferent to the advantages of flanking defences.[3] In Hungary lies the great ring of Bény, an earthwork of three crescent mounds, extending for 1700 feet along a steep bluff. In Switzerland and Perm we have crescent works fencing mountain spurs; and crescent ring-walls are found in Sweden.[4] The type also occurs in America.

Whether the walls of Dun Aengusa were all crescents from the first we can never know; for they, their foundations, and the rock for over 300 feet beneath are devoured by the Atlantic and "their memorial has perished with them." We have no means of calculating the advance of this destruction; and it may have been very slow for centuries.

The fall of cliffs is nowhere uniform; even at the same locality all depends on the jointing, the currents, and the prevailing winds. A fort like Doon, in Iraghticonor,[5] Kerry, was evidently a crescent from the first; the sea has

[1] Journal R.S.A.I., vol. xxxi., pp. 275, 276.

[2] See Dr. Christison's "Early Fortifications in Scotland," pp. 130, 131, Coldingham; p. 134, Arbory; Upper Cademur; p. 204, Raecleuchead; p. 206, Errickstane; and Mr. A. R. Allcroft's "Earthwork of England," pp. 53, 54, 59, 63, and 113.

[3] "Société Préhistorique de France," Bulletin. Tome iv., p. 311; vi., pp. 231, 415. Rapport, Tome v., p. 76. Comptes Rendus (1905), pp. 27, 30, 36, 52; and Dr. Adrien Guébhard's "Enceintes Préhistoriques" (1907), pp. 11, 12.

[4] The notes on many of these continental forts are brought together in "Ancient Forts of Ireland," sections 8, 11, 20, with plans, &c., figs. 2, 3. For a Scandinavian "ring mur," crescent-shaped in plan, see Borlase, "Dolmens of Ireland," vol. iii., p. 1133. For Russian forts in Perm, see "Camps Retranchés," Dr. A. Guébhard in "L'Association Française pour l'avancement des Sciences" (36th Congress, 1902), p. 3. From plans by M. Vladimir Tolmatcheff.

[5] Described in a paper read before R.S.A.I. in July, 1909, now printed, but as yet unpublished.

run harmlessly for centuries along the smooth faces of the upturned strata, and the fosse died out in the grassy slope above as its diggers left it, unworn, save by "the slow tooth of the sky." At the Black Fort, east from Dun Aengusa, we see that the headland originated from two synclinal curves, the inner arches of which were constantly worked into caves, eventually falling in and leaving long bays.[1] The destruction of the sides and even of the outer end of the promontory is slow compared with that at the ends of the bays, and the fort between them may be very ancient, though hardly three thousand years old, as O'Donovan fancied. As we noted, Loop Head, the ancient "Leap of Cuchullin" (probably from long before A.D. 850,[2] when the name first occurs), must have been, in early times as at present, a high rocky islet divided by a narrow chasm from the main cliff, to judge from the name and legend. The only fall of rock recorded at Dun Aengusa for over seventy years is that of a slab from which a man was fishing when it fell in 1837[3]; but cliff falls are more usually sudden and at long intervals than persistent and gradual.

So far we have only dealt with the changes made by the great forces of nature; now we turn to other evidences of mutability in extensive alterations by the hand of man. They give us the much-needed warning as to how many features, what extensive additions and what puzzling eccentricities of plan found in these forts, are not to be attributed to the original design. Probably when, by the building of the greater outer wall, the defensive value of the abattis and middle wall was less felt (whether at the same time or on later occasion or occasions) extensive works were carried out on the inner walls. The abattis, as we noted, clung even to the foot of the old outer wall (as it does also at the Black Fort, at Dunnamoe,[4] and at Ballykinvarga caher in Clare); its divergence leaving a long open tract between it and the present wall, along with the fragment of wall to the north and west, tells the story clearly enough. The builders demolished the old outer wall from the ridge opposite the east face of the central fort to the avenue at the north-east bend, and also the eastern part of the second wall; of the materials of these they made an irregular line from the east end of the curve of the latter bowed out like a bastion, and then running in a comparatively straight line, from over 50 feet to about 15 feet from the abattis. It joined the old outer wall rather at right angles, a new gateway being made at the sharp turn. Having been built on the surface of the rock, every trace of the demolished

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[1] Journal R.S.A.I., vol. xxxvi., p. 240.

[2] *Ibid.*, vol. xxxviii., p. 345.

[3] "O. S. Letters," Co. Galway (MS., R. I. Acad., 14 D. 3.), 249.

[4] If we so consider the former curious wall-loops and outwork at the gangway and along the landward edges of the fosse, shown by the Rev. Caesar Otway in his plan, 1841, "Erris and Tyrawley," p. 68.

walls was easily removed. The north-western reach of the old outer wall was now useless, and, owing to the reach of the second wall being retained, it was not required for material, so it was left standing, a problem (like that of the open space to the north inside the abattis) hitherto unexplained. It extends from near the present cliff to the ridge nearly opposite the seeming bastion. Petrie supposed it to be an annexe, as at Dun Conor; but the end did not curve inward, nor was there any connecting wall from it to the middle ring. It ended abruptly in O'Donovan's time, as now, near the rock ridge.[1] So far as can be seen, this is the true explanation of its existence and of the bare space, so regularly curving to the south-east turn, between the wall and the abattis, now devoid of pillars. The work was probably

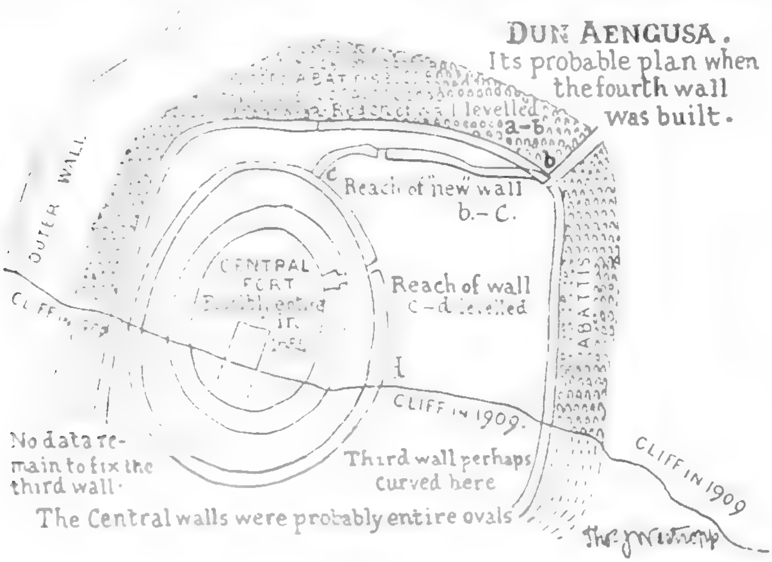

Fig. 2.

done to open a larger court beside the central fort, while the north-east part of the second wall was retained to keep the middle rampart, at its most exposed side, on the level of the hill-top, within range of missiles from the towering inner fort. Arrows seem to have been little used by the Irish in warfare; spears were too scarce to throw, but the second wall, barely 30 feet from the citadel, could be swept by stones slung or even thrown from the commanding wall of the latter. The fragment itself could be used as an extra line of defence till the enemy had struggled with great loss and difficulty through the jagged and close-set pillars round its base.

[1] C. C. Babbington thought "they" were built "where the slope of the ground seemed to render additional defences requisite." Archaeologia Cambrensis, vol. iv., ser. iii.

Till June, 1904, I had on four previous visits regarded the sharp curve of the middle wall as a bastion, and the waving part from it to the north-east bend a mere wanton irregularity. I then compared it with O'Donovan's and Petrie's plans, and found these so inaccurate as to this and the outer wall that I was led to reconsider the whole question. It is evident that all antiquaries who came to this fort hurried to the "citadel," after noting the chevaux de frise and outer walls to the west and south-east (the two lines of approach), passing by, with at most a casual glance, the defaced and unimposing middle wall. Hence even in plans they did not lay down its remarkably irregular line, but showed it as a curve. Then when I found evidence for the occurrence of the "bastion" in 1878, the need of a solution of the problem became evident. I accordingly re-examined it a few months later, with Signor Boni and others, and realized the meaning of the strip without pillars along its base. After a third complete and leisurely examination, made last August, I offer this solution of the problem of the middle walls.[1]

The central fort might seem to have required no modification, but such certainly took place. The ope, leading to nothing, inside its wall, to the north-west, which Mr. Babbington noted[2] as closed by later work, the joints beside the gate, noted by Mr. P. J. Lynch, and a line of blocks to the south of the gateway, outside the face of the present wall, all imply considerable alterations in early times.

The selection of the site (apart from the question of where the cliff then existed) shows much forethought and skill in the earliest fort-builders. The inner ring occupies a natural platform, a few feet high, its faces evidently scarped artificially. The outer wards were strengthened against attack by the upper and lower ridges, the middle, on the north-western and north-eastern, and it and the outer wall on the eastern sides, towards the most probable point of attack—Portmurvey.

Landing in that bay, or coming from the Kilronan harbours, an enemy had to struggle up a long reach of broken crag, and either up the narrow slippery path to the north-east gate, or through the hedge of jagged stone spikes in face of a lofty wall. All these surmounted, the central citadel, once over 18 feet high on its ridge, manned by desperate men, had still to be captured. We cannot endorse Mr. Burke's suggestion[3] that the middle court was left clear for "military manœuvres"; it was possibly filled with huts of

[1] I hope the "personal element" in this paragraph may be condoned, as making the origin of and responsibility for the theories clear to all.

[2] "Archæologia Cambrensis," vol. iv., ser. iii., p. 96.

[3] "South Isles of Aran," p. 16.

clay and wattles which have left no trace.[1] The fort seems to have had no traverses which, were attack much feared, should have been made especially across the great outer garth, a most suitable position occurring at the upper ridge. The weakest point in Dun Aengusa and its congeners was lack of water-supply; and blockade does not seem to have been very probable, though the monastic ring fort of Tulla was blockaded and nearly reduced for want of water in 1086.[2]

As to the features, the perfect gate in the outer wall was described before 1870 by Lord Dunraven; the northern gate of the middle wall I noted as a "creepy door" in 1878, and dimly recall its narrow ope under large stones. The perfect gate of the inner ring was noted by O'Donovan and many writers, from 1839 to 1878, and its outer face sketched roughly by Petrie in 1821, and most accurately by Burton in 1859. I made a camera sketch of the inside in 1878.[3] Miss Stokes (or Lord Dunraven) implies that it had collapsed,[4] but the gate now standing is the one sketched in 1859 and 1878. It is strange that Lord Dunraven did not secure photographs of these most interesting and characteristic features, but they fortunately survived to be photographed by others. The broken gates in the middle wall, the double sections or terraces of the two outer ramparts, and the fragment and the three sections of the citadel wall, are all attested by several writers; so is the "blind ope" inside to the north-west of the latter. The steps near this ope, and the traces of the terraces, and the steps to the north of the inner gate, were recorded. The only features not named before the "restoration" are the double flight of steps to the south of the gate, and the upper flight to the north-west. O'Donovan mentions that the wall to the south of the gateway was entirely defaced, and it was a shapeless heap in 1878. It is, however, most probable (and may even have been recorded) that the lower firmly set parts of the two flights of steps and their long fallen blocks were found in the debris, which covered both the upper banquette and the

[1] Ledwich, in his "Introduction" to Grose's "Antiquities of Ireland" (1807), was probably right where he says of Dun Aengus, p. iv, "The houses having been of wood have long since disappeared." We find in 1162 that eighty houses had to be removed when the fort of Cashel an Urlair was rebuilt at the church of Derry by Murcheartach Hua Lochliunn and Flathbertus O'Brolchan, the coarb of St. Columba.

[2] "Analecta Bollandiniana," vol. xvii., p. 149, chapters xv.–xviii. Tulla nan espoc is translated in this account, "Collis Episcoporum" in "the district of Lumbrecia," Luimneach Limerick or "Limbricensis," under which forms the editor could not identify the places.

[3] See p. 30, *infra*. The stonework in this is easily recognizable in a recent photograph.

[4] "Notes on Irish Architecture," vol i., p. 4, implies that the gateway had "shared the melancholy fate of the rest of the structure." The drawing of the outer face by Burton, and my camera sketch of the inner face, show that as it stood in 1878 so it still remains. Some who had not seen the fort before its restoration, alleged the rebuilding of the gate on no better authority than "Dunraven's" words.

base in 1854, as in 1878. Such firm-set bottom steps often survive the wall and the upper steps. Two such flights were recently uncovered by us in Caherminaun. There is one in Ballyshanny caher, and we find two more in Caherfeenagh fort, in Clare. In Dunoghil the remains of two such flights were not restored in 1884–5, one to the north of the gateway, at the ground-level (its other steps are used in the circular "thing" then built in the garth), the other above the south-east stair. In the Black Fort are sloping joints, evidently remains of two unrestored sidelong flights near the huts. The steps in Dun Aenghus are exactly like the untouched examples. The allegations about the supposed sunken way in the top of the rampart rest on a mistaken reading of O'Donovan's Letter of 1839, the "internal division" meaning in his letter the banquette inside the rampart.

As to the age of the fort, worked implements of chert and flint have been found in it, and also bronze ornaments, one probably later than the fifth century. The comparatively small sharp masonry gives less impression of age than the large blocks, well-marked batter, and (as a rule) lower walls on the forts on the mainland in Mayo, Clare, and Galway. The blocks of the wall are not as weather-worn as those in the ramparts of Moghane and the Cahercarbery forts on Kerry Head. It is hard to believe that walls so slightly battered are of vast age as they stand; but the inception of the fort and the collection of the material may date far back in the past. The chevaux de frise, with the evident channelling of the tops of its pillars, is probably very early; but we have seen reason to believe that the walls have been extensively rebuilt in the past; and perhaps this was done when repairs were required, on several occasions, long before the restoration of 1884.

The inroads of the sea give us no measure of its age. We have no reason to assert that its circles were either complete rings or crescents at first. It may have stood (like Dun Oghil) on a hill-side, or have been built (like Cahercommaun), adapted to an already existing cliff, though, of course, the cliff stood much farther southwards in the earlier times. Its advanced plan may have grown up gradually from a simple beginning, though we agree with Dr. Guébhard[2] that its skilful construction, terraces, and steps imply the work of builders with long and experienced traditions to guide them; but these accomplished masons were probably rebuilders; and the original fort may have been as rude and simple as some of the ring-walls of Clare and Kerry.

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[1] "Age of Dun Aenghus" Dr. Colley March. Proc. Soc. Ant., London, vol. xv., ser. ii., p. 226.

[2] Préhist. Congrés iii., Autun, 1907, "La structure relativement compliquée, certainement attribuable à une humanité déjà passablement éloignée de ses origines," p. 998.

(4) Records of its Features.[1]

Before describing the fort as it stands at present, we must examine, in more detail than above, the record of its features before 1883. The reference letters are as follows:—P, Dr. George Petrie, "Military Architecture" (1821 and 1858); O'D, John O'Donovan, "Ordnance Survey Letters," 1839; F, Sir Samuel Ferguson, "Dublin University Magazine," 1852; W, John Windele, "Supplement," *ante* 1854; C, Most Rev. Dr. George Conroy, Bishop of Ardagh, "Aran of St. Enda," *ante* 1870; D, Lord Dunraven, "Notes on Irish Architecture," *ante* 1875; IB, anonymous writer in "Irish Builder," notes, 1877; TW, notes and sketches taken 1878.

Inner Fort.

Gateway.—All the above writers. *Its rising Lintels.*—O'D; W, "like inverted steps." TW, "stepstones in top." Views (outer face), F.W. Burton, 1857; (inner face), TW. *Stair to north-east.*—F, "On the right are the remains of a flight." *Terraces,*[2]—P (map); F, "lower banquette"; C, "banquette on the east side"; W, "banquettes"; D, "now no trace"; TW, "nearly gone." *North-west Ope.*—P (map); O'D; F; C; D; (? TW, "a hole"). *Stairs next Ope.*—P, and map; F, "one or two"; C, "traces of stairs"; W, "a succession of stairs"; TW, "slopes or steps." *Wall in three sections.*—P and map; O'D; F; C; D and photographs; TW and sketch. *Stone Platform.*—P (map); TW (sketch plan).

Middle Walls, &c.

Gateways.—*North-west Gate*, P; D; TW, "gaps like doors." *North Gate.*—TW, "creepy door." *North-east Gate.*—O'D, "much destroyed"; *Passage leading to it.*—O'D (he thinks it modern); P; F; TW, "road through pillars very steep." *Terrace.*—P (and map); W; C; D; TW. Fragment.—P (and map); O'D; D (and photograph); Wilde in "Lough Corrib"; TW

[1] The Irish terms applied to the features of forts are—"Murclodh" a stone wall (Togail Troi); "Mur," a wall of earth or stone (Mesca Ulad and many other early works), "Cladh," fosse; "Tulchin," flat summit of a fort of the mote type; "Iarom," the garth or enclosure; "Fordorus," the gate in the outer enclosure; "Fordorus," used for a lintel; "Aurlann," the slope before that gate; "Dorus," a gate; "Tairsech," its threshold; "Aursa," a jamb; "Aurduine," the 'porch' of a gate, "Erdam," a porter's lodge (as in the Kerry and Mayo forts); "Bodun," the 'bawn' or cattle-yard; "Ithla," the 'haggard' enclosure; "Faitche," the green, or game-field, before the fort; "Sonnach," the palisade or abattis. (See Silva Gadelica ii., p. 408, for an "Aurla.") The "Sonnach" references are given *infra*. See also Dr. Joyce, "Social History of Ancient Ireland," vol. ii., pp. 34, 60. E O'Curry, "Manners and Customs of the Ancient Irish," in the introduction by Professor Sullivan, p. 107.

[2] O'Donovan, in his notes on Dun Oghil, contrasts the good preservation of its steps and terraces with the dilapidation of those of the other forts on Aranmore (O. S. L., p. 239).

(sketch and plan). *Terrace.*—P, "Terrace half its height" (and map). ABATTIS.—All writers (save Ledwich, John O'Flaherty, and Windele) since Roderic O Flaherty in 1684.

OUTER WALL.

Wall.—P (and map); O'D; D. (map and photograph); TW, "old tumbled wall" (and sketch). *Gateway.*—D. *Two sections.*—O'D. This wall is passed over or only shown in maps by most writers.

(5) THE FORT IN 1909.

The two most conspicuous high grounds of Inishmore are each crowned by a great stone fort, the western hill rising to over 300 feet above the sea, by Dun Aengusa, the eastern by the Dun of Oghil, the ridge rising over 400 feet above the sea. As we pass round the shoulder of the Oghil plateau the great mass of Dun Aengusa presents a most imposing appearance, its three tiers of walls being fully visible at the fall of the steep slopes to the "Blind Sound" and Portmurvey. We ascend the hill past the fuchsias and low trees at Kilmurvey House, passing the low crag cliffs with their wells of sweet, clear water: cross the craggy fields (their crannies full of maidenhair and hartstongue ferns, of small, sweet wild roses, cranesbills, and dewberries) and gain a view of stately and ever widening spaciousness, along the dark southern cliffs, out to Clare, and even to Kerry, and northward across the bay of Galway. We next reach a low ridge of crag which has been strengthened with a thick rampart (unlike the tottering field-walls around), and enter the ambit of the great fortress or "town": "though high the situation of the cathair, not easy is its storming methinks . . if you come to the southern side."[1]

OUTER RAMPART.—The wall is for the most part greatly levelled and spread about from 10 to 15 feet wide; but, where better preserved, it shows two faces of well-laid blocks (many of fair size, 2 to 3 feet long, and 18 to 20 inches thick), being usually 6 or 7 feet thick from face to face; it follows along its eastern reach a low, irregular ridge about 5 or 6 feet high, rarely higher. This wall has been passed by in silence by most writers, but is, when realized, a most imposing adjunct of the upper fort, being over 2000 feet long in its wavy, irregular course. Its garth is over 1250 feet long by the cliff edge, 1174 feet across the clear garth east and west, and 650 feet deep past the eastern face of the abattis north and south. It is usually found in heaps 3 to 4 feet high, and is 8 feet thick near the sea, and until we turn

[1] "Caithreimh Conghail Clairinghnigh" (ed P. M. Mac Sweeney), p. 121.

up the slope, where it is better preserved. The masonry is coarser to the east when compared with the upper reaches and the inner walls. To the north, we find its most interesting feature, the nearly perfect gateway, first described by Lord Dunraven, before 1875, as being 4 feet wide and 3 feet high (over the debris), with a lintel 9 feet long. This is virtually correct, as we found it to measure 49 inches wide above, but only 45 inches below, owing to a projecting block at the base. The height, as now cleared, is 4 feet 10 inches to the east and 4 feet to the west, being on a steep, ridgy slope. The wall is 6 feet 7 inches to 7 feet thick on top, and nearly 8 feet at the base, the passage being covered by a huge inner lintel, 8 feet 4 inches long, 6 to 10 inches thick, and 15 inches deep and two similar outer lintels. The space between them and the inner one is covered by short "cross-bearers," which is also the case in the north gate of the inner wall, and is a common feature in souterrains, but rare in gateways. From it westward the wall has been greatly and unnecessarily rebuilt, raised to a level top, about 5 feet high, till we reach the upper ridge; there it has been repaired with a terrace, and is 2 or 3 feet higher. The ridge crosses it, and is from 12 to 18 feet high.

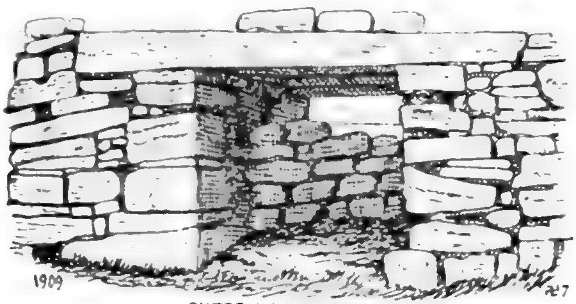

Fig. 3.—Dun Aengusa, Outer Gate.

O'Donovan notes that it had two sections. They are not apparent in the untouched wall. It (very likely) had a terrace, though none appeared (so far as I remember) in 1878. He was fond of asserting at that time (it was very early in his field-work) that the sections in fort-walls were to provide another solid face against the enemy when the walls were sapped and fell in a siege. Most of the succeeding writers have adopted that view. We have, however, no suggestion of so elaborate siege-work in Ireland in those early times; and I believe the system was adopted rather to allow the more equal settlement of the dry-stone walls, which, when of any great thickness, naturally (especially if the filling be small), bulge out, and even burst the faces of the wall. Another possible reason was that the terraces and outer sections were added to the first and lowest wall; but the fact that such sections occur in non-terraced forts bears out the view that it was to prevent bulging; for escalade in assault, or blockade—not battering or mining—was the danger besetting the early fort-dwellers. Walls of double or triple sections are well authenticated in dry-stone forts. Dun Aengusa is triple in the citadel (double in all the other walls); so are the Black Fort, Dun Conor, Ballykinvarga in Clare, and Caher na Spungaun in Mayo;[1] while double walls occur at Dun Onaght and Dun Moher in the Aran Isles; Lower Caherbullog, Caherscrebeen, the upper fort of Ballyallaban and Caheridoula in Clare; Ballylin Caher in Limerick; and the forts of Dunbeg (Fahan) and both the Cahercarberys in Kerry.[2] Of these, the two last examples in Clare and the Cahercarberys were so constructed down to the foundation, and evidently the others are similar. The enclosure possibly defended a number of huts of wattles, or osiers, and clay, for it is noticeable that while stone huts are common in the forts of Mayo, north-west Clare, and west Kerry, evidence for their existence in Aran is only afforded by Dun Conor and the Black Fort. There were thickets of scrub (dwarf oak, &c.) at Oghil, the place (Eochoill, oak grove) and a wood "Leamchoill,"[3] near the shore below it, as named in the "Life of St. Enda," showing that twigs and branches could be procured in ancient times even on these storm-swept rocks.[4] We have a historic mention of a "dun and the houses outside the dun" so late as 1014;[5] and indeed so late as 1675, in a deed where the caher of the O'Davorens, the fine existing ring-wall of Cahermacnaughten in Burren, with the group of houses in and around the caher, is fully described.[6]

The Abattis.—In 1684 Roderic O'Flaherty was struck by "several long stones erected slopewise against any assault," at Dun Aengusa. Ledwich, in his hearsay and warped account, John O'Flaherty, and the usually careful John Windele, alone, since that time, have failed to note this striking

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[1] Mr. Hubert T. Knox kindly gave me notes and a section of this fort: it is at Bushmount, near Hollywood.

[2] Walls of three sections occur in French forts in the Alpes Maritimes—e.g. Casteouvasson and the Castelars in Var. See "Soc. Préhist de France," tome iii., p. 146, by Dr. Adrien Guébhard; and the volume of the "Congrès Préhistorique" for 1905, p. 48; also "Comptes Rendus de l'Association pour l'avancement des Sciences," xxxiii. (Session of 1904).

[3] This is alleged to be a mistake for "Eochoill"; but there is no evidence that it is not a name which became extinct on the destruction of the trees or bushes.

[4] The Grant of the Aran Isles of 1586 in the Patent Rolls reserves "great trees," minerals, and great hawks to the Queen. We cannot, however, regard this as more than a conventional "saving" by people ignorant of the islands. Traces of "druidical" oak groves are even named by John O'Flaherty, 1825, as existing in Aran. He found fir, pine, and oak in the peat (? submerged), and wild ash and hazel on the crags. O'Donovan heard of dwarf oak scrub and hazels near Dun Oghil (O. S. L., p. 230).

[5] "Annals of the Four Masters."

[6] Copy in the O. S. Letters, County Clare, Rathborney Parish, vol. i.

feature of the fortress. The abattis consists of a closely set mass of little pillars, usually 3 to 4 feet high, girding the whole middle walls in a band from 30 to 80 feet wide, more open between the north-west and northern gates, but nearly impassable to the north-west and to the east, at which latter side they are set with wonderful pains up a steep rock-slope below the rampart. The tops of the pillars, as noted by Dr. Colley March,[1] are greatly worn and furrowed by the weather, like those at Ballykinvarga, and give a more convincing proof of age than is afforded by the facing of the wall, which is less fretted, though probably already weather-worn when raised from the crag; for in many forts on the mainland we have seen evidence of such wear on faces embedded in the wall. We must bear in mind, however, that similar evidence of weather-wear is found on the upper parts of sculptured crosses of the ninth to the twelfth century; and the base of the twelfth-century cross of Dysert O'Dea is also deeply fretted. The rock at Dun Aengusa did not afford such convenient crannies to form sockets for the pillars as were found at the Black Fort; nor was the soil sufficiently deep (as at Ballykinvarga) to fix them; so, in many cases, they simply lean against each other or fall over in picturesque confusion.[2] There is no outer kerbing or later annexe to the abattis, as at Ballykinvarga or the somewhat similar fort at Mohne in the Baltic; nor, like the former, have they lesser spikes between the pillars (spikes sharp enough to cut through the side of a boot); but they are jagged and sharp indeed. O'Donovan exaggerates when he writes that "many of them are so sharp that, if one fell against them, they would run him through"; but they are very perilous to pass, even when undefended. He picturesquely compares them to an army petrified in act of attack.[3] The band measures about 700 feet from the west to the north-east gate, and over 200 feet more from it to the cliff eastward.

The feature is very rare: it occurs at Dun Aengusa, the Black Fort, and Ballykinvarga, and was once found at Dunamoe promontory fort in Mayo, the pillars from which were used for house-building in Belmullet.[4] In Great Britain patches of such stones are set to form obstacles at the more accessible

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[1] "*Loc. cit.*, vol. xv., ser. ii., p. 226.

[2] See Plate I., fig. 2; and Plate III., fig. 1.

[3] Mr. Burke chooses the less dignified and rather misleading simile of "almonds in a pudding," for the stones are not set out apart as drawn by Cheyne. These inaccurate views led to the theory noted by Mr. Wakeman, that they were tombstones of those buried round the fort; or by Dr. March, that they were to protect cattle from slingers.

[4] Journal R.S.A.I., vol. xix. (consec.), p. 182; Trotter's "Walks in Ireland," pp. 503, 504. He calls them "stone stakes of great size and height." Rev. Caesar Otway says that O'Donovan remembered them "more numerous and much larger" than in 1841; but they had been "removed for sills and lintels." See "Erris and Tyrawley," p. 68.

approaches to the forts of Pen Caer Helen in Wales[1] and Cademuir and Dreva in Scotland.[2] Rows of pillars of similar intent occurred in the destroyed fort of Cap Sizun in France,[3] two Swiss forts near Laufen, Berne,[4] and the "Bauerberge" of Möhne in Russia.[5]

Irish scholars could help archaeology by searching in our early literature for mention of such a feature. It could, however, hardly be expected that where our older writers seem to pass over our countless dolmens without notice, they would have preserved mention of so rare a feature confined to four of our cathairs. It is, however, very probable that a similar timber defence surrounded many of our forts, and was called a "sonnach"; it may have filled those narrow, flat spaces inside the outer rings which gird some earth-forts, like Doonaghbwee and Lisheencroneen, in Corcavaskin; and it originated the place-names "Lisatunna" and "Sonnagh."[6] To take a few examples from ancient works: there is mention of two mythical forts; one made by the divine builder Aenghus, son of the Daghda (already noted),[7] "with lofty *sonna* (stockades); another, "with seven walls and an iron *sonnach* on each *mur*."[8] When Cuchullin was pressed to fence the fort of Howth, he said: "A heap of spears closes it for me." He evidently compared his warriors to an abattis.[9] Aedh Guaire, King of Connaught, in the sixth century, built a new house in a *dun*, and, "outside all, a *sonnach* of red oak round about his *dún*."[10] The breaking of such a palisade to admit the king's spear, held lengthways, is alleged to have caused the quarrel of the Ardrigh Diarmaid with St. Ruadhan, the cursing of Tara, and its desertion. "The Voyage of the Hui Corra," a tenth-century romance, tells us of yet another mythical island *dun*, "with a brazen *sonnach* round it, and a brazen net spread on the spikes outside."[11] It is as curious to find so early a foreshadowing of spiked-wire entanglements as of another modern invention, where the Mabinogion

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[1] "Archaeologia Cambrensis," ser. iv., vol. xii., p. 345; and "Ancient Forts of Ireland," fig. 6.

[2] "Early Fortifications in Scotland," pp. 225, 226. Dreva has a side-annexe like Dun Conor; both are in Peebles.

[3] For Cap Sizun, see "Archaeologia Cambrensis," series iv., vol. ii., p. 287; and "Ancient Forts of Ireland," fig. 4.

[4] "Dictionnaire Archéologique de la Gaule, Epoque Celtique," tome i., p. 122.

[5] Borlase, "Dolmens of Ireland," vol. iii., p. 1130.

[6] There are a dozen townlands called "Sonnach," chiefly in Connaught, and four named Lissatunny; but in field-names and compounds it is far from uncommon.

[7] "Agallamh." Translated by S. H. O'Grady, "Silva Gadelica," ii., p. 3.

[8] Lebor na hUidre, "The Fairy Chariot of Cuchullin" (Siabar charpat Conculaind), Journal R.S.A.I., vol. xi. (consec.), ser. iv., vol. i., p. 387, copy *circa* 1106.

[9] "Revue Celtique," vol. viii. (1887), p. 55.

[10] "Silva Gadelica," vol. ii., p. 70, "The Story of Aedh Baclamh."

[11] "Revue Celtique," vol. xiv. (1893), p. 47, "Voyage of the Hui Corra," ante 1100.

describes the wonderful flask that kept hot drinks warm and cold drinks cool. Old fiction, however, usually based its non-magical surroundings on "things seen," and it is evident that spikes, if not of stone, "brass," or "iron," at least of wood, girt many a fort in ancient Ireland.

The abattis of Dun Aengusa has been removed for a short distance at each end by idlers who love to hurl stones down the precipice into the sea below. There is, as we noted, an avenue nearly 80 feet long through the pillars to the north-east gateway; it is probably ancient, being similar to that at Ballykinvarga. O'Donovan overlooked the accessibility of all the cliff-edge when he supposed it a modern work to give access to the sea-face.[1] No avenues lie to the north and north-western "gaps"; the former (as we tried to prove) is in the later reach of wall; the latter was a shapeless gap, with no trace of piers, in 1878. It is not necessary even to regard such an avenue as made in ancient, but more peaceful, times later than the actual foundation of the fort. The gangways left in the rock-cut fosses at Doon Fort[2] (probably the reputed seat of the brother of Aenghus the Firbolg) and Lisduff, near Kilkee, show that the old fort-dwellers little regarded this undoubted weakening of their defence. This was not from thoughtlessness in early times; for in the "Book of Leinster" the danger was noticed. "It is a peril to be upon the fort unfortified; and the shout of the person in its door that has conquered it."[3] The only fairly defensible gateway of an Irish fort known to me is at Dunbeg in Kerry; perhaps, too, at Dunnamoe, the entrance was capable of more than mere passive resistance.[4]

The Fragment.—To the north and west of the central fort is a fragment (as I believe) of the old outer wall. It is 7 feet 6 inches thick and about the same height at the east end, and is about 250 feet long with a terrace 4½ feet high and wide. It lies 54 feet from the middle wall at that end, but approaches it to within 20 feet to the west. It is entirely levelled near the cliff and from the upper ridge to the north-east gate, while much of its western reach is very low.

The Middle Wall.—The eastern part was evidently the old outer wall, and the western, from the "bastion" westward, the older middle one. The intermediate part was an afterthought. It is terraced throughout and varies much in height, being from 5 or 6 feet at the north-east to nearly 12 feet high at the upper ridge. In 1878 long reaches of the terrace were extant, but no

[1] "O. S. Letters," p. 213.
[2] Journal R.S.A.I., vol. xxvii., p. 126.
[3] "Book of Leinster," p. 37.
[4] Miss Stokes notes the advance implied by the gateways of Irish stone-forts over the gaps in British forts ("Christian Architecture of Ireland," p. 26). Perhaps the "gaps" had wooden gateways: some Irish ones have lining slabs.

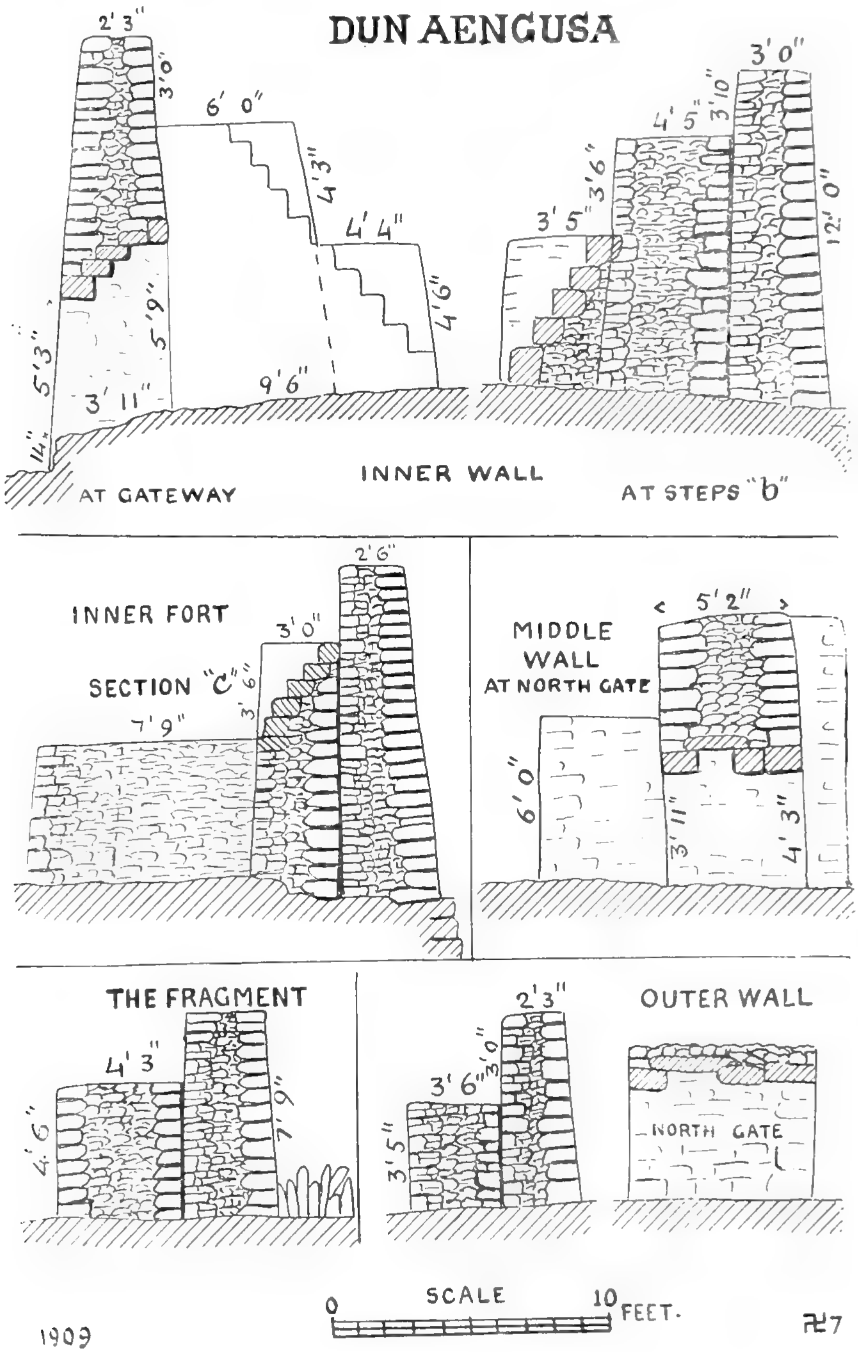

Fig. 4.—Dun Aengusa. Sections of the Walls.

steps. The north gate was nearly buried in fallen stones, so that one could hardly creep under its lintels ; and the other gates were shapeless gaps. The walls show little batter to the east, but bulge in and out, showing traces of long periods of settlement in every reach. Like the inner citadel, the masonry is of good and at times fairly large blocks, largest at the north gate, the joints packed with spawls. The sections next the sea have been little altered. It runs in an unusually straight line to the cliff, which perhaps implies that even when first built it ran to an earlier edge of the precipice farther to the south. It is interesting to note a similar curved wall, with two gates to the north, and at the north-east corner as at Dun Aengusa, turning abruptly and running in an almost straight line to a sea-cliff, at Seafort in Sussex.[1] The link-wall starts from the eastern part with an abrupt bend a little to the south of the corner gate. The latter is 4 feet 9 inches wide (4 feet 6 inches in O'Donovan's letter), varying a little, the wall being 8 feet 2 inches thick, and the lower three feet of the jambs are ancient. From it the gate of the citadel is seen facing and about 235 feet away. The space between the walls at the cliff-edge is practically the same (234 feet), and is 240 feet at the middle of the east section. The abattis, which clings to the foot of the old wall, curves out from the "link," and is about 60 feet out from the "bastion." The older north-east gate was probably some 10 feet in advance of the present one at the steep avenue and slope. ("*h*" on plan, p. 10.)

Westward from the gate the wall runs in a wavy line[2] shown as regular in the two older sketch-plans (of Petrie and O'Donovan), and so reproduced in the maps used by Babbington, Haverty, and even Dunraven. Modern steps ascend to the ends of the terrace at either side of the gate ; an inward curve is found from about 50 to 70 feet westward ; the north gate (*g*) at 161 feet. This is perfect now as in 1878. It is 4 feet 3 inches wide and high outside, over 6 feet wide in the passage. Some of the outer jamb-stones are over 4 feet long and a foot thick. Inside, the piers being on a slope, are (like the outer gate) of different heights (3 feet 2 inches to 3 feet 11 inches). The passage is 5 feet 2 inches deep, covered (like the outer gate) with three lintels, the inner over 6 feet long and 10 inches to 14 inches thick ; the outer 5 feet 5 inches long and 8 to 9 inches thick. The width inside is most unusual, and probably had a narrowing pier which had fallen or was ignorantly

[1] Archæologia, vol. xlii., part i., p. 52, and plate vi. "Hill Forts in Sussex," by Col. A. H. Lane Fox.

[2] The outer wall of Tre Ceiri in Wales is as irregular and, like the "link-wall," is terraced, but the irregularity in the Welsh fort, as at Cashlaun Gar, Langough, and other rock-forts, originates in the contour of the ground, while that of Dun Aengusa runs on an unimpeded floor of crag, the more regular reaches of the inner walls being alone on the rock ridges.

removed by the restorers in 1884. This cracked the lintels when the wall was rebuilt above them, and two stone props were inserted. The space between the two outer lintels and the inner one is covered by cross-bearers. My notes of 1878 are too vague to verify this feature; but (like the outer gate) it is possibly correct. The terrace at this point is 6 feet high; and the outer wall makes a little curve at the west pier of the outer ope. The fine inner lintel of this gate probably belonged to a predecessor; otherwise it is, and indeed the other gateways of the citadel are, of very poor construction when compared with several of the Mayo, Clare, and Kerry forts. The irregularity and poor, small blocks of the side-jambs give the gateways of Dun Aengusa a somewhat ragged and late appearance, and quite account for the complete ruin of all those of the other forts of the islands. Westward

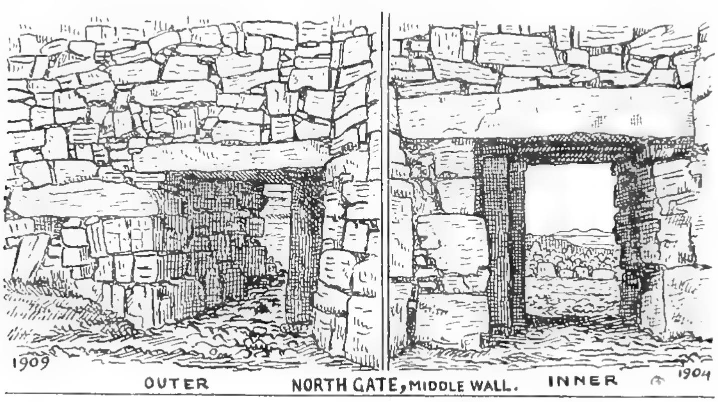

FIG. 5.

from this, at the upper ridge, the wall makes a curve like a bastion, and meets the older portion nearly at right angles (*f*). Inside they, with their terraces, meet in another practically right angle on the crown of the ridge, at 83 feet from the inner west pier of the gateway. This is evidently the junction with the old second wall, which runs thence, in a regular curve, practically equidistant (27 to 30 feet) from the central wall to where it has been demolished near the cliff. The terrace at the sharp bend is 4 feet high and 20 inches wide on the "link," and 3 feet on the old wall, which is 7 feet thick and high, the outer section being from 3 to 4 feet thick. This bend appears in one of my camera sketches of 1878,[1] and probably in Dunraven's photographs. At 54½ feet from the bend is the gap of another gate (*e*). It is shown in Dunraven's third photograph,[2] and seems then to have had the foundations of piers. The probable continuation has been as entirely removed to the east

[1] See p. 40.
[2] See Plate II., fig. 2.

of the fort as at the ends near the cliff. This enclosure is about 400 feet east and west by 200 feet north and south, but was probably at first very much larger.

The Inner Fort.—This fine early citadel has, as a rule, nearly monopolized the attention of all antiquaries and visitors; so the descriptions before 1880 are fairly satisfactory. We must, however, describe it fully once again. Before doing this let us first examine what O'Donovan[1] wrote about the ramparts, which has been thoroughly misunderstood. He writes that the internal division is 3 feet 4 inches thick, the central 5 feet, and the external 4 feet 5 inches thick; total, 12 feet 9 inches. "The two external divisions are

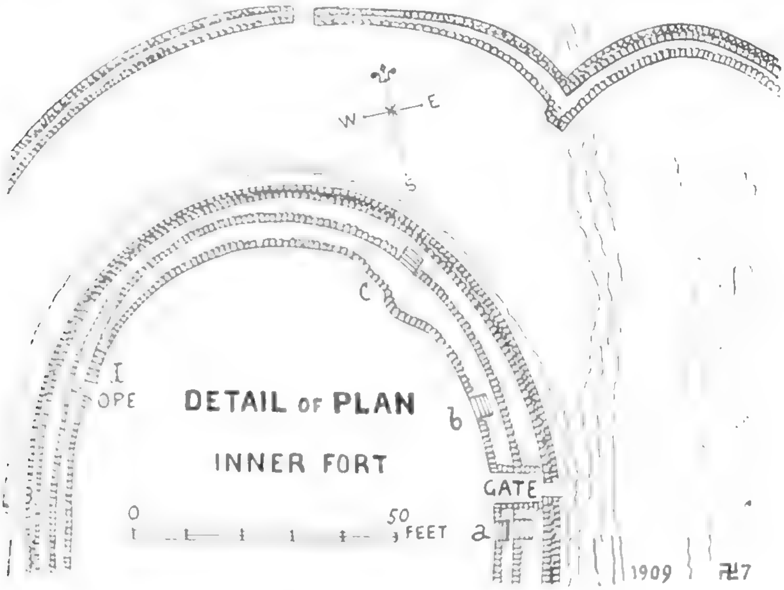

Fig. 6—Dun Aengusa. Alteration in middle wall.

here raised to the height of 18 feet; but the internal division is ... 7 feet high.... I find in all the other forts that the internal division is generally 4 feet lower than the other two." This was understood by Lord Dunraven,[2] W. F. Wakeman,[3] myself, and others[4] to imply that the central section of the wall

[1] "Ordnance Survey Letters," Co. Galway, p. 205.

[2] Dunraven, "Notes on Irish Architecture," vol. i., p. 4.

[3] "Traces of the Elder Faiths of Ireland" (Colonel Wood-Martin, 1902): Wakeman's view, vol. i., p. 316. It has ∧ steps, which do not occur in Dun Conor, some thirty-four huts all over the area, and the sunken way round the wall, all incorrect.

[4] As corrigenda to my own errors, see Journal Roy. Soc. Ant., Ir., vol. xxv., p. 258, and its Handbooks, ii., p. 66, and vi., p. 73. "Ancient Forts of Ireland," section 81, and the same essay in Trans. R.I. Acad., vol. xxxi., p. 632. Dr. Christison, in "Early Fortifications of Scotland," p. 151, is also misled by O'Donovan's equivocal language. The non-occurrence of a sunken way in any untouched stone-fort, or at Dun Aengusa itself in 1878, should have kept me at least from this mistaken interpretation.

was 11 feet lower than the others. Wakeman went so far as to draw an ideal restoration of Dun Conor with a sunken way round the top. Some censured the restorers for having obliterated this interesting feature, and refused to believe that the wall had had an inner section till confronted with the third Dunraven photograph. This feature (which I sketched and well remember) first led me to reconsider O'Donovan's account in 1904, when I saw that by the "internal" division he meant the banquette, being indeed the true inner section, which removes the apparent inconsistency of his further statement that the two outer divisions were of equal height, and explains his allusion to the section 4 feet lower than the summit in all the other forts which have banquettes behind the outer walls exactly as O'Donovan describes.

The rampart has a slight batter (usually 1 to 5, or 1 to 7), but is usually distorted and bulged out. It is 12 to 13 feet high at present, but rose in parts to 18 feet high in 1839; resting on a low, and evidently scarped, ledge of rock, 3 or 4 feet high, all round which, when covered by debris, may have brought the old height to 18 feet. The third Dunraven photograph, Mr. Cheyne's view in 1847, and two of my camera sketches in 1878, show that a large patch of the facing opposite the north-west gate had fallen, showing a second face inside; and I recollect this condition in 1878. The outer section had only one face, with filling between it and the next (or middle) section; but the latter had two faces. The inner sections were terraces, the lower 4 to 7 feet high. The upper is, I think, a modern development, 4 feet higher, as the outer sections were certainly of the same height in 1839, and even in 1878. As we noted, a line of large foundation blocks on the ledge outside, and to the south of the gate, implies a later rebuilding. So do the joints, first noted by Mr. Lynch, but shown in Burton's sketch of 1857; they lie 23 inches to the south, and 30 inches to the north of the entrance outside,[1] and 14 inches to the north, and 16 inches to the south inside. This suggests a rebuilding of the present door and outer wall in early times, as does the useless ope to the north-west under the terrace. The wall is of unusually good, though somewhat small, coursed masonry, with a facing of headers. A few larger blocks, or perhaps only stretchers, 3 and 4 feet long, are found in the lower courses. The masonry, as usual, gets smaller about 8 or 9 feet up, owing probably to difficulties in lifting the blocks. It is inconceivable that so many persons should have described such masonry as "cyclopean." That of the neighbouring churches better merits this oft-abused term.

The gateway is perfect, facing slightly to the north of east, and is a

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[1] See Pl. III., fig. 2.

fine typical structure, with a long outer lintel, and two long relieving stones over it. It is 5 feet 9 inches high, but a step of the natural rock inside it reduces its height to at most 5 feet 3 inches. The passage rises steeply 18 inches in 5 feet; the two outer ledges or steps are 14 inches and 16 inches high, so the garth inside is nearly 4 feet above the foot of the ledge. The gateway tapers very slightly upward from 3 feet 5 inches to 3 feet 4 inches wide; it is 4 feet deep above, and 9 inches more below, of fairly large stones, some 3 feet 7 inches long, and 1 foot thick. The lintels rise inside like inverted steps, such as we find over stairs in certain late

Fig. 7.—Dun Aengusa: The inner gateway, interior and exterior.

peel towers. There are five covers, their depths being—the outer, 15 inches (by 14 inches thick, and 5 feet 10 inches long), the next three 9 inches to 10 inches deep, the inner being 4 feet 6 inches long. They rise 9 inches, 6 inches, and 8 inches, the two inner being level, and keep the passage at a fairly even height above the slope. The inner ope is 5 feet 9 inches high, and 3 feet 2 inches wide. An unroofed passage, 6 feet 7 inches wide, and 9 feet 6 inches deep, runs, as is usual in Irish forts, through the inner sections of the wall. The lower blocks are large; some are 3 feet 7 inches, 4 feet 9 inches, and 5 feet 9 inches long, and 15 inches to 28 inches thick; but the upper part is rebuilt, having been a ragged, shapeless heap of blocks in

1878, to both sides of the gateway.[1] The rampart is 13 feet 6 inches thick here,[2] 12 feet 6 inches thick farther south, and 14 feet 2 inches to the north-east.

There are two terraces, such as we find at Ballykinvarga and other forts,[3] running round the interior; the lower is 4 feet to 5 feet high to the east, 6 feet to 7 feet to the west, the upper 4 feet to 5 feet high; they vary greatly in width, being usually 4 feet to 5 feet wide, but 7 feet 9 inches wide at one point. The upper was noted by O'Donovan in 1839; there was some trace of it even in 1878; the lower was noted by Ferguson in 1853. Two "ladder-flights" of steps run up the two terraces at 5½ feet to the south of the entrance: the type is common in Aran and Clare; the other, or "sidelong flight," being more common in Galway, Mayo, and Kerry, though not unknown in the former districts. The flights are each nearly 4 feet wide, and are of five and six slightly projecting steps. Northward, at 9 feet 3 inches from the gateway, is a flight of five "ladder-steps," 4 feet wide, and 2 feet 4 inches deep in all, up to the lower terrace; it is mentioned by Ferguson; 27 feet farther northward is an upward flight of six steps, 3 feet 4 inches wide; the lower terrace is broadest at this place. The north-west stair is 61 feet farther round the terrace, consisting of two sidelong flights,[4] eight steps in the lower, and six in the upper; all are reset, but they are marked on Petrie's plan, and there were "slopes" in 1878, with some trace of a terrace. The whole double flight is 12½ feet long. At the foot is the oft-mentioned ope in the lower wall; it is a low, lintelled passage, ending in loose filling, and is 3 feet 10 inches high, 33 inches wide, and over 6 feet deep, with four lintels, the outer being 2 inches thick; it is 80 feet from the pier of the main entrance; there are no other features seaward.

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[1] The south side of the inner passage appears to have been standing when Burton sketched the doorway, and at least the lower part on the north remained in 1878; the sketch at that date tallies with nearly all the existing stonework above the door up to the present summit, but part has been added to the ends at the terraces.

[2] Not 15 feet 5 inches, and 13 feet on top, as in Petrie's "Military Architecture."

[3] Though rare outside of Ireland, terraces are found at Tre-ceiri in Wales; Worlebury (Somerset. in England—where there were six sections rising as terraces, each about 4 feet higher than the next lower. Dr. Christison implies that some are extant in Scotland. Dr. Guébhard illustrates (from "Monuments primitives des Baleares," E. Cartailhac) terraced stone forts in Majorca and Minorca. There are probable examples in France, at Baou de la Grande (Alpes Maritimes), and an apparent terrace at Cidada Velha de Santa Luzia in Portugal, all in primitive structures closely comparable to Irish cathairs.

[4] This type is, perhaps, the later, as occurring in the very advanced and elaborate forts of Staigue and Cahergel, in Kerry. It is also found in Moneygashel, Sligo; Cahergel, Galway; Caherahoagh and Cahergrillaun, in Clare. The examples in Aran, save at Dun Aengusa, are unrecorded before the works of 1884; but some may be true restorations, as we noted the sloping marks of unrestored flights in the Black Fort. There is also a record of a very early flight of "sidelong steps" in the fort of Erimokastro, in Rhodes. ("Revue Archéologique," N. S., vol. xviii. (1886), p. 156).

The garth is from about 140 feet to 150 feet across, 150 feet at the cliff; it was very probably oval, but there seems no datum for the dimensions given in the "Letters" of 225 feet north and south. In the middle, on the edge of the precipice, is a rock-platform, evidently scarped and squared, a few feet high, 42 feet north and south, and 27 feet across. From it we can drop a stone into the waves raging, in their unwearied sapping of the cliff, 302 feet below. There are no hut-sites in the garth; if they ever existed, the materials may have been thrown over.

The view from the summit of the fort is most impressive and solemn: the desolate-looking fields, "the soil almost paved with stones," as in 1684, fall away to the golden crescent of Kilmurvey strand, and rise up the opposite hill, past the village of "Gortnagappul,"[1] to the old lighthouse near Dun Oghil. Eastward runs the long range of steep, dark headlands, and deep bays, rarely unsheeted by high-leaping spray; while beyond the huge cliff, and "the trouble of the sea that cannot rest," we see the "great wall of Thomond"—Moher—with its violet-shaded bastions. The limits of the view on clear days reach from the giant peaks of Corcaguiny in Kerry to those of Connemara; while to the south-west is only the horizon of the landless deep, whirling sea-birds, and the sparkling silver tideways.

APPENDIX A.

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[1] Oortnagappie on the maps.

[2] Only those earlier than 1880, or avowedly founded on notes dating before that year, are given.

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VIEWS.

1795. Imaginary view given by Dr. Ledwich, in Grose's "Antiquities of Ireland," ii., p. iv, and in his own "Antiquities of Ireland," plate xi., p. 140.[3]

1839. Masonry of Dun Aenghus, by W. F. Wakeman, in "Ordnance Survey Letters."

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[1] He only mentions one rampart of flaggy limestone and the *chevaux de frise.*

[2] Ledwich regards the fort as a monastery; he neither visited it nor took any pains to get any accurate view or description of the ruin. "There are many of these mandrae dispersed over this kingdom hitherto unnoticed; one remarkable is Dun Aengus . . . situated on a high cliff over the sea, and is a great circle of monstrous stones without cement." The inaccuracy and dogmatism are very characteristic of the work cited. Windele also grievously attacks "this pretentious antiquary," while giving a theory of his friend, Mr. Thomas L. Cooke, who supposed the fort to be a pagan temple, and the little recess in the wall a room for "a priest or two, with attendants"! it being (as we noted) less than 3 feet wide, 4 feet high, or 8 feet long.

[3] The view is stated to be by M. Hooper, July 5th, 1795, engraved by Sparrow, in Grose, but we read "W. Beaufort del. J. Ford sculp. Pub. by John Jones, 90 Bride S^t Dublin" on the plate in Ledwich's own work.

1836. Dr. Petrie's beautiful view, reproduced in Miss Stokes's "Christian Antiquities of Ireland." It shows the fort and cliff from the east.[1]

1847. C. Cheyne, reproduced by Babbington and Wilde, *ut supra,* and Dr. Joyce's "Social History of Ancient Ireland," ii., p. 58. Fort from the north-west.

1857. F. W. Burton, reproduced by Dunraven and Stokes, *ut supra.* Door of the central fort.

1875. Lord Dunraven's fine photographs. (1) Fort and cliff from east. (2) Fort from north-west. (3) Portions of middle and inner walls.[2]

1878. Camera sketches—(1) Fort, distant, from east. (2) From north. (3) From north-west.[3] (4) The inner gateway. (5) The inner fort from east. (6) Interior showing terrace.

Plans.

O'Donovan and Petrie. O'Donovan is followed by Dunraven, Babbington, and Haverty. All these are little better than sketch-maps. Windele gives an extremely crude plan, only showing two crescent walls concentric and with gates.

APPENDIX B.

Unpublished Descriptions before 1880.

The records of a fort whose origin is lost in the darkness, and which apparently finds no place in later Annals, of course must consist largely of the papers written on its remains. An unrestored fort is its own record; but, to one who recalls the weird chaos of ruin-heaps in 1878, and contrasts it with the neat, level-topped enclosures left by the restorers six years later, the old descriptions, no matter how rude, assume a great importance, and should be laid before one's readers. We collect those of Petrie, O'Donovan, Windele, and the result compiled from our own notes and sketches before the restoration. We cannot believe that these have exhausted all the early unpublished descriptions; but we hope to lead anyone who has notes on Dun Aengusa, taken in or before 1884, to publish the same and perfect, as far as possible, the record of that great fortress.

[1] The artist overpowered the antiquary; by increasing the size of the waves and the human figures he makes the cliff a mere fraction of its height, and overhanging too far. The fort, however, is accurately drawn.

[2] I have been kindly permitted to reproduce these last two by Messrs. George Bell and Sons, York House, London. The latter also appears in Journal R. S. A. I., vol. xxxiv., 257.

[3] This was published in Journal R. S. A. I., vol. xxv., p. 257, in 1895. I trace from it, as the original seems lost.

GEORGE PETRIE (1821 and 1857). The notes used by Dr. Petrie for his "Essay on the Military Architecture of Ireland previous to the English Invasion" (two manuscripts classed 12.0.9 and 10 in the collection of the R. I. Acad.), most probably date from his leisurely visit in 1821, not from the confused picnic meeting of 1857, when detailed observation was almost impossible. We slightly condense his and the other accounts, but keep every essential feature. [p. 131][1] The "overhanging cliff is 360 (error of copyist, *recte* 300) feet above the level of the ocean." His sketch of the gateway, with strongly inclined jambs, and section of the wall, 13 feet wide on top, and 15 feet 5 inches below, with a strong S curve, are both inaccurate. Neither manuscript is in the handwriting of Petrie. [p. 135.]

"The keep or caher is 115 feet [150 on the plan] in diameter, the wall 20 feet high, and 14 feet 6 inches thick. It has one small entrance doorway, 5 feet high and 3 feet wide. The wall contains a small chamber or cell within it. The wall is of nearly equal thickness, making allowance for a curve in its outer faces. The steps which led to the parapet are destroyed. In the centre of the area there is an oblong level elevation of rock, apparently formed by art, 42 feet long, 27 feet wide, and 2 feet high. The keep is strengthened by three concentric walls, on ledges of rock, each rising above the other. The first [p. 136] varies from 10 to 12 feet, and is about 11 feet in thickness. It has a level terrace at the height of 6 feet from the ground, and an entrance doorway, which varies in breadth from 3 to 6 feet. This wall is 30 feet from the inner, and at the doorway, 234 feet. The second concentric wall is situated on a lower ledge of rock, and extends only about half the circumference of the first. It is about 10 feet high and 6 feet wide; this wall has also a terrace at about half its height, which is reached by two flights of steps *d* and *d* [shown, but not lettered, in the plan as in the "fragment," which is in the text confused with the second wall], and has a doorway about 4 feet wide. Its distance from the inner wall varies from 20 feet to 30 feet. The third and outer wall (E) occupies an irregular ledge of rock, considerably below the preceding [p. 139], and varies in its distance from the former from 140 feet to 675 feet; it is about 6 feet in height and in thickness.

"I have yet to notice the most remarkable feature in this great work, namely, a sort of *chevaux de frise* formed of high and sharp stones placed irregularly in an upright position, with their points upwards. This extraordinary barrier surrounds the second and third [*sic*] walls, and extends to a

[1] The smaller copy is paginated, so that p. 60 corresponds to p. 135 in the larger one. The amount on each successive page is the same.

distance varying from 50 to 70 feet. A passage leads by a steep ascent of 80 feet to the gateway in the second wall; and this passage has a wall of 3 feet on either side."

John O'Donovan (1839).—The most valuable description of the unrepaired fort, and one which has coloured every published account since it was written, was made for the Ordnance Survey Letters, and is now given practically *in extenso* (MSS. R. I. Acad. 14 D. 3, p. 197). It commences with a long and controversial section which we omit, as it is merely a series of attacks on Rev. Mr. Healy, Dr. Ledwich, and John O'Flaherty, for their translations, descriptions, and theories.

[p. 197.] "Dun Aengus.—A name now forgotten by all the inhabitants except one old man of the name of Wiggins, dwelling at Killeany" (a Cromwellian by descent), who remembered "that the old people were accustomed to call it Dun Innees," the correct Connaught pronunciation of the ancient name; "all the other inhabitants style it Dunmore." "Dun Aengusa a nAraind," Book of Lecan, f. 277.

[p. 204.] "Dun Aengusa, pronounced Doon Innees, is situated on the south side of the Great Island, in the south-west of the townland of Kilmurvy, on the edge of a cliff which is 302 feet above the level of the sea. It is, perhaps, one of the finest specimens of barbaric fortresses in the world,[1] but very much ruined . . .; the boys of the island are destroying the remaining part in rooting for rabbits which burrow in its walls. As it stands at present, it consists of three concentric walls, of which the central one is in a tolerable state of preservation, but the two outer ones are nearly destroyed, excepting in spots. . . . The central fort or keep is by far the most perfect and interesting part. It was originally of an oval form; but now only the two-thirds of the oval remain, the Atlantic having, in the course of two thousand years, worn away the remaining part. It measures from north to south—i.e. from the northern part of the ring to the edge of the cliff—150 feet, and from west to east, along the cliff, 140 feet. When the oval was perfect, it measured 225 feet in length from north to south. . . . The wall of the keep of Dun Aengus [p. 205] is built of large and small stones, the large ones being placed in the face of it, and the small ones in the centre. This wall is made of three distinct walls, built up against each other, each well faced with stones of considerable size. . . . The greatest height of this wall at present is 18 feet. This is at the west side, where the original characteristics of the masonry appear. The internal division of the wall is here 3 feet

[1] W. F. Wakeman in Duffy's "Hibernian Magazine," vol. i., N.S., p. 470) records a quarter of a century later his recollection of O'Donovan's "wild joy" on first seeing "the old palace fortress of the days of Queen Maeve."

4 inches thick; the second or central division is 5 feet thick, and the external division, 4 feet 5 inches thick—total thickness, 12 feet 9 inches. The two external divisions are here raised to the height of 18 feet; but the internal division is at present only 7 feet high; but it is probable that it was originally many feet higher, though, I think, never so high as the two external parts, as I find in all the other forts that the internal division is generally 4 feet lower than the other two, which are always carried to the same height." [pp. 206, 207; map and some comments are next given. Some pencil-notes give the measurements which he uses later on.] [p. 208.] The doorway which led into this keep is still nearly perfect; it is placed in the north-east side, facing the Aran lighthouse, which is situated on the highest point of the island. It is nearly stopped up on the inside with stones which fell from the top of the wall; I removed them on the outside down to the solid rock on which the wall is built, and found the doorway to measure in height exactly 5 feet. [He then gives the dimensions and rise of each of the four lintels.] The doorway would be 21 inches higher on the inside than on the outside were it not that the solid rock on which the wall is built rises in proportion. . . . [p. 209.] At this doorway the external part of the wall only remains perfect, measuring 4 feet 5 inches in thickness, and the other two divisions are nearly level with the area of the fort, but immediately to the north and south of it they are tolerably perfect.

"In the north-west side of this ring there is a passage, leading from the inside into the thickness of the wall to the extent of 5 feet 6 inches, measuring 2 feet 9 inches in width at the top, 3 feet 7 inches from the bottom to the roof where it is covered by large stones laid horizontally across. . . .

[p. 210. Middle Wall.] "Outside the internal keep are the remains of a strong cyclopean wall which surrounds it at irregular distances. Immediately to the west, near the cliff, it is within 28 feet of the keep. To the north and by west is 32 feet from it, and to the north-west, 42 feet 6 inches. To the north from the keep this wall is in tolerable preservation, for here its original thickness and perhaps height remain. It is 6 feet thick and 12 feet high, and well faced inside and outside with stones of considerable size. It consists of two distinct walls, one built up against the other. . . . A line drawn from this part of the wall to the doorway of the interior fort, or keep, measures 131 feet. In the north-east part of this external wall there is a doorway now much destroyed. It is 4 feet 7 inches in width, and the wall is here 8 feet 2 inches in thickness. A line drawn from this doorway to that of the internal fort or keep measures 235 feet. At the distance of a few feet to the east of this broken doorway this wall forms an angle from which a straight line, drawn to the doorway of the keep measures 240 feet. From this angle the wall turns southwards towards the cliff, which [*sic*] is now very much destroyed. Its length from the angle above mentioned to the brink of the cliff is 176 feet.

"Outside this second wall is placed a host of sharp stones slopewise . . . [p. 211.] Many of them are so sharp that if one fell against them they would run him through. [p. 213.] This army of stones is in some places 30 feet deep, and extends all round immediately[1] outside the second wall from cliff to cliff. They are nearly perfect on the west side, and also on the east; but on the north-east many of them have been removed by the islanders to facilitate the passage to the sea.

[Fragment of Old Wall.] "Outside the second wall and between it and the *chevaux de frise* [*sic*] there is another fragment of a wall which seems never to have been carried around more than about the one-tenth part of the ring. The part of it at present standing is 7 feet 9 inches in height and 6 feet in thickness.

[Outer Wall.] "Outside the *chevaux de frise* of stones there is another wall which encloses a great extent of ground, and runs from cliff to cliff; a line drawn from the north and by the west side of the second wall to this, passing through the *chevaux de frise*, measures 129 feet, and a line drawn from the northern part of the same wall in a north-west direction to an obtuse angle formed by this at the north-west point, measures 393 feet. This wall is here very much injured; but from what remains of it I have been able to ascertain that it was built exactly similar to the second wall already described, that is formed [p. 214] of two distinct divisions which would stand independently of each other. A line drawn from the broken doorway in the second wall, already mentioned, to the north-east point of this measures 434 feet. At the portion I have been able to ascertain that the wall was 8 feet thick, and well built: but the original height could not be inferred from any fragment of it now remaining. A line drawn from this point to the edge of the cliff measures 586 feet; and a line drawn from the second wall at the edge of the cliff to the extremity of this at the edge of the cliff, also measures 640 feet."

[O'Donovan then rightly points out the falsity of Beaufort's imaginary view, which imposed on Ledwich, "Antiquities of Ireland," p. 139, and gives, on p. 221, sketches of the bronze antiquities found, not many months ago, by boys rooting for rabbits. A "fish-hook," $3\frac{1}{4}$ inches long, portion of a fibula, and pins, now in Petrie Museum.]

I need only comment on the above description, that O'Donovan does not

[1] This is only true of the eastern face, as we pointed out.

appear to have seen (or at least noted) any steps in the inner fort or either of the northern gateways in the middle and outer walls. The gates, we know from other sources, existed before the restoration; but the lower terrace of the inner fort (as my sketch shows) lies buried in vast heaps of debris, so any steps were probably hidden.

JOHN WINDELE (*ante* 1854). In that extraordinary mass of rough notes on antiquities and folk-lore (the life-work of one of the most industrious and least-known of the Munster antiquaries), we find a description of Dun Aengusa. We strive with pleasure to rescue a fragment of the work, so unjustly ignored and yet so valuable, of John Windele. It is found in his Supplement, vol. i. (MSS. R. I. Acad., 12 K. 27). We condense.

[pp. 739–40.] "Dun Aongus. It stands on the verge of the sea, high perched upon the edge of a perpendicular cliff at least 300 feet in height, and forms something more than a half-circle, consisting of two enormous walls. . . . The breadth of the intervallum to the left 14 paces (39 feet), at the east 94 paces (300 feet)."

[pp. 740.] "The appearance of the Dun as we first approach is that of a great chaos of ruins; but as it is reached, its general form soon develops itself. The upper outline of the walls is jagged and most irregular, by reason of injuries of one kind or another. The exterior surface is tolerably regular; but on the interior the face has fallen into terrible ruin; and it is only at particular points that its outline [p. 745] can be descried. They are built of limestone, of moderately large stones, of irregular surface and outline, and without any cement—the height about 20 feet, and thickness 12 feet; the walls perpendicular on the outside, and diminishing in thickness within by receding stages and banquettes. The outer face of the interior wall has, at the west side, a succession of stairs, just as we find in the inside of Staigue Fort. I am not prepared to assert or deny that these staircases encompass the whole circle of that wall. [p. 747]. The inner area has a horseshoe form, and measures along the cliff 48 paces (133 feet), and to the crown of the circle at the north, 51 paces (141 feet). A table of rock, square in form, crops up near the cliff above the surface at a height of about 4 feet. It is in a rude and perfectly unwrought state.[1] In the eastern side of the inner encompassing wall is the only entrance, a doorway of narrow proportions. . . Height, 5 feet 2 inches; breadth at top, 4 feet 3 inches [*sic*]. It is covered over with four great lintel-stones, which rise one over the other inwards like inverted steps. The length of the passage thus formed is only 6 feet, which would indicate the thickness of the wall here. The floor is now covered with loose

[1] If "perfectly unwrought" means without chisel marks, Windele is right: but I believe Petrie to be right as to its having been "formed by art."

stones, probably placed there by design or fallen." [He then examines and rejects the temple theory, agreeing with Petrie's statement that it is a fortress, and continues on p. 752.] "A writer, describing Dun Aengus, says the larger of the three (there are only two) enclosures is encircled by a rampart of large stones standing on end. This is a decided error; the stones are polygonal in form. . . sometimes hammer-dressed, but never by the chisel." It is indeed remarkable that he so entirely overlooked all outside the middle wall.

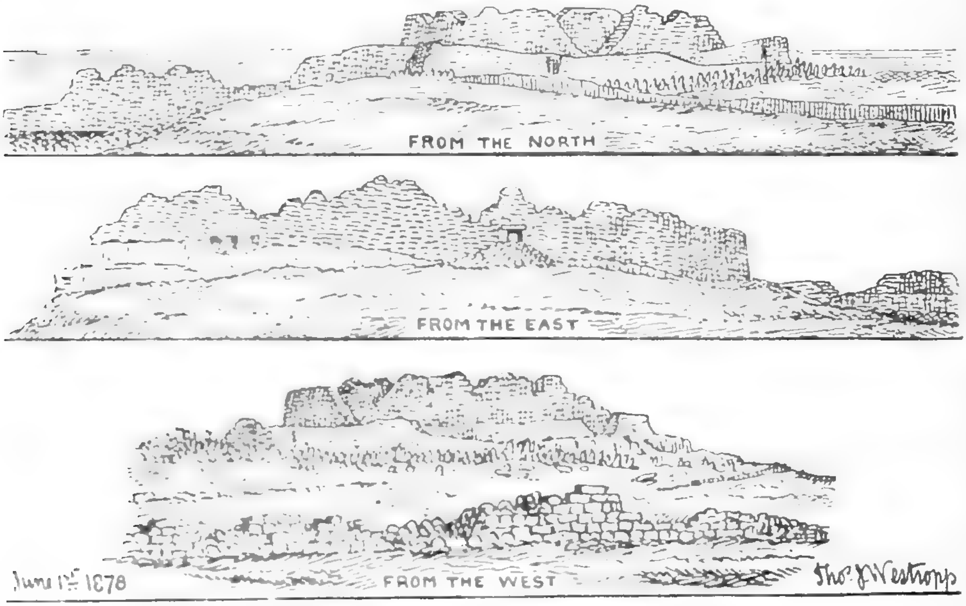

Fig. 8.—Dun Aengusa from camera sketches, 1878.

Notes, June 1st, 1878.—The rarity of records made before the restoration may excuse my giving an adaptation of my own very rough notes: "Doon Engus, Ainuss or Aingus." There is "an old tumbled wall; very much is quite down"; then, "pillars set on end; inside is a piece of detached wall" (sketch). The "inner wall has a sort of terrace, nearly gone near the cliff, with gaps like doors, and one 'creepy' door." There is "a road through the pillars, very steep . . . the second wall runs back round a steep (ridge), with pillars at the foot towards Clare. The middle fort wall has fallen down in one patch, with another wall inside; there is a hole (? the ope inside). The wall was three times a man's height, of rough stones, naturally very square. An old gate looking towards Clare is perfect with a top stone, the wall rising like a gable over it, broken to each side (sketch); another gap higher than one can reach. Inside the door is perfect (sketch); it has step-stones on top (of the passage); all the wall seems very shaken here. There was a sort of terrace round the inside (sketch), and slopes, or steps, up to the top, which is dangerous and loose. There is a square platform of rock. The fort is not a bit like Grose (the view in Grose's 'Antiquities of Ireland'), but like 'Dunraven'; you can hardly get through the pillars. There are lots of rabbits in the stones." The following was written probably the month after our visit:—"Dun Engus, which rises with three tiers of walls. . . . The outer wall is insignificant; then you come to a *chevaux de frise* of jagged pillar-stones; behind this is a low middle rampart; next the great inner wall in which, through a square-headed door, we entered the interior—a level rocky piece of ground with an oblong raised platform of rock, 2 or 3 feet high, and so squared as to look artificial. The Firbolgs were certainly no savages: the smooth-faced walls, well-built door, clever *chevaux de frise,* and flights of steps on the interior" show this.[1]

APPENDIX C.

Published Accounts before 1880.

For completeness it may be well to give a short account of the previous descriptions in print.

Roderick O'Flaherty (1684–6).—"Ogygia," p. 175, "Dun Aengus, ingens opus lapideum sine coemento . . . supra altissimam maris crepidinem, e vastae molis rupibus erectum." "hIar Connaught," p. 76, "On the south side stands Dun Engus, a large fortified place on the brim of a high clift, . . . being a great wall of bare stones without any mortar, in compass as big as a large castle bawn, with several long stones erected slopewise against assault.[2]

Edward Ledwich, ll.d. (1797).—In Grose's "Antiquities of Ireland," Introduction, p. iv, and in his own work of the same name, he follows "Ogygia," and gives a delusive view done not from nature but from the description. He regards the fort as a mandra or monastic enclosure.

John O'Flaherty (1824). — In Transactions Royal Irish Academy, xiv., p. 135, he adds nothing to his predecessors'[3] accounts of the fort, even omitting any allusion to the abattis.

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[1] The sketch-plan shows the north-west steps, east terrace, and gateway in the inner ring; the middle wall with north-east and north gates, the fragment, the abattis all round the wall, and the outer wall.

[2] Its only "measure," "which might contain 200 cows," of course refers to the inner fort.

[3] Though devoting much space to futile theories on the non-existent "relics of druids, open temples, altars, stone pillars, sacred mounts of fire-worship, miraculous founts, and evident vestiges of oak groves." O'Donovan writes of this author with much bitterness in "O. S. Letters."

SAMUEL FERGUSON (1853).—In the "Dublin University Magazine," vol. xli., p. 494, "S. F." (as he also signs some of his poems[1] in the same pages) gives this excellent description, which, being rather inaccessible to antiquaries living outside Dublin, may be given in a condensed form:—"After a walk of half a mile (we) reach the outer rampart of Dun Angus, a dry stone wall of about 3 (perhaps 8) feet in thickness. The circumvallation covers a space of about 11 acres. A similar wall on each side of the avenue flanks it onward from the outer entrance to a second line of wall lying close to the main body of the fortress. This second wall apparently consisted of a banquette and a parapet. . . . All round the base of this second rampart . . . sharp-pointed fragments of rock are pitched around: . . . it is with difficulty one can approach the place save by the avenue. . . . The entrance is still perfect . . . about the middle of the eastern front. . . . The visitor must climb in on his hands and knees, under the wide massive lintel-stones. On the right, on entering, are the remains of a flight of steps conducting to the lower banquette; . . . one or two other indications of steps may be detected."

DR. CONROY (1870).—The Most Rev. George Conroy, Bishop of Ardagh, in "A Visit to Arranmore of St. Enda," published in "The Irish Ecclesiastical Record," N.S., vol. vii., p. 24, follows S. F. closely. He describes the beautiful cliffs and rock-pools. Notes "the dry-stone wall, an irregular ellipse," built "in two divisions," the abattis 60 to 80 feet wide, where a narrow avenue is left: it runs all round the second wall, between which and it is "a fragment of wall covering about one-tenth of the second line," which is 32 feet to 42 feet from the central fort to the north-west and in two sections. The central fort is a half oval, the wall in three sections, "like the coats of an onion," traces of stairs, and the banquette, on the east side": the nearly perfect door 3 feet 4 inches wide, with a lintel and two stones to shift the pressure, and a passage leading into the wall, are mentioned. The dimensions are from the "Ordnance Survey Letters."

"THE IRISH BUILDER" (1877).—A series of anonymous articles, partly from notes taken in 1877, but (so far as Dun Aenghus is described) a compilation from O'Donovan, Ferguson, and Conroy, were published in this paper, from August 15th, 1886. The notes seem hurried and unrevised: for example, they describe Dun Moher and Dun Farvagh as separate forts, p. 237.

LORD DUNRAVEN (*ante* 1875).—This splendid work is too well known to

[1] For example, "Archytas and the Mariner," following the Aran paper, on p. 506. His history and topography of Clare are inferior; he locates the Battle of Corcomroe Abbey, 1317, at Doolin, and asserts Killilagh Church to be "the Abbey"; places Magh Adhair (in eastern Clare) at "Moy Adha," (Moyadda), near Kilrush; probably confuses Caherlaherta with Ballykinvarga, and makes Richard de Clare survive the Battle of Dysert.

require description. The account and views of Dun Aenghusa (the latter the only photographs known to have been taken before the Restoration) are in volume i., "Notes on Irish Architecture." The sketch of the door of the central fort is also given. The plan is only a sketch-plan from the "Ordnance Survey Letters," which the writer follows largely for dimensions. He saw "no trace of inner platform; there was a chamber or passage" in the central fort. He alone describes the perfect gateway in "the outermost wall," the "interior covered with flags, the wall being 8 feet high, and 5 feet thick." I have to thank the kind courtesy of the publishers, Messrs. George Bell & Sons, for permission to reproduce two of the photographic views of this work.

THE OTHER ACCOUNTS are rarely of any independent value. That of Martin Haverty (1859) for the British Association Handbook is very brief, hardly filling two pages,[1] while fourteen are devoted to the picnic and long speeches, but little to the point—much sack to but little bread.

There are two other widely known accounts which have given many (as the earlier gave the writer of these lines) their first interest in the fort. The one, dating 1867, is by Lady Ferguson in "The Irish before the Conquest"; the other, by Miss Margaret Stokes, is a preface to her "Early Christian Architecture," 1876; both are excellent and impressive general descriptions, but do not give details of the ruin.

ACCOUNTS BY ENGLISH WRITERS.

There are two papers on this fort in "Archaeologia Cambrensis," which, as being published in Great Britain, are perhaps more studied by antiquaries outside Ireland, and call for some comment to correct the strange mistakes made, especially in the first.

Charles H. Hartshorne (vol. iv., new series, p. 296) gives a very picturesque description of the site of the fortress in 1853. He then gives details: "The area includes half an acre; this is partly surrounded by a triple wall of most unusual character, and beyond . . . by a glacis, two ditches, two concentric walls, which gradually die out to the south-east on the naked rock, and lastly, on the north side, by a *chevaux de frise.*" He gives the height of the walls as from 20 to 50 feet; mentions the portal of the entrance to the south-east; "on the north side is a much larger entrance, with a parallel sallyport running underground. The lower part of the interior wall at about half its height forms an 'alure,' on which people can walk all round"; it "is reached by steps running to the top of the wall, which

[1] Haverty gives the size of the inner fort as 144 feet on the cliff, and 160 feet north and south; he calls it "the Acropolis of Aran—the palace fortress of the days of Queen Maeve."

regularly cross each other, forming a reticulated zigzag."[1] The *chevaux de frise* is of "slabs of jagged limestone," 3 to 6 feet high, and "set so insidiously in the narrow fissures of the rock that it is rather difficult to extricate oneself." From the great skill of its works, he cannot believe that the fort is of the first century, but regards it as monastic.[2] The rest of the paper, where not concerned with slight notes on the other forts, wanders into religious controversy and assertion.

It must be noted that there are *no ditches*: the walls do *not die out* to the south-east: the *chevaux de frise* is not confined to the *north* part; the walls were 18 feet high; where best preserved, not 20 feet (still less 50 feet) high; the gate does not face the *south*-east. The other ope is *smaller* than the main gateway: the "sallyport" *does not run* underground, or even pass through the wall; and the steps do not cross each other. Thus there are eight vital errors in the paper, which nevertheless has been treated as absolutely reliable.

The other paper, by Charles C. Babbington[3] (vol. iv., third series, 1858, p. 60) depends much on Haverty's Handbook, 1859; it makes the suggestions that the middle section of the citadel-wall was the oldest, the outer sections being added on its decay, and that the north-west passage was an older entrance closed by the outer wall. This last is not improbable, as we have noted evident traces of older rebuilding of the outer section. He suggests that the Firbolgs were the Gwyddel; that they were driven out of Wales by the Cymry, and conquered in Ireland by the Tuatha De Danann. The description of the fort is good, the best description as yet published outside of Ireland.

Though not falling strictly within the limit of the papers noted here, being so late as 1894, and not (avowedly at least) from notes taken before 1884, we must notice a valuable paper on the date of the fort by Dr. Colley March in Proceedings of the Society of Antiquaries of London (vol. iv., second series, p. 224). He found no marks of any implement on the stones. The wall has a rubble centre, with compact faces of dry stones, and is penetrated by passages and lintelled chambers. Along its inner side run lofty platforms . . . to which independent flights of steps give access. He accepts the "siege theory" to account for the wall, and (p. 226) suggests that the stones of the *chevaux de frise* were to shelter the cattle driven into the fort from slingers.[4] Petrie, Miss Stokes, &c., date the fortress before the Christian

[1] A confused recollection of Staigue Fort.

[2] "All these duns, cathairs, and cashels were erected as defences around the sacred buildings," p. 303. He did not observe that all the existing churches in Arran are unfortified.

[3] "On the Firbolgic Forts in the South Isles of Aran."

[4] It seems strange how the low, close-set stones could be supposed to be cattle-shelters.

era; but "so careful an antiquary as Rev. Charles Henry Hartshorne" considered it of monastic origin. The pillars of the *chevaux de frise* were worn into deep digitations; the bronze acus of a fibula of the "spring pin type" was found by Mr. Wakeman; and in the autumn of 1893 the author found in a rabbit-earth a small hinged ring of a bronze pin, though the acus was missing. It had a cable decoration, and there is a socket opposite the hinge for some kind of setting." The Dublin Museum has one inferior pin-ring. The British Museum has a perfect example. It dates from the fifth to the tenth century. In the enclosure of Dun Aenghus, not far from the spot where the bronze pin was found, the author picked up a leaf-shaped arrow-head of chert, from which minute flakes had been chipped, and also a small piece of true flint worked up. These favour the pre-Christian origin of the fort.[1]

THE RESTORATION.[2]

The subject of the restoration (rather than "conservation") of Dun Aengusa has excited so much distrust, severe criticism, and strong assertion, that one who studied the fort before the event is to some degree compelled to "find a verdict." The unnecessary rebuilding and levelling up of parts of the walls and the "tidy" and new appearance thereby produced, show how desirable it was that the work should have been constantly under the supervision and direction of an antiquary who had studied our ring-walls carefully. Left to non-antiquaries and the natives, the work was of course done unsympathetically, like repairing a fence, and no steps were taken to differentiate the old work from the new, or (I understand) to secure any full record of the structure in its untouched condition. Anyone, however, who studies the above accounts, especially the tabular statement of the authorities for each feature, must arrive at the conclusion that very little "falsification" took place. In fact (save the two flights to the south of the gate in the inner fort, and the upper flight in the north-east[3]), all the features are attested. Even the unrecorded steps (as we suggested) had probably warrant in existing bottom steps, and long blocks in the debris. In this case, as at Dunbeg, want of accurate reports has led antiquaries to a judgment too severe to be justified by the evidence against the restorers.

The Appendix to the 48th Report of the Commissioners of Public Works

[1] Stone implements were also found at Caherblonick near Corofin, and Cahermackmole (Cahermackirilla), in Carran, Co. Clare, both in reputed Firbolg neighbourhoods. See R.S.A.I. Journal, vol. xxviii., p. 264, and xxv., p. 208.

[2] The fort was vested as a "National Monument" by order of the Irish Church Temporalities Commissioners, October 30th, 1880.

[3] Even the latter may be implied in Most Rev. Dr. Conroy's account. *See above.*

in Ireland (1879–80), p. 75, in a note on "Dun Aengus," says:—"I carefully examined the fort, and although many stones may be put into the walls to prevent further ruin, little more can be done towards its preservation." The Superintendent suggests stopping boys from rabbit-hunting, insertion of stones in gaps, and building up dry stone buttresses where the walls overhang. It is evident that the building of the level tops and of ranges of terraces was never contemplated by him. No money was expended at that time [see p. 51].

The sum of £591 2s. 1d. was laid out in works on the Aranmore National Monuments (under 32 & 33 Vict. c. 42 in 1884–5 (Appendix to the 53rd Report, p. 55). No detailed account appears, nor is Aran mentioned in the brief section, pp. 29, 30. In the Report, 1885–6, only mention is made on p. 53 of an expenditure of £11 7s. 9d. for work on North Aran; while for these and many subsequent years, complete silence prevails as to the extent and character of the works done on the Ancient Monuments. It is hardly wonderful that distrust and hostile (at times unfair) criticism prevailed among antiquaries and others.

These, so far as I have been able to ascertain, are the records of one of the most remarkable and fascinating of the ancient fortresses of Ireland.[1]

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[1] I must acknowledge my indebtedness to those who helped me on the subject in various ways—namely, my late brother, Ralph Hugh Westropp, the late Dr. W. Stacpoole Westropp, Miss G. C. Stacpoole, Miss Neville, and Rev. E. Hogan, S.J.; and in photography, the late Mrs. Shackleton of Lucan, and Dr. George Fogerty, R.N. Also, as already noted, to Messrs. George Bell & Sons for permission to reproduce two photographs.

Fig. 1.—Dun Aengusa from the East. (Photograph by T. J. Westropp.)

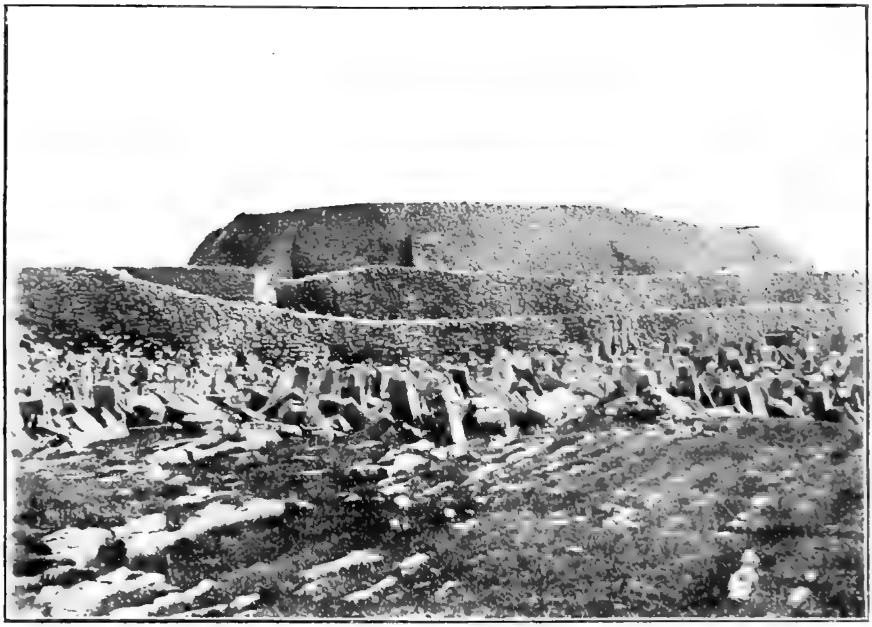

Fig. 2.—Dun Aengusa from the North. (Photograph by Dr. George Fogerty, R.N.)

Fig. 1.—Dun Aengusa from the West before the restoration. (Dunraven Collection.)

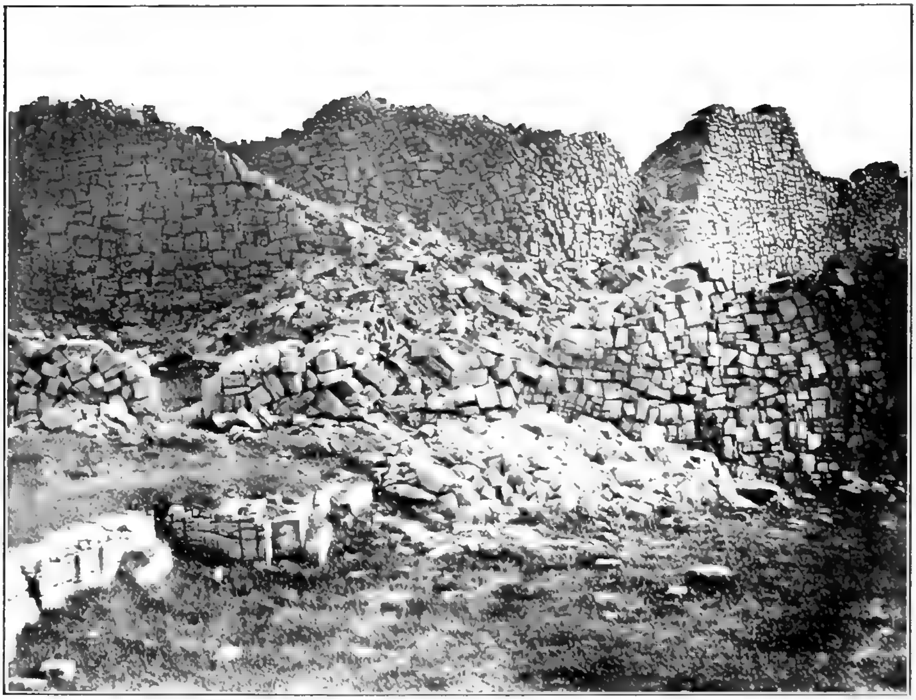

Fig. 2.—Dun Aengusa. The inner Fort before the restoration. (Dunraven Collection.

Fig. 1.—Dun Aengusa. The Abattis.

Fig. 2.—Dun Aengusa. The Doorway. (Photographs by T. J. Westropp.)

II.

CATALOGUE OF THE MAYORS, PROVOSTS, AND BAILIFFS OF DUBLIN CITY, A.D. 1229 TO 1447.

BY HENRY F. BERRY, LITT.D., I.S.O.

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THE dates of office of the mayors and bailiffs of Dublin in ancient times are of considerable importance, as old deeds and documents were undated, and these constantly acted as witnesses in their official capacity. In the Preface to his "Chartularies of St. Mary's Abbey, Dublin" (vol. i., p. xxxiii), published in 1884, Sir John Gilbert makes the following statement:—"Many of the Dublin grants are attested by the mayors and bailiffs of that city. Materials, however, are not at present accessible for fixing precise years of some of these civic officials at the early period to which the instruments belong."

The publication of a Calendar of the Christ Church Deeds in the 20th, 23rd, and 24th Reports of the Deputy Keeper of the Records, Ireland (1888–1892), made a considerable addition to the materials necessary for the construction of a chronological catalogue of the mayors, provosts, and bailiffs of Dublin; and without it this work could not have been undertaken. As a matter of fact, a list of mayors, bailiffs, &c., extending from the year 1308 to 1765, is printed as an appendix to Walter Harris's "History and Antiquities of the City of Dublin" (1766), which the author describes as a "Catalogue of the names of the Chief Magistrates of the city of Dublin under their different appellations of Provosts, Bailiffs, Mayors, Lord Mayors, and Sheriffs from the second year of King Edward the Second to this time, taken from the Table in the great room of the Tholsel." This catalogue—at least down to the period included in the present list—has been found unreliable as to sequence of mayors, &c., erroneous in dates, and many of the names of officials enumerated are wrong or corrupt.

On considering that much more information might be obtained from original Deeds not hitherto consulted; that Sir John Gilbert's published Calendars and Registers gave much assistance; and that each year further sources of information were being supplied, the time appeared to have arrived at which an attempt might be made to compile a list of the mayors, bailiffs,

&c., of Dublin from 1229, the date at which King Henry the Third granted to the citizens the privilege of choosing their own chief magistrate, &c., down to the year 1447, when the Assembly Rolls, which are printed in Sir John Gilbert's "Calendar of Ancient Records of Dublin," commence.

The original documents consulted with this end in view include—numerous ancient deeds connected with the city of Dublin, dating from A.D. 1246, Box No. 1207, MSS. Room, Library, T.C.D.; ancient deeds of the parish of St. Werburgh, dating from about A.D. 1243, to which access was kindly permitted by the Rev. W. J. M'Creery, B.D., rector; deeds of St. Catherine's Parish, from 1295; deeds of the Religious Gild of St. Anne in St. Audoen's Church, from 1285;[1] ancient deeds of the church of St. John the Evangelist, from A.D. 1249, in the Library, T.C.D. (MSS. room, No. 1477; deeds of the church of St. Nicholas within, from A.D. 1282, now in the Public Record Office; Register of the Abbey of St. Thomas the Martyr, Dublin, which contains copies of ancient deeds from about 1285 (Haliday Collection, Royal Irish Academy): Pipe Rolls series, from 13th Henry III to 15th Henry VI.[2] There are also three rolls in Trinity College Library, which contain lists of mayors and bailiffs of Dublin from the commencement of the fifteenth century—one from 1406–7, classed E. 3. 18; a second from the same date, classed E. 3. 28; and the third from 1418–19, classed E. 2. 19. Another list, dating from 1406, is to be found in the British Museum (Additional MSS. 4791, f. 141), which I have collated with the lists in Trinity College.

In addition to these original documents, have been used the Calendar of Christ Church Deeds; Calendar of Patent and Close Rolls, Ireland; Sweetman's Calendar of Documents relating to Ireland; Calendar of Justiciary Rolls, Ireland (Pub. Rec. Off. series); Register of the Priory of All Hallows, Dublin (Irish Arch. Soc.); Obits of Christ Church, Dublin, (Irish Arch. Soc.); Calendar of the Chartulary called "Dignitas Decani," of St. Patrick's Cathedral (ed. Dean Bernard), Proc. R.I.A., vol. XXV., sec. C, p. 481; and the following works edited by Sir John Gilbert:—Historical and Municipal documents; Calendar of Ancient Records of Dublin, vol. I; Chartularies of St. Mary's Abbey, vols. I and II; Register of the Abbey of St. Thomas the Martyr, Dublin.

A Charter of King Henry the Third in 1229 authorized the citizens of Dublin to elect annually from among themselves a loyal, discreet, and proper

[1] Calendar, by H. F. Berry, Proc. R.I.A., vol. XXV., sec. C, p. 21.

[2] A Catalogue of these, to 10th Edward II, has since been made, and has appeared in the 35–39 Reports, D.K.R.

mayor for the government of the city of Dublin, who should bear fealty to him, and be presented to his Justiciar if the King were not in Ireland. He was to hold office for one year, at the end of which the citizens might retain him or elect another. Elections took place yearly on Michaelmas Day. To the mayor and his colleagues were addressed all writs and mandates as to matters arising within the city limits, or that concerned the revenues of the Crown in the same. The term "provosts" was applied to the mayor's coadjutors during the period 1229 to 1292, from which date they were called "bailiffs."

The early mayors of Dublin were occasionally called on to perform military duties, and in 1316, it is recorded that discovery having been made that Richard, Earl of Ulster, was instrumental in bringing Bruce and his Scots into Ireland, Robert de Nottingham, then mayor, with a number of the commons, marched to St. Mary's Abbey, where the Earl was, and they arrested and imprisoned him in the castle of Dublin, where he was kept in close confinement until 1317. In 1402 John Drake, mayor, with a body of citizens, marched out of Dublin against the O'Birnes and other Irish rebels, of whom they are reported to have slain a large number. In 1419, the then mayor, Thomas Cusake, marched with the lord lieutenant to the county of Wicklow, when Castle Kevin was razed.

Sir John Gilbert specially instances Geoffrey de Morton, who served as mayor in 1303–4, as exemplifying the energy, activity, and independent movement of traders among the Anglo-Norman settlers here in the early part of the fourteenth century. He was ship-owner, purveyor to Edward I and II, and a collector of murage; he also traded to England, Scotland, Ireland, and France. In consideration of their important services rendered to the Crown, King Henry the Fourth, in 1407, granted to the mayor of Dublin and his successors that they might have a gilded sword borne before them as the mayors of London had. Some particulars gleaned from the ancient deeds already mentioned, with regard to certain of the mayors and bailiffs named in the list, will be found in Notes at the end.

It is remarkable that so many of the mayors were re-elected, some of them frequently. To Thomas Cusake belongs the honour of heading the list, as he held the mayoralty on nineteen occasions. His term extended from 1390 to 1430, so that he must have reached an advanced age during his later tenures of the post. John le Seriaunt comes next with ten years of office (between 1341–1356), and he was elected six consecutive years. John le Warre follows with eight years, while another John le Seriaunt (who served between 1294 and 1312), and Robert de Nottingham, were mayors seven times. John le Decer held office six times, and some of the others are found acting five, four, and three times during the couple of centuries through which the catalogue extends.

As to the native places of some of the early mayors and provosts—those of the thirteenth century—the following English cities and towns, &c., were represented:—Beverley, Bristol, Chester, Chichester, Cornwall, Coventry, Durham, Exeter, Gloucester, Hereford, Leicester, Nottingham, and Winchester. One was from Poitou, and three are named as of Irish places—namely, Bray, Castleknock, and Callan.

During the first fifty years comprised in the present catalogue, only seventeen dates have been precisely ascertained, while the remaining dates, taken chiefly from the Christ Church Deeds, are approximate. The true sequence of mayors and provosts is believed, however, to have been obtained, as that of the provosts is identical with the order in which their names are found in Sir John Gilbert's lists (1225–1250) in "Hist. and Mun. Documents." The years during which they held office are, no doubt, substantially correct. From about the year 1280 onwards, nearly all have been strictly proved, as for a considerable period it was usual not only to supply in deeds names of mayors and bailiffs, but to add a saint's day or eve, and the regnal year.

With regard to the manuscript lists in Trinity College, some explanation is necessary. They are not contemporary, but each is a copy made at a much later date, with more or less correctness, from a common original. From the term of office of Thomas Cusake, Richard Boone, and John White (1412-13 in the present catalogue), the lists in E. 3. 18, and E. 3. 28, and in the MS. in the British Museum, *as far as the names and their sequence go*, are practically identical; they also agree with the MS. E. 2. 19, from the period of its commencement (1418–19). A difference, however, occurs in dates, sometimes to the extent of two years; at other periods, of one year. As the dates of some of the officials can be proved with certainty from other sources, it has been found necessary to work from these fixed data, so as to arrive at correctness with regard to officials between 1406-1412, when they appear redundant. In the list 1406–1414 in E. 3. 28, the names of Thomas Cusake, Richard Boone, and Thomas Shortall are given as acting for six successive periods, and in E. 3. 18 for only four, which appears correct. Again, Robert Gallane, John Walsh and William Heyfforde appear three times in each list; but as there are only six terms of office to be accounted for between 1406 and 1412, it seems evident that these names have been repeated once too often. This is borne out by Harris's catalogue, in which Cusake, &c., are enumerated four times, and Gallane, &c., twice.

Since the compilation of the present list, it has been found possible to date numerous undated documents in Sir John Gilbert's works, as well as those in other calendars and publications.

CATALOGUE.

	MAYORS.	PROVOSTS.
1229–30	Richard Muton,[1]	Guy the Cornishman, William Tayleburgh.
circ. 1230–1	Henry de Exeter,	Ralph le Hore, Adam de Gloucester, [Dispensar].
„ 1231–2	Thomas de la Corner.	William de Flamstede, Ralph le Hore.
„ 1232–3[2]	Robert Pollard,	Same, Richard de Hereford.
„ 1233–4	Gilbert de Lyvet (or del Ivet).	Robert Pollard, Ralph le Porter.[3]
„ 1234–5	Roger Owain,	Henry de Cicestre, William de Flamstede.
„ 1235–6	Gilbert de Lyvet,	Robert de Bristol, William de Lenne.
„ 1236–7	Same,	Ralph de Stanton (or Stanes), Thomas le Poitevin.
„ 1237–8	Elias Burell,	Roger Hoky, Adam de Gloucester.
1238–9	Robert Pollard,	Adam le Despenser, William Colet.
circ. 1239–40	Same,	Philip fitz Stephen, Adam Rudipack.
„ 1240–1	Henry de Exeter,	Ralph le Hore, Richard Pel.
„ 1241–2	William Flamstede,	William de Lenne, William Sweteman (or de Wetenia).
„ 1242–3	John le Warre,	Philip le Bel,[4] John Pollard.
„ 1243–4	Same,	Richard Pel, Philip le Bel.
1246–7	Same,	Philip le Bel, Roger Okey.
circ. 1247–8	Same,	Elias Burel, Philip fitz Stephen.
„ 1248–9	Philip de Dureham,	Philip fitz Stephen, Elias Burel.
„ 1249–50	Roger Oeyn,	Elias Burel, Philip fitz Stephen.
„ 1250	Elias Burel,	Adam de Gloucester, Elias Ruffus [the Red].
„ 1252	Same,	William Sweteman, Alexander de Hereford.

[1] Also called Multon and Motoun.

[2] In Gilbert's "Hist. and Mun. Documents," among the Provosts (1225–1250), at about this period (1233) appear William de Wetenia, William Russell; and Roger Owain, William le Bas; those names are not found together in this capacity in any other document.

[3] Called also de Stanes.

[4] Called Philip de Ultonia in Register of St. Mary's; he is identical with Philip fitz Stephen.

1255-6	John le Warre,	. Adam de Gloucester, Elias the Red. Thomas de Winchester, Peter Abraham. appear also in this year.
circ. 1256	Same,	. Sir Elias Burel, Richard Pel.
1256-7	Richard Olof,	. Thomas de Winchester, Roger de Asshebourne.
,, 1257	Sir John la Ware,	. Elias the Red, Humphry the Tailor.
,, 1257-8	Same,	. Simon Unred, Same.
,, 1258	Peter Abraham,	. Same, Thomas Wrench. (Vincent Taverner appears as provost in room of Thomas Wrench.)
1259-60	Elias Burel,	. Gilbert Wale, Raymond the Poitevin.
1260-1	Thomas de Winchester,	Reymund the Poitevin, Simon Unred.
1261-2	Roger de Asshebourne.	William de Chester, Peter Abraham.
1262-3	Same.	Same, Walter Unred.
circ. 1263-4	Thomas de Winchester.	Sir Walter Unred, William de Chester.
1264-5	Vincent Taverner,	. Same, Hugh (or Huchun) the Tailor.
circ. 1265-6	Thomas de Winchester,.	William de Bristol, Thomas Wrench.
1266-7	Same,	. Reymund the Poitevin, Laurence the Tailor.
1267-8	Vincent Taverner,	. Simon Unred, Reymund the Poitevin.
,, 1268-9	Roger Asshebourne,	. Walter Unred, Vincent Taverner.
1269-70	Vincent Taverner,	. Same, Geoffrey de Lyvet.
,, 1270-1	Thomas de Winchester,.	William de Bristol, Humphrey le Gaunter.
1271-2	William de Bristol,	. John Garget, Robert de Asshebourne.
1272-3	John Garget,	. Robert de Asshebourne, Laurence Unred.
1273-4	Same,	. Master Nicholas de Beverley (Medicus), Henry White. (Walter Unred appears as provost in a deed of St. Werburgh's.)
1274-5	Same,	. Master Nicholas, Thomas de Lexinton.
1275-6	(The city in the King's hands; in the Pipe Roll, appear as accounting, Andrew Spersholt, Clement de Sunors, Thomas Burel, Simon de Stokes, Laurence Unred, and Laurence the Tailor.)	
circ. 1276-7	Walter Unred,	. Robert le Decer, Laurence Unred.

1277–8	David de Callan.	. Laurence the Tailor,[1] Robert Turbot.
1278–9	David de Callan,	. Hugh de Kersey, Robert le Decer.[2]
1279–80	Henry le Mareschall,	. Laurence Unred, Hugh de Kersey.
1280–81	David de Callan,	. Adam Unred, William de Beverley.
1281–2	Same,	. Same, Same.
1282–3	Same,	. Laurence the Tailor, John le Graunt.
1283–4	Walter Unred,	. Thomas de Coventry, William de Nottingham.
1284–5[3]	Same,	. Thomas de Coventry, Robert de Wyleby.
1285–6	Same,	. William de Nottingham, Robert le Decer. William de Beverley, William de Nottingham, appear later.
1286–7	Thomas de Coventry,	. Roger de Asshebourne, Roger de Castleknock.
1287–8	Same,	. John Gyffard, William le Graunt.
1288–9	William de Bristol,	. Roger de Castleknock, John le Seriaunt.
1289–90	Same, Robert de Wyleby appears June, 1290.	. Adam de Hereford, Robert de Bray.
1290–1	William de Bristol,	. Robert[4] le Decer, John le Seriaunt.
1291–2	Same,	. Same, William de Nottingham.

		BAILIFFS.
1292–3	Robert de Bray,	. Richard Laghles, Bartholomew Creks.
1293–4	Same.	. Roger de Castleknock, William le Graunt.
1294–5	John le Seriaunt,	. John Gyffard, Hugh de Carletone [Silvester.]
circ. 1295	Same,	. [ ] Woder, Richard de St. Olave.
1295–6	Robert de Wyleby,	. Nicholas the Clerk, Thomas Colys.
1296–7	Thomas Colys,	. Same, Philip Carryk.
1298–9	Same,	. Same, Richard de St. Olave.
circ. 1299–1300	John le Seriaunt,	. Same, John Heyward.
1300–1	Same,	. Same, Richard de St. Olave.

[1] In a deed in All Hallows' Reg. Hugh le Seriant appears in place of Laurence the Tailor.

[2] In September, 1279, appear Robert le Decer, Thomas de Coventry.

[3] In a C. C. Deed, John Serjant and Nicholas the Clerk appear as bailiffs *circa* 1285.

[4] Called "John" in *Reg. All Hallows.*

1301–2		Robert de Nottingham, Richard Laghles. E. 1301 to Nov., 1301, when the liberty of the city was taken into the King's hands; liberty replevied, St. John Bapt., 1302. "John le Seriaunt and Thomas de Coventry, bailiffs, when the liberty was in the King's hands." Hist. and Mun. Doc., p. 521.
1302–3	John le Decer, .	Richard Laghles, Nicholas the Clerk.
1303–4	Geoffrey de Morton, .	John de Cadwelly, Edward Colet.
1304–5	John le Seriaunt, .	John de Leicester, Richard de St. Olave.
circ. 1305–6	John le Decer, .	Robert le Woder, John Seriaunt.
1306–7	John le Seriaunt, .	William Douce (or le Douz), Richard de St. Olave.
1307–8	John le Decer, .	Richard de St. Olave, John Stakepol.
1308–9	Same. .	William le Devenys, Robert Bagot, Knt. John Bowet, John de Castleknock also found as bailiffs this year.
M 1309	Liberty of the city taken into the King's hands; restored in Dec., 1309.	
1309–10	Robert de Nottingham, (John le Decer acted as deputy mayor, when Nottingham quitted the city).	Richard de St. Olave, Hugh de Carleton [Silvester].
1310–11	John Seriaunt, .	Richard de St. Olave, John de Leicester.
1311–12	Richard Lawles, .	William le Serieant, Hugh Silvester.
1312–13	Same, .	Nicholas Golding, Thomas Hunt.
1313–14	Same, .	Robert de Moenes, Richard de St. Olave.
1314–15	Robert de Nottingham,	John de Castleknock, Adam Phelipot (Fulpot), the clerk.
1315–16	Richard Lawles, .	John de Castleknock, Robert de Moenes. (In Hil. 1316, John Bowet is found in place of John de Castleknock.)
1316–17	Robert de Nottingham,	Robert Woder, Robert de Moenes.
1317–18	Same, .	Same. Robert Burnell.
1318–19	Same, .	Robert Woder, Robert Burnell. (In E. 1319, Robert de Moenes is found in place of Robert Burnell.)

1319–20	Robert de Moenes, .	Luke Brun, William le Mareschal.
1320–1	Robert de Nottingham,	Robert Woder, Stephen de Mora.
1321–2	Same, .	Same, Robert de Eyton.
1322–3	William Douce, .	William le Mareschal, Stephen de Mora.
1323–4	William Douce, .	Stephen de Mora, John de Moenes.
1324–5	John le Decer, (In a T.C.D. deed Elias de Assheborne appears as mayor). .	William le Mareschal, Robert le Tanner
1325–6	Same, .	Stephen de Mora, Giles de Baldeswell.
1326–7	Robert le Tanner, .	John de Moenes, Robert Wodefoule.
1327–8	William le Mareschal,	Richard de Swerdes (Swords), John de Creek.
1328–9	Robert Tanner, .	John de Moenes, Philip Cradok.
1329–30	Philip Cradok, .	Richard de Swords, Robert [de Walton] the clerk.
1330–1	William Douce, .	John Creks, John le Seriaunt.
1331–2	John de Moenes, .	William le Waleys (called Twyford in a deed of St. Anne's), John de Callan.
1332–3	William Beydyn,[1] .	John de Callan, William le Waleys.
1333–4	Geoffrey Cromp, .	John Creks, Giles de Baldeswell (sometimes called Gilbert, which appears to be a mistake).
1334–5	William Beydyn, .	William de Wyverton, (or Wytherton), Roger Grauntcourt.
1335–6	John de Moenes, .	John Callan, Kenewreck Scherman.
1336–7	Philip Cradok, .	Roger Grauncourt, Robert Hony.
1337–8	John de Moenes, .	Giles de Baldeswell, John Callan. (On 30 Mar. 1338, and subsequently, John Creks appears in place of John Callan.)
1338–9	Robert le Tanner, .	John Creek, Robert de Houghton.
1339–40	Kenewrek Scherman, .	John Callan, Adam de Louestoc.
1340–1	Same, .	William Walsh, John Crek.
1341–2	John le Seriaunt, .	John Crek, Walter de Castleknock.
1342–3	Same, .	Same, Same.
1343–4	Same, .	William Walsh, John Taylor.

[1] In some documents called Geydyn.

1344–5	John le Seriaunt,	. William Walsh, John Callan.
1345–6	Same,	. Same, Thomas Dod.
1346–7	Same,	. Walter Luske, Roger Grauntcourt.
1347–8	Geoffrey Crompe,	. William Walshe, Walter de Lusk.
1348–9	Kenewrek Sherman,	. John Callan, John Dert (or de Dertt).
1349–50	Geoffrey Crompe,	. Roger Grauntcourt,[1] Walter de Lusk.
.. ..	John Seriaunt,	. John Dert, John Bek, appear in deeds of St. Werburgh as in office this year.
1350–1	John Bathe,	. Robert Burnell, Richard Heygrewe.
1351–2	Robert de Moenes,	. John Dert, Peter Morvile.
1352–3	Adam Louestoc,	. John Callan, Peter Woder.
1353–4	John Seriaunt,	. David Tyrrell. Maurice Duncrewe (or Duncroyve). (On 10 May, 1354, Thomas Wodelok appears in place of David Tyrrell.)
1354–5	John Seriaunt,	. Maurice Duncrewe, Thomas Wodelok.
1355–6	John Seriaunt,	. Peter Barfot, William Wellis (or de Welles).
1356–7	Robert Burnell,	. Thomas Wodelok, Thomas Brown.
1357–8	Peter Barfot,	. John Wydon, Robert Walshe.
1358–9	John Taylor,	. Thomas Wodelok, Roger del Wych (or Wyth).
1359–60	Peter Barfot,	. Peter Morvill, John Passavaunt.
1360–1	Same,	. Roger del Wych, Thomas Brown.
1361–2	Richard Heygrewe,	. David Tyrrell, Thomas Wodelok. (On 2nd June, 1362, and subsequently, William Herdman appears in place of Thomas Wodelok.)
1362–3	John Beke,	. John Passavaunt, Thomas Brown.
1363–4	Same.	. Same, Same.
1364–5	David Tyrrell,	. John Grauncet (or de Grauntset), William Herdman.
1365–6	Richard Heygrewe.	. Walter Crompe, Maurice Young.
1366–7	David Tyrrell,	. John de Grauntset, Richard Chamberlain.
1367–8	Peter Woder,	. Thomas Brown, Same.
1368–9	John Wydon,	. Roger Bekeford, John Beke.
1369–70	John Passavaunt,	. Roger Bekeford, John Foyll.

[1] Called Grauncecter in Reg. All Hallows.

1370–1	John Passavaunt,	. William Herdman, Edmund Berle.
1371–2	John Wydon,	. Richard Chamberlain, William Tyrrell.
1372–3	Same,	. John Foyll, Roger Faliagh.
1373–4	Same,	. John Elys, Robert Piers.
1374–5	Nicholas Seriaunt,	. Robert Piers, Robert Stackpolle.
1375–6	Same,	. Roger Faliagh, Robert Piers.
1376–7	Same,	. Roger Kilmore, John Hull.
1377–8	Same,	. Robert Piers, Roger Faliagh.
1378–9	Robert Stakebold,	. Walter Passavaunt, William Bank.
1379–80	John Wydon,	. Roger Kilmore, William Blakeney.
*1380–1	John Hull,	. William Tyrrell, Roger Faliagh.
1381–2	Same,	. Walter Passavaunt, sen., John Holme, jun.
*1382–3	Edmond Berle,	. Robert Burnel, Richard Bertram.
*1383–4	Robert Burnel,	. John Bermingham, John Drake.
1384–5	Roger Bekeford,	. Thomas Mareward, William Seriaunt.
" "	Same,	. Edmond (Edward) Berle, Peter Woder, appear 28 July, 1385, in Gilbert's "Cal. Ancient Records."
*1385–6	Edmond Berle,	. Thomas Cusake, Jeffry Callan.
*1386–7	Robert Stackbold,	. Nicholas Finglas, Richard Bertram.
1387–8	John Bermingham,	. Richard Cruys, Robert Piers.
*1388–9	John Passavaunt,	. Walfran Bran, Simon Long.
*1389–90	Thomas Mareward,	. Thomas Cusake, William Wade.
1390–1	Thomas Cusake,	. Geoffrey Gallane, Richard Bertram.
1391–2	Richard Chamberlain,	Same, Thomas Donewyth.
*1392–3	Thomas Mareward,	. Thomas Donewith, Ralph Ebb.
*1393–4	Thomas Cusake,	. Ralph Ebb, Thomas Duncreef.
1394–5	Same,	. William Wade, Hugh White.
1395–6	Same,	. Richard Giffard, Geoffrey Parker.
1396–7	Geoffrey Gallane,	. Thomas Duncref, John Philpot.
1397–8	Thomas Cusake,	. Geoffrey Parker, Richard Clerc.
1398–9	Nicholas Fynglas,	. Richard Bacon, Richard Bone (or Boone).
1399–1400	Ralph Ebbe,	. Richard Bonde, Richard Taillour.
1400–1	Thomas Cusake,	. Robert Piers, Same. (In Apl., 1401, Walter Tyrrell appears in place of Robert Piers).

* Supplied from Harris's list.

1401–2	John Drake	John Philpot, Walter Tyrrell.
*1402–3	Same,	Walter Tyrrell, Simon Long.
1403–4	Thomas Cusake.	John Philpot, Richard Clerk.
1404–5	John Drake,	John Philpot, Walter Tyrrell.
1405–6	Same,	Walter Tyrrell, Robert Gallane.
1406–7	Thomas Cusake.	Thomas Shortall, Richard Boone.
1407–8	Same,	Same, Same.
	William Wade,	Robert Gallane, Nicholas Woder, appear also this year.
1408–9	Thomas Cusake.	Thomas Shortall, Richard Boone.
1409–10	Same,	Same, Same.
1410–11	Robert Gallane,	John Walshe, William Heyfforde.
1411–12	Same,	Same, Same.
	John Drake,	Thomas Walleys, Luke Dowdall, appear also this year.
1412–13	Thomas Cusake,	Richard Boone, John White.
1413–14	Luke Dowdall,	Stephen Taylor, Nicholas Fitz Eustace.
1414–15	Thomas Cusake.	John White, Thomas Shortall.
1415–16	Same,	Same, Same.
1416–17	Walter Tyrrell,	John Barrett, Same.
1417–18	Thomas Cusake.	Nicholas FitzEustace, Ralph Pembroke.
1418–19	Same,	John Barrett, Robert de Ireland.
1419–20	Walter Tyrrell,	John Kylbery, Thomas Shortall.
1420–1	John Burnell,	Same, Same.
1421–2	Same,	Same, Same.
1422–3	Thomas Cusake,	Stephen Taylor, Thomas Shortall.
1423–4	John White,	Ralph Pembroke, Robert de Ireland.
1424–5	Thomas Cusake.	Thomas Shortall, John Kylbery.
1425–6	Sir Walter Tyrrell,	Same, Same.
1426–7	John Walshe.	John Barrett, Robert de Ireland.
1427–8	Thomas Shortall.	Thomas Ashe, Thomas Bennet.
1428–9	Same,	Thomas Bennet, John Fitz Robert.
1429–30	Thomas Cusake,	Same, Robert Chambers.
1430–1	John White,	John Brayn, John Hadsor.
1431–2	Same,	John Hadsor, Nicholas Woder.
1432–3	John Hadsor,	Nicholas Woder, Robert Ireland.
1433–4	Nicholas Woder,	Philip Brayn, Thomas Newberry.
1434–5	Ralph Pembroke,	James Dowdall, Richard Willet.

* Supplied from Harris's list.

1435–6	John Kylbery,	. Richard Willet, Robert Clifford.
1436–7	Robert Chambre,	. John Brayn, Nicholas Clerke.
1437–8	Thomas Newberry,	. Nicholas Clerke, John Bennet.[1]
1438–9	Nicholas Woder,	. Robert Ireland, John Brayne.
1439–40	John Fitz Robert,	. Richard Fitz Eustace, David Rowe.
1440–1	Nicholas Woder.	. . John Brayne, John de Veer (or Wer).
1441–2	Ralph Pembroke,	. Thomas Walshe, Robert Clifford.
1442–3	Nicholas Woder,	. John Walsh, William Curraght.
1443–4	Nicholas Woder, jun.,	. Same, Same.
1444–5	Same,	. Same, Same.
1445–6	Same,	. Philip Bedlowe, John Tankerd.
1446–7	Same,	. Robert Wode, Thomas Savage.
1447–8	Assembly Roll begins.	

NOTES.

Page.

51 **Gilbert de Lyvet**, *circ.* 1234, granted to Holy Trinity Church the land on which his stone hall, without the King's gate, was built. He had also land in the Lormery, Castle Street. He died before 1244, and he and his wife Sibella were to be buried in Holy Trinity, if they died in Ireland.

„ **Ralph le Porter** had a stone house in St. Audoen's Lane, between the gate and the river.

„ **Roger Owain**, *circ.* 1260, granted land in St. Audoen's parish, and in the street of Oxmantown bridge.

„ **Elias Burell** had land in Castle Street, 1263. His daughter, Juliana, married William de Bristoll, and in 1273 they made a grant of land in St. Werburgh's parish, near the Church, to William Boniur.

„ **Richard Pel** had a tenement on the Key, *circ.* 1300.

„ **William Sweteman** had a grant of the tower beyond St. Audoen's Gate.

52 **Richard Olof**, *circ.* 1249, made a grant of land in Gilleholmock's Street. He also owned a "conigere by Baggotrath."

„ **Roger de Asshebourne**, *circ.* 1307, had a grant of a shop on the bridge outside the New gate, between the shop of Henry le Mareschall and that of John le Decer, extending from said bridge to the foss of Dublin.

„ **William de Chester** owned land with buildings, in the Great Street, within the walls of Dublin, in the parish of St. Audoen, *circ.* 1266–7.

[1] In MS., T.C.D., Robert Clifford appears here.

Page.

52 **Geoffrey de Lyvet**, *circ.* 1243, granted to Elias Burell land in Castle Street, which had belonged to Guy of Cornwall. The deed is endorsed, "Folley's Grove in the Castle Street," and again in 1454, "Folleys grove."

„ **John Garget** held the tower on Gormund's Gate.

„ **Andrew Spersholt** was Keeper of the Mint and Exchange of Dublin, in the reign of Edward I.

53 **David de Callan.** The name of the family known as "de Callan" was Sampson. In 1336–7 appears John fitz William Sampson de Callan. In 1282–3, there was a suit between the Abbot of St. Mary's and David de Callan, mayor, as to a felon, who, by the Abbot's authority, was incarcerated in the Abbey. The Abbot averred that by royal charters, as well as under an instrument under the municipal seal of Dublin, the Abbey was exempt from civic jurisdiction. In 1288, Archbishop John Saundford let to David de Callan land in Colloyn (Cullenswood). Cal. Lib. Nig. Alani (Stokes).

54 **John le Decer** held a tenement on the Key in the parish of St. Michael. in 1327. In 1338, is mentioned a messuage, with shops, wherein John le Decer used to live, within the New gate, parish of St. Audoen.

„ **John Stakepol**, in 1325, held a cellar in Taverns Street, from Thomas le Mareschall; and in 1357, he had a quarry and orchard, &c., in the parishes of St. Peter de hull and St. Michael del Poll. "Derndall."

Robert de Nottingham held, in 1327, a tenement on the Key, parish of St. Michael. He married Loretta, daughter of Robert de Bray.

„ **William Douce** held ground in St. Francis Street. The Inventory and Testament of his daughter, Joan Douce, will be found in "Religious Gild of St. Anne, Dublin." (Proc. R.I.A., Vol. xxv., Sec. C, p. 20.)

55 **Stephen de Mora** held a tenement in Thomas Street.

„ **Adam de Louestoc.** In 1328 Wm. de St. Olave granted him a tenement and shop in High Street.

56 **Richard Heygrewe** had leases and grants of tenements in 1356–7, in Gilmoholmok's Lane, parish of St. Michael; in Winetavern Street, near the great stone house formerly Robert de Wyleby's; also of water mills in the Poll, and of a tenement called the Ramme, in High Street.

Page.

56 **John de Grauncet.** In 1334, he held a messuage in Taverns Street, at the gate anciently called the King's Gate, formerly Vincent Taverner's.

„ **John Foyll.** His will, made in 1379, is No. 251 Christ Church Deeds.

57 **John Drake** died 1433.

58 **Thomas Shortall** died 1445.

„ **Robert de Ireland,** and Anna Montgomery, his wife, granted a messuage in Skinner Row, *alias* Bothe Street, in 1435. He also held Punchestown, Co. Kildare, which he received from Peter Wotton; and he had also land in Oxmantown, Dublin.

„ **Ralph Pembroke** held land in Skinner Row in 1436.

„ **Robert Chambers.** His will, made in 1441, is No. 291 of Christ Church Deeds.

III.

HIBERNO-LATIN MANUSCRIPTS IN THE LIBRARIES OF SWITZERLAND.

By MARIO ESPOSITO.

Part I.

Basel, Einsiedeln, Schaffhausen, St. Gallen, and Zürich (Kantonsbibliothek).

Read January 24. Ordered for Publication January 26. Published March 14, 1910.

In the course of a visit to Switzerland in the summer and autumn of 1909, I had occasion to search the libraries of that country for MSS. containing mediaeval Hiberno-Latin literature—a subject on which I have been at work for the past five years.[1] By "Hiberno-Latin literature" I designate those works composed by Irishmen in the Latin language. In the present paper only those MSS. which contain writings by authors whose names are known will be dealt with, the anonymous works being reserved for future study. For the sake of completeness, brief mention will also be made of those MSS. which have been already studied by other workers.

The history of the civilizing work carried out in Switzerland by wandering Irishmen ("Scotti"[2]) from the seventh to the tenth centuries, has hitherto not been much studied.[3] There is no doubt that they achieved much. The founding of the celebrated monastery on the spot now known as St. Gallen is alone sufficient to entitle them to the everlasting gratitude of the learned world.[4]

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[1] Cf. Dublin Review, October, 1905, pp. 327–337; Proc. R.I. Acad., 1907, xxvi, section C, pp. 378–446; Hermathena, 1907, xiv, pp. 519–529; Irish Theological Quarterly, April, 1909, pp. 181–185; Hermathena, 1909, xv, pp. 353–364; Zeitschrift für Celtische Philologie, vii, Heft 2, 1910, pp. 475–483.

[2] Till the eleventh or twelfth century the terms Scottus, Scottia, Scotticus, etc., applied almost exclusively to Ireland. Cf. Holder, Alt-Celtischer Sprachschatz, Bd. ii, 1902, cols. 1406–1418.

[3] The most important work on this subject is that of F. Keller, Bilder und Schriftzüge in den irischen Manuscripten der Schweitzerischen Bibliotheken (Mittheilungen der Antiquarischen Gesellschaft in Zurich, Bd. vii, 1851, pp. 59–97).

[4] Cf. Zimmer, Preussische Jahrbucher, 59, 1887, pp. 26–59; Schultze, Centralblatt für Bibliothekswesen, vi, 1889, pp. 185, 233, and 281; and Gougaud, Revue d'Histoire Ecclésiastique, Louvain, ix, 1908, pp. 21 and 255.

Basel, Universitätsbibliothek.

The University Library at Basel is rich in mediaeval Latin MSS. Unfortunately, with the exception of Haenel's very summary index, published in 1830,[1] no printed account of these MSS. has yet appeared.

1. MS. F. V. 33.

A folio parchment MS., consisting of forty-four unnumbered folios, measuring 28¼ cms. by 25¼. It is beautifully written in a tenth-century hand, in double columns, with thirty lines to the column. Initial letters and sentences are frequently in red, and there are a few marginal notes and interlinear corrections. The cover is in parchment.

This important MS. contains the group of scriptural commentaries by Sedulius Scottus, printed by Angelo Mai,[2] from a MS. in the Vatican (Palatinus 242, saec. x/xi).[3] The same commentaries are also found in the Einsiedeln MS., No. 132, which will be mentioned further on, and in a MS. at Berlin (Phillipps MS., No. 56).[4]

The following is a complete description of the Basel MS., from which it will be seen that Mai's edition is very defective, many arbitrary alterations and omissions having been made in the original text. In an Appendix I have given a full edition of two of these tracts of Sedulius Scottus, one of which, as far as I am aware, has never yet been printed.

The origin of the MS. is not known. It formerly belonged to Remigius Faesch (ob. 1666), whose books and MSS. passed into the possession of the Basel Library in 1823.[5]

Fol. 1 r°–14 v°: Incipit epistolae Hieronimi ad Damasum papam explanatio. Beatissimo Papae Damaso Hieronimus. Hic Damasus sedis apostolicae magnificus praesul Valentiniani et Theodosii principum temporibus floruit, etc.

Ed. Mai (ap. Migne, Patrol. Lat., 103, cols. 331–348).

The text of the MS. differs greatly from that of Mai's edition, and is very much fuller. In the edition the tract ends with the words confortatus existit, but in the MS. there is another sentence: Unde conexe ait; Et memineris[6] mei beatissime papa. Illud nimirum latenter intimare volens,

[1] Catalogi Librorum Manuscriptorum, etc., 1830, cols. 513–659; the total number of MSS. in the library is variously estimated at from 1500 to 4000 volumes.

[2] Scriptorum Veterum Nova Collectio, tom. ix, 1837, pp. 159 sq.; Spicilegium Romanum, t. ix, 1843, pp. 29 sq. Mai's edition was reprinted by Migne (Patrologia Latina, t. 103, col. 271 sq.). On Sedulius Scottus consult Esposito (Hermathena, xiv, 1907, p. 534; xv, 1909, p. 360).

[3] Cf. De Rossi, Codices Palatini Latini Bibliothecae Vaticanae, t. i, 1886, p. 59.

[4] Cf. Rose, Die Handschriften-Verzeichnisse der K. Bibliothek zu Berlin, Bd. 12, 1893, p. 104.

[5] Haenel, Catalogi, etc., col. 514.

[6] me minelis cod.

quod is vere in Christo valet, qui virtutum nitore vitaeque supernae spe atque contemplatione licet per speculam et enigma beatus. Ob hoc autem spiritum et mentem in Christum valere diximus, non quod quorumlibet sanctorum corpora in Christo non valerent, sed propter melioris naturae excellentiam spiritum et mentem in Christo valere pro toto homine synechdochicos posuimus. Finit.

Fol. 14 v°–19 r°: A commentary on the system of Canons for a harmony of the Gospels addressed by Eusebius to Carpianus.[1] It has not, as far as I am aware, yet been printed. A full edition will be found in the Appendix.

Fol. 19 r°–22 v°: Incipit prologus quattuor evangeliorum. Plures fuisse qui evangelium scripserunt et Lucas evangelista testatur dicens. In hoc prologo de numero atque ordine evangeliorum expositurus prius pseudo-evangelia eorumque temerarios auctores eleganter refutat, ac nescio quasi quodam praeiudicio illo respuere videretur. Beatum Lucam evangelistam huius rei testem esse ostendit. Quoniam quidem multi conati sunt ordinarem narrationem rerum, quae in nobis completae sunt, sicut tradiderunt nobis qui ab initio ipsi viderunt et ministri fuerunt sermonis et perseverantia usque ad praesens tempus monumenta declarant, etc., ... et plenitudo donorum.

Ed. Mai (Migne, 103, cols. 348–352).

The MS. text is again very different from the edition and much fuller.

Fol. 22 v°–29 r°: Incipit in argumentum secundum Matheum. Inter argumentum et argumentationem hoc distat: nam argumentum est sensus totius orationis. Argumentatio vero est argumenti elocutio verbisque competentibus explicatio, etc.

Ed. Mai (Migne, 103, cols. 274–279).

The text is here again very different from the edition and much fuller.

Fol. 29 r°: Finit in argumentum secundum Matheum Sedulii Scotti expositio.

Fol. 29 r°–37 v°: Incipit eiusdem explanatiuncula de breviariorum et capitulorum canonumque differentia et connexione, etc.

[1] The Greek text of Eusebius will be found in Migne (Patrol. Graeca, 22, cols. 1275–1292). The old Latin version, commented upon by Sedulius Scottus, has been printed by Vallarsi (Hieronymi Opera, Veronae, t. x, 1740, cols. 667–670), by Fabricius (Bibliotheca Graeca, ed. Harles, t. vii, 1801, pp. 400–401), and by Migne (Patrol. Lat., 29, cols. 529–531), all of whom have also given the Greek text. The Latin version was attributed by Fabricius (loc. cit., t. iv, 1795, p. 881) to St. Jerome; but the latter's authorship, though probable, cannot be proved (cf. Vallarsi, loc. cit., col. 668). In the text of the Latin version incorporated in the commentary of Sedulius Scottus there are some slight variations from the text as given by Fabricius. These will be noticed in the foot-notes to the Appendix.

Ed. Mai (Migne, 103, cols. 271–272).

As this tract is very short, and as Mai's edition of it is practically worthless, I have given it in full in the Appendix.

Fol. 31 v°–38 r°: Incipit in argumentum secundum Marcum eiusdem Sedulii expositiuncula. Hoc argumentum genus et officium electionem quoque Marci evangelistae prima sui parte declarat, secunda intentionem eiusdem evangelistae in scribendo Christi evangelio subtili argumentatione ostendit, etc.

Ed. Mai (Migne, 103, cols. 279–286).

Here again Mai has made many arbitrary alterations and omissions in the text.

Fol. 38 r°: Finit expositiuncula Scotti Sedulii in argumentum secundum Marcum.

Fol. 38 r°–43 v°: Incipit eiusdem explanatiuncula in argumentum secundum Lucam. In argumentis evangelicis haec praecipue nobis sunt attendenda, quod et sermonis brevitas sensuumque clandestina subtilitas in eisdem scintilla recernitur. Unde nostrum torpens ingenium ex inertiae somnio[1] suscitant. Et ante introitum doctrinae evangelicae nos exercitatiores evigilantioresque reddunt, ne lippidulis fortasse oculis pedibusque sensuum titubantibus prata dominica segniter incedamus, sed illustrata mentis acie florida Christi rura coruscis praecedentibus lucernis percurramus. Quid etenim sunt argumenta evangelica nisi quaedam caelestium thesaurorum praevenientes lampades, simul et aureae claves gazas reserantes dominicas. In huius itaque argumenti exordio, etc., ... simul et inquisitoribus aliquam conferre utilitatem videremur.

Ed. Mai (Migne, 103, cols. 286–290).

As in all the other tracts, the text of the MS. is very different from Mai's edition and much fuller. Folio 43 is slightly defective at the top.

Fol. 44 r°: An index to the contents of the MS., now partly illegible.

Fol. 44 v°: A prayer: Pater noster, etc., now partly illegible.

2. MS. O. IV. 34.

A small quarto parchment MS. consisting of 90 numbered folios measuring 21¼ cms. by 14⅛. It is written in a twelfth-century hand in single columns with 30 lines to the page. Initial letters are sometimes coloured in red and blue. There are a few marginal notes in a fifteenth-century hand.

This MS. contains the commentary by Joannes Scottus Eriugena[2] on the

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[1] sommo cod.

[2] On this writer and his works consult Esposito, Hermathena, xiv., 1907, pp. 525, 529; xv., 1909, p. 361.

Celestial Hierarchy of the Pseudo-Dionysius. It was published by Floss in 1853 (ap. Migne, Patrol. Lat., 122, cols. 125–266), to whom the existence of this MS. was apparently quite unknown. The text of the MS. agrees on the whole well with the edition of Floss.

Fol. 1 r°–90 v°: Incipiunt expositiones Johannis Scoti super Ierachias sancti Dyonisii. Sancti Dyonisii Ariopagitae primus liber, qui inscripbitur de celesti ierachia, XVta capitulorum serie contexitur, quorum primi titulus est, etc., . . . εὐπαθείαι sunt, id est constantiae tres secundum Stoicos, voluntas, gaudium, cautio, et non nisi in animo. In this MS., as indeed in all the others at present known, a large portion of the text—from the beginning of chapter iii to the middle of chapter vii—is wanting (cf. the ed. of Floss, col. 176). The break occurs on fol. 33 v°, without any indication, the text running on continuously. No doubt all our existing MSS. of this work are ultimately derived from the same mutilated archetype.

3. MS. O. iii. 5.

An octavo parchment MS. consisting of 124 unnumbered folios measuring 21½ cms. by 13¼. It is written in a twelfth-century hand in single columns with 35 lines to the page. There are a few illuminations and some marginal notes. The cover is wanting.

Among other things this MS. contains the translation of the Celestial Hierarchy of the Pseudo-Dionysius by Joannes Scottus, published by Floss (Migne, 122, cols. 1029–1070).

Traube has re-edited the poems prefixed to this work (Mon. Germ. Hist., Poetae Latini Aevi Medii, iii, 1896, pp. 518 sq.). Neither Floss nor Traube mentions this MS. In his edition Traube (loc. cit., p. 525) has divided the codices of this translation into three groups, the "Franco-Gallic," the Italic, and the Germanic. The Basel MS. (like the Bern MS., No. 19, to be mentioned later on) belongs clearly to the first or "Franco-Gallic" group, as it preserves the letter of Anastasius, and has the correct form Eriugena for the corrupt Ierugena of the Italic and Germanic groups.

Fol. 1 r°: Dionisius Johanni evangelistae. Saluto te sacram animam, dilectissime, et est michi hoc apud te supra apostolos inseparabilius. Ave vere dilectissime, etc., ... traditum et memoria custodi tuorum.

This is Joannes' translation of the tenth letter of the Pseudo-Dionysius.

Ed. Floss (Migne, 122, cols. 1123–1124).

At the bottom of the page is written in a later hand: Liber sanctae Mariae in valle sancti Petri.

Fol. 1 v°: blank.

Fol. 2 r°–3 r°: Praefatio Anastasii apostolicae sedis bibliothecarii ad excellentissimum et christianissimum regum Karolum. Inter cetera studia, quae tam laudabilis actio, etc., ... Explicit. Data decimo Kal. April. Indictione viii.

Ed. Floss (Migne, 122, cols. 1025–1030).

Fol. 3 r°–18 v°: The translation of the Celestial Hierarchy of the Pseudo-Dionysius by Joannes Scottus, edited by Floss (loc. cit., cols. 1029–1070). There are a number of minor variations from the printed text. Fol. 3 r° contains the first set of dedicatory verses. The following is a collation with the edition of Floss (cols. 1029–1030): l. 2 spondo MS. σπένδω Floss; l. 3 stemata MS., stemmata Floss; l. 5 tempnere MS., temnere Floss; l. 6 ginnasia MS., gymnasia Floss; l. 16 Ieronimo MS., Hieronymo Floss; l. 21 temptabunt MS., tentabunt Floss. Then follows the dedicatory epistle to Charles the Bald: Gloriosissimo Catholicorum regum Karolo Johannes extremus sophiae studentium salutem, etc. Fol. 4 v°: In hoc libro sancti Dionisii Ariopagitae continentur libri iiiior quos Johannes Eriugena transtulit de Graeco in Latinum, iubente ac postulante domino gloriosissimo rege Karolo, Ludowici imperatoris filio. Then follow on fol. 5 r° another set of verses and an index to the fifteen chapters of the work. I give here a collation of these verses with the edition of Floss (cols. 1037–1038): l. 1 sidereo dionisius MS., siderio Dionysius Floss; l. 2, Ariopagites MS., Areopagites Floss; l. 4 quos tauro MS., quo σταυρῷ Floss; l. 5 ut . . . elympsi MS., et . . . eclipsi Floss; l. 7 quo MS., Qui Floss; l. 10 Attidas . . . adest MS.; Ἀτθίδα. . . et est Floss; l. 13 simmachus instar MS., symmachus instans Floss; l. 16 empirii MS., Empyrei Floss; l. 22 ouraniis MS., uraniis Floss; l. 24 mistica MS., mystica Floss.

The translation begins on fol. 5 v° with the words: Dionisii Ariopagitae, episcopi Athenarum ad Timotheum episcopum de celesti ierarchia. It ends on fol. 18 v°: Explicit Ierargia Dionisii Ariopagitae. Amen.

Fol. 19 r°–116 r°: The commentary on the Celestial Hierarchy of the Pseudo-Dionysius by Hugo of St. Victor (c. 1120).

Ed. Migne, (Patrol. Lat., 175, cols. 923–1154).

In this work Hugo employed the translation of Joannes Scottus. It commences on fol. 19 r°: Iudei signa quaerunt, et Greci sapienciam. Fuit enim quaedam sapiencia, quae sapiencia videbatur his qui veram sapienciam non noverant, etc. Fol. 19 v°: De differentia mundanae theologiae atque divinae cum demonstrationibus earum, etc. A later hand has added in the margin Ierarch. Magistri Hugonis de sancto Victore. It ends on fol. 116 r° with the words silentio honorificantes.

Fol. 116 r°–120 r°: Incipit liber Baruch.

Fol. 120 r°–121 r°: Incipiunt capitula Ysaiae prophetae.

Fol. 121 r°–122 v°: Incipiunt capitula Ezechielis prophetae.

Fol. 122 v°–124 r°: Incipiunt capitula Ieremiae prophetae.

4. MS. B. iv. 9.

A folio parchment MS., consisting of 212 numbered folios, beautifully written in double columns, with 38 lines to the column. The initial letters are in red, and there are a few marginal annotations. It contains the Manipulus Florum of Thomas de Hibernia[1]—a work which achieved great popularity during the fourteenth and fifteenth conturies. This MS. was copied by a certain Wilhelmus Zuremont in 1324.

Fol. 1 r°: Incipit Manipulus Florum. Abiit in agrum et collegit spicas post terga metentium Ruth, etc. At the bottom of the page is written in a later hand: Iste liber est Cartusiensium Basileae.[2]

Fol. 212 r°: Laus tibi sit, Christe, quoniam liber explicit iste. Explicit manipulus florum. Hoc opus compilatum est a magistro Thoma de Ybernia, quodam socio de Sarbona. Anno Domino MCCCXXIIII in vigilia Epyphaniae finitus est liber iste. Wilhelmus Zuremont sit semper crimine liber.

Then follows a note in a later hand: Iste liber est vallis sanctae Margarithae in Minori Basilea ordinis Carthus.

5. MS. B. iii. 16.

A folio parchment MS., consisting of 153 unnumbered folios beautifully written in double columns, with 30 lines to the column, in a hand of the thirteenth or fourteenth century. The initial letters are illuminated in blue and red, and there are a few marginal notes. On the inside of the front cover a later hand has added an index to the contents of the MS., and the words Iste liber est . . . conventus Basiliensis.

This MS. contains extracts from a number of theological works, including the Regula Coenobialis of St. Columbanus—a work which has been edited and fully studied by Seebass (Zeitschrift für Kirchengeschichte, 8, 1886, p. 459; 17, 1897, p. 215; 18, 1898, p. 58).

Fol. 1 r°–8 v°: Incipit tractatus beati Cassiani de institutis coenobiorum et de vii principalium vitiorum remediis. Opus utique totius quodam

[1] On this work and its author consult Esposito, Hermathena, xv., 1909, p. 356.

[2] The library of the Carthusians at Basel was acquired by the University Library in 1592 (Haenel, Catalogi, etc., 1830, col. 513).

modo moralitatis speculum et religionis exemplar, quod in libros xii est distinctum. Hic est igitur de habitu monachi liber Ius.

Ed. Migne (Patrol. Lat., 49, cols. 53 sq.).

Fol. 8 v°–21 v°: Incipit prologus eiusdem Cassiani super collationes patrum. Fol. 18 v°: Expliciunt collationes patrum maiores. Incipit prologus Cassiani praedicti super collationes minores.

Ed. Migne (Patrol. Lat., 49, cols. 477 sq.).

Fol. 21 v°–28r°: Incipit liber magistri Hugonis de institutione novitiorum.

Ed. Migne (Patrol. Lat., 176, cols. 925–952).

Fol. 28 r°–33 r°: Incipit de pastorali Gregorius quae est quidem regula praelatorum.

Ed. Migne (Patrol. Lat., 77, cols. 13 sq.).

Fol. 33 r°–38v°: Explicit pastorale domini Gregorii papae. Incipit exceptum regulae beati Benedicti.

Ed. Migne (Patrol. Lat., 66, cols. 215 sq.).

Fol. 38 v°–48 v°: Tractatus magistralis de praeceptis legis et evangelii.

Fol. 48 v°–54 r°: Incipit regula beati Basilii.

Ed. Migne (Patrol. Graeca, 31, cols. 889 sq.).

Fol. 54 r°–55 r°: Incipit regula sancti Columbani. Ut primum diligendus sit deus, etc.

Ed. Migne (Patrol. Lat., 80, cols. 210–224).

Only extracts from the work of St. Columbanus.

Fol. 55 r°–59 r°: Incipit Hugonis de Sancto Victore tractatus de claustro animae.

Ed Migne (Patrol. Lat., 176, cols. 1017 sq.).

Fol. 59 r°–152 v°: Incipit liber exceptionum collectarum de diversis opusculis beati Bernardi abbatis Clarevallensis.

Bernardi Opera ed. Migne (Patrol. Lat., 182–184).

Fol. 153: blank.

6. MS. A. vii. 3.

A beautiful interlinear Greek and Latin Psalter, written in an Irish hand of the ninth or tenth century. On fol. 2 r° occurs the Hymn of St. Cuchuimne, which has been edited from this and other MSS. by Bernard and Atkinson (Irish Liber Hymnorum, 1898, i, pp. xix, xxvii, 33, and ii. p. 124; cf. also

Keller, Mittheilungen der Antiquarischen Gesellschaft in Zürich, vii, 1851, p. 86, Taf. xii. 5; Todd, Book of Hymns, etc., i, 1855, p. 55; Baumeister, Denkmäler des Klassischen Altertums, ii, 1887, pp. 1132, 1133).

Another Basel MS., F. iii. 15, of the ninth century, is said, by Halm (Sitzungsberichte der K. Akademie in Wien. Phil.-Hist. Classe, 50, 1865, p. 134) to contain on fol. 50 a poem of Columbanus entitled, "Praecepta Vivendi": but Dümmler, who has edited the poem from this and other MSS., has shown that its real author is Alcuin (Mon. Germ. Hist. Poetae Latini Aevi Medii, i, 1881, pp. 164, 275).

Einsiedeln, Stiftsbibliothek.

An excellent catalogue of the MSS.[1] preserved in the Library of the Benedictine Monastery at Einsiedeln is in course of publication by the Librarian, Père Gabriel Meier, O.S.B. The first volume, describing the 500 most ancient and important MSS., appeared in 1899.[2]

1. MS. No. 132.

A tenth-century parchment MS., fully described by Meier (Catalogus, etc., p. 109). It contains the group of tracts by Sedulius Scottus, found in the Basel MS., F. v. 33, fully described above.[4] The tracts of Sedulius occupy pages 2 to 112. From a brief examination of this MS. I was enabled to ascertain that the text agrees well with that of the Basel MS.

2. MS. No. 103.

A sixteenth-century paper MS., described by Meier (Catalogus, etc., p. 86).

Fol. 184 v°–188 v°: S. Columbani Instructio V.

Ed. Migne (Patrol. Lat., 80, cols. 240–241).

Fol. 214 r°–223 r°: S. Columbani Regula Coenobialis.

Ed. Migne (Patrol. Lat., 80, cols. 216–222).

3. MS. No. 257.

A tenth-century parchment MS., fully described by Meier (Catalogus, etc., p. 229).

P. 294–296: The poem in honour of St. Columbanus, Clare sacerdos, clues duro rutilus decore tuis, Columbane, etc., published by Mone (Lateinische

[1] The library contains in all about 1500 MSS.

[2] Catalogus Codicum Manu Scriptorum qui in Bibliotheca Monasterii Einsidlensis servantur. Tomus I, Lipsiae, 1899. A copy of this valuable work was kindly presented to me at Einsiedeln by the author.

[3] Cf. also Morel, Sitzungsberichte der K. Akademie in Wien. Philos.-Histor. Classe, Band 55, 1867, p. 259.

[4] Cf. *supra*, p. 63.

Hymnen des Mittelalters, iii, 1855, p. 255, cf. also Daniel, Thesaurus Hymnologicus, v, 1856, p. 371) from this MS. It is also found in a MS. of the thirteenth century in the Royal Library at Brussels, No. 3176 (Ancien 7460), fol. 99 v°, in which it is attributed to St. Gallus (cf. Chevalier, Repertorium Hymnologicum, i, 1892, p. 199, and Van Den Gheyn, Catalogue des Manuscrits de la Bibliothèque Royale de Belgique, V, 1905, p. 137). It has been printed from this MS. by the Bollandists (Catalogus Codicum Hagiographicorum Bibliothecae Regiae Bruxellensis, pars i, tom. 2, 1889, p. 12), who do not mention the other MSS. and edition.

4. MS. No. 235.

A tenth- or eleventh-century parchment MS., described by Meier (Catalogus, etc., p. 192).

P. 96–164: The commentary on the Opuscula Sacra of Boethius by Joannes Scottus Eriugena, studied and edited by Rand (Johannes Scottus, München, 1906, p. 4, ap. Traube, Quellen und Untersuchungen, etc., Heft 2). The same commentary occurs in MSS. at St. Gallen and Bern, to be mentioned further on.

Two other Einsiedeln MSS., Nos. 27 and 234, are said by Père Gallus Morel (Sitzungsberichte der K. Akademie in Wien, Phil.-Hist. Classe, Bd. 55, 1867, pp. 250–251) to contain writings of St. Columbanus, but this is doubtful (cf. Meier, Catalogus, etc., pp. 18, 191). According to Seebass (Zeitschrift für Kirchengeschichte, 15, 1895, p. 368n), MS. No. 27 would contain not the Instructio Quinta of St. Columbanus, but St. Augustine's Sermo de corpore et anima.

Schaffhausen, Stadtbibliothek.

The Town Library at Schaffhausen contains few MSS. earlier than the sixteenth century. Of these one alone is of interest to Hiberno-Latin literature.

A summary index of the Schaffhausen MSS. (numbering 561) by Drs. Boos and Henking was published at Schaffhausen in 1903.[1]

MS. No. 1.

The celebrated codex of the original and longer recension of Adamnan's Life of St. Columba, which was taken by Reeves as the basis of his edition (Irish Archæol. Soc., 1857). It is a folio parchment MS., consisting of 137 numbered pages, written in an Irish hand, in double columns with 28 lines to the column. There are many illuminated titles and ornamental letters,

[1] Verzeichnis der Inkunabeln und Handschriften der Schaffhauser Stadtbibliothek, Schaffhausen, 1903.

some of very considerable beauty (cf. the facsimiles in Reeves's edition, Plates 1 and 2). It was copied by Dorbbéne, who died in 713, and is said to be the oldest MS. in Switzerland. It is possible that it is not so ancient as is generally supposed. The MS. was obtained from the ancient monastery at Reichenau; as is shown by the somewhat faded note at the top of page 1, col. a, "Liber Augie Divitis," and at the foot of same page now partially erased, "Lib' Augie Maioris." The exact date at which it passed into the possession of the Schaffhausen library is not now known. It was, however, there before the year 1795. Formerly it bore the number 22 (cf. Haenel, Neue Jahrbücher für Philologie und Paedagogik, Supplementband vi, 1840, p. 458). Pages 1 to 136 contain the work of Adamnan. On page 137 is written the Lord's Prayer in Greek. A collation of this MS. with the old editions was used by Reeves in 1857, but an examination of the MS. has shown me that it was by no means a complete one.[1] Moreover, Reeves did not follow the orthography of the MS., on the ground that it is "barbarous, or at least provincial"; nor has he inserted all the peculiar spellings in his Variae Lectiones, "as they would have swelled them to an inconvenient length" (Reeves, ed. of Adamnan, p. xvii). A considerable literature is attached to this MS.: Keller, Mittheilungen der antiquarischen Gesellschaft in Zürich, vii, 1851, p. 85; Reeves, ed. of Adamnan, 1857, pp. xiii–xxiv; J. S., Anzeiger zur Schweizerische Geschichte und Altertumskunde, v und vi Jahrgang, Zürich, 1859 und 1860, p. 60 sq.; Fowler, ed. of Adamnan, 1894, pp. viii and 166; Stokes and Strachan, Thesaurus Palaeohibernicus, ii, 1903, p. xxxi; Boos, Verzeichnis, etc., 1903, p. 67.

St. Gallen, Stiftsbibliothek.

The Monastic Library at St. Gallen contains one of the most valuable collections of MSS. in Europe.[2] Having been founded and much frequented by Irish monks, it is naturally rich in works relating to Hiberno-Latin literature. An excellent catalogue of the MSS. by G. Scherrer was published at Halle in 1875.[3]

[1] Since the the above was written Mr. R. I. Best has kindly called my attention to an article in The Academy (vol. xxx., 1886, p. 227), by the late Dr. Whitley Stokes, in which the latter records the results of his examination of the Schaffhausen codex in the summer of 1886. His observations are in complete agreement with my own. "Reeves has in his text disregarded the peculiarities of Adamnan's orthography, which are often both curious and instructive. In some instances, where the spelling of the MS. is perfectly correct according to Brambach and the best Latin codices, it has been spoiled in the edition."

[2] Amounting in all to 1793 volumes.

[3] Verzeichniss der Handschriften der Stiftsbibliothek von St. Gallen, Halle, 1875.

1. MS. No. 433.

A large folio MS., consisting of 708 parchment pages, splendidly written in a ninth-century hand in double columns with 27 or 28 lines to the column. There are many illuminations. A full list of the contents is given by Scherrer (Verzeichniss, etc., p. 142).

Pages 685 to 706 contain the scriptural work of Aileranus Scottus,[1] published from this MS. by Fleming in 1667, whose edition was reprinted by Migne (Patrol. Lat., 80, cols. 327–342). The end is wanting in this MS., but can be supplied from a MS. in the Imperial Library at Vienna.[2]

P. 685: Ailerani Scotti Interpretatio Mystica Progenitorum Domini Jesu Christi. In Nativitate Sanctae Genitricis Ipsius Legenda. Oportunum videtur de nominibus genealogiae, etc., ... exemplis sacrae scripturae asseruimus.

P. 694: Item Moralis Explanatio eorundem nominum ab eodem compilata.. Oportunum quoque nunc videtur ut eiusdem genealogiae nomina, etc., . . . [P. 706] in Azor ut adiuvante Domino . . . .

The rest is lost. A number of words are omitted in the printed edition, and the orthography of the MS. has been frequently altered.

2. MS. No. 776.

A quarto paper MS. copied by Gallus Kemli (d. c. 1477), described by Scherrer (Verzeichniss, etc., p. 257).

P. 163–168: The same work of Aileranus Scottus copied from MS. No. 433.

3. MS. No. 254.

A folio parchment MS. consisting of 256 pages, measuring 29 cms. by 23 cms., written in double columns with 25 lines to the column in a ninth-century hand. Titles and initial letters are in red. This MS. is mentioned in the ninth-century catalogue of the books at St Gallen, published by Weidmann (Geschichte der Bibliothek von St. Gallen, 1846, p. 373), and also in the catalogue of the year 1461 (Weidmann, loc. cit., pp. 409 and 236).

P. 2–252: Isaiae brevibus lector mysteria verbis, etc., ... Octavo decimo sit terminus iste libello.

This is the commentary on Isaiah compiled from the well-known work

[1] Cf. Esposito, Hermathena, xiv, 1907, p. 522, and xv, 1909, p. 359.

[2] Cod Membr. Theol. cix, or, as it is now numbered, No. 740, of the tenth century (cf. Denis, Codices Manuscripti Theologici Bibliothecae Palatinae Vindobonensis, i, pt. 1, 1795, col. 294; Tabulae Codicum Vindobonensium, i, 1864, p. 124).

of St. Jerome by an Irish monk Josephus Scottus, a disciple of Alcuin, like whom he emigrated to France about 790, and died there before 804 (Esposito, Hermathena, xiv, 1907, p. 523, and xv, 1909, p. 360). This commentary, which in Scherrer's catalogue (Verzeichniss, etc., p. 95) is wrongly attributed to Bede, has not yet been printed. It is also found in a ninth-century MS. at Paris, No. 12154, fol. 1–192. To each of the eighteen books into which the work is divided is prefixed a hexameter, and in addition there are sets of verses at the beginning and end. These verses have been edited by Dümmler (Mon. Germ. Hist., Poetae Latini Aevi Medii, i, 1881, pp. 149–151) from both the MSS. Dümmler has also given (loc. cit., p. 151) from the Paris MS., fol. 192 r°, the closing prose epistle, which, together with some of the final hexameters, is wanting in the St. Gallen MS., p. 252.

Several acrostic poems which are found in a MS. at Bern, and which have for their author the same Josephus Scottus, will be dealt with later on.

P. 252–255: In another hand: Incipit de valetudine et obitu venerabilis Bedae presbyteri. Munusculum quod misisti, etc. On p. 253, col. 1, lines 6–11, is written an Anglo-Saxon poem in the Northumbrian dialect said to have been repeated by Bede on his death-bed. It has been printed by Hattemer (Denkmahle des Mittelalters, St. Gallen, 1844, tom. i, p. 4), and by Sweet (The Oldest English Texts, 1885, p. 149); cf. also Whitley Stokes (The Academy, xxx., 1886, p. 228).

P. 255: Epitaphium beati Bedani presbyteri. In 21 hexameters. Printed by Mabillon (Vetera Analecta, iv, 1685, p. 521).

P. 255–256: Ymnus. Ardens amoris mentio . . . . caeli in arce condita. In ten lines. It will be found in Mabillon (loc. cit., p. 522).

Then follows another poem in ten lines: Hic legentes, octo pes sunt metra, clare cernere. . . . . Uni ac trino deo sit summa semper gloria. Printed by Huemer (Wiener Studien, ii, 1880, p. 73).

At the end in large letters: vi. Idus Mai. Nat. Sancti Bedae Presbyteri.

4. MS. No. 274.

A small folio parchment MS., consisting of sixty-six pages, written in single columns, in a ninth-century hand. Titles and initial letters are in red. The MS. is mentioned in the ancient catalogue of the year 1461 (Scherrer, Verzeichniss, etc., p. 104; Weidmann, Geschichte der Bibliothek von St. Gallen, 1846, p. 406). This MS. contains a few sentences by Joannes Scottus Eriugena on the Categories of Aristotle, which have not yet been printed (Esposito, Hermathena, xv, 1909, p. 362). I give these sentences in full below.

P. 1–3: Blank.

P. 4; Verba Iohannis Scotti. Aristotiles, acutissimus apud Grecos, ut aiunt, naturalium rerum discretionis repertor, omnium rerum quae apud deum sunt et ab eo creata innumerabiles varietates in decem universalibus generibus conclusit. Quae decem cathegorias id est predicamenta vocavit. Nihil enim, ut ei visum, in multitudine creaturarum rerum variisque animorum moribus[1] inveniri potest quod in aliquo praedictorum generum induci non possit. Haec enim a Grecis vocantur: [**Ουσια, Ποσοτη, Ποιοτη, Προς τι, Κεισθαι, Εχειν, Τοπος, Χρονος, Πραθειν, Παθειν.**][2] Quae latialiter dicuntur: Essentia, Quantitas, Qualitas, Ad Aliquid, Situs, Habitus, Locus, Tempus, Agere, Pati.

P. 4–5: Versus Alcuini Diaconi ad Karolum Regem Franchorum, "Continet iste decem naturae verba libellus," etc., with a short preface and interlinear and marginal notes. This poem, in ten lines, was printed by Dümmler (Mon. Germ. Hist., Poetae Latini Aevi Medii, i., 1881, p. 295), from MSS. at Vienna and Munich. Dümmler does not mention this MS.

P. 5–66: Incipiunt Cathegoriae Aristotelis ab Augustino translatae ad filium. Cum omnis scientia disciplinaque, etc., with interlinear notes, and a copious marginal commentary.

This work, incorrectly attributed to St. Augustine, will be found in Migne (Patrol. Lat., 32, cols. 1419–1440).

5. MS. No. 555.

A small quarto parchment MS., consisting of eighty-three folios, written in the early part of the ninth century (Scherrer, Verzeichniss, etc., p. 175). It contains only the shorter recension of Adamnan's Life of St. Columba, and was collated for Reeves's edition (Irish Archaeol. Soc., 1857, p. xxvii) by Karl Greith. On page 166 is a picture of St. Columba, which is reproduced in facsimile in Reeves's edition (Plate V). This MS. is mentioned in the ninth-century catalogue of the monastic library of St. Gallen (Weidmann, Geschichte, etc., p. 386).

6. MS. No. 320.

A small octavo parchment MS., written in the twelfth century, in single columns with 34 lines to the column. It is fully described by Scherrer (Verzeichniss, etc., p. 113). It contains, on pages 254–284, Adamnan's work De Locis Sanctis, without the plans, and was collated by Tobler and Molinier for their edition (Itinera Hierosolymitana et Descriptiones Terrae Sanctae, Geneva, 1879, i, p. xxxiii). Other MSS. of this tract occur at Zürich and Bern. They will be mentioned further on.

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[1] Correctio supra scripta: motibus.

[2] Several of the Greek words in brackets have been added by myself. In the MS. they are written in red ink, which has become so faded that I could only decipher a few letters in each word, and Dr. A. Fäh, who has since very kindly re-examined the MS. at my request, has not been more successful.

7. MS. No. 150.

A quarto parchment MS., dating from the beginning of the ninth century (Scherrer, Verzeichniss, etc., p. 55). It contains, on pages 365–377, the Poenitentiale of St Finnian of Moville (Esposito, Hermathena, xv, 1909, p. 353, and Seebass, Zeitschrift für Kirchengeschichte, xiv, 1894, p. 437). The tract was printed from this and other MSS. by Wasserschleben (Die Bussordnungen der abendländischen Kirche, Halle, 1851, pp. 10 and 108 sq.). Pages 285–287 contain only the preface of the Poenitentiale of Cummean. The penitential piece which follows on pages 287–318 is not the work of this author (Wasserschleben, loc. cit., pp. 69, 70, 460 n., 505 sq.).

8. MS. No. 550.

An octavo parchment MS. written in the ninth century. It contains, on pages 162–234, the Poenitentiale of Cummean (Scherrer, Verzeichniss, etc., p. 169, and Esposito, Hermathena, xv, 1909, p. 358). This MS., and also the one to be next mentioned, was employed by Wasserschleben (Die Bussordnungen, etc., pp. 12 and 460 sq.) for his edition. It is mentioned in the catalogue of 1461, published by Weidmann (Geschichte, etc., p. 412) from MS. No. 1399.

9. MS. No. 675.

A quarto parchment MS., dating from the beginning of the ninth century (Scherrer, Verzeichniss, etc., p. 219). On pages 224–267 occurs the Poenitentiale of Cummean. This MS. was employed by Wasserschleben (cf. the preceding article). It is possibly referred to in the ninth-century catalogue, printed by Weidmann (Geschichte, etc., p. 388) from MS. No. 728.

10. MS. No. 915.

A quarto parchment MS. written in the tenth or eleventh century, fully described by Scherrer (Verzeichniss, etc., p. 336). Pages 154–167 contain the Regula Monachorum of St. Columbanus, which was printed from this and other MSS. by Seebass (Zeitschrift für Kirchengeschichte, xv, 1895, p. 368). On pages 167–169 we have the Instructio Quinta, "O tu vita" attributed to St. Columbanus (Ed. Migne, Patrol. Lat., 80, cols. 240–241); and, lastly, on pages 170–184 occurs the Regula Coenobialis of St. Columbanus, which was edited from this MS. by Seebass (Zeitschrift für Kirchengeschichte, xvii, 1897, p. 216).

11. MS. No. 1191.

A duodecimo paper MS. dating from the year 1596. It contains the Regula Coenobialis (?) of St. Columbanus (Scherrer, Verzeichniss, etc., p. 422).

12. MS. No. 1347.

An octavo paper MS. written in 1696. It contains the Regulae of St. Columbanus (Scherrer, Verzeichniss, etc., p. 451).

13. MS. No. 1348.

A duodecimo paper MS. written in the seventeenth century (Scherrer, Verzeichniss, etc., p. 451). It contains the Regula (Coenobialis ?) of St. Columbanus, and his Instructio Quinta (cf. above, MS. No. 915).

14. MS. No. 1346.

A quarto paper MS. copied by J. Metzler in the beginning of the seventeenth century (Scherrer, Verzeichniss, etc., p. 450). It contains six of the Epistolae of St. Columbanus, which have been printed from this MS. by Gundlach (Mon. Germ. Hist., Epistolae, iii, 1892, p. 154). It further contains the Instructiones sive Sermones, attributed to St. Columbanus, only four of which are regarded as genuine by Seebass. These latter he has edited from this and other MSS. (Zeitschrift für Kirchengeschichte, xiv, 1894, p. 77; cf. also Seebass, Neues Archiv der Gesellschaft für ältere Deutsche Geschichtskunde, xvii, 1891, p. 253).

15. MS. No. 273.

A quarto parchment MS. written in the ninth century (Scherrer, Verzeichniss, etc., p. 103). Pages 38–49 contain three of the poems of St. Columbanus, which have been edited from this and other MSS. by Gundlach (Mon. Germ. Hist., Epistolae, iii, 1892, p. 154; cf. also Neues Archiv, etc., xv, 1889, p. 514). Schenkl, Sitzungsberichte der K. Akademie in Wien, 43, Phil.-Hist. Classe, 1863, p. 17 sq.; Riese, Anthologia Latina, i, pt. 1, ed. 2, 1894, p. 221, pt. 2, 1906, p. 59).

16. MS. No. 899.

A quarto parchment MS. of the ninth or tenth century (Scherrer, Verzeichniss, etc., p. 315). It contains on pages 109–111 the three poems of St. Columbanus found in MS. No. 273, and was used by Gundbach for his edition (cf. preceding article). A full account of this MS. was given by Dümmler (Mittheilungen der Antiquarischen Gesellschaft in Zürich, Bd. 12, Heft 6. 1859, p. v; also Neues Archiv, etc., 4, 1879, p. 276, and Mon. Germ. Hist., Poetae Latini Aevi Medii, i, 1881, pp. 31, 442; ii, 1884, pp. 159, 264); Schenkl (Sitzungsberichte der K. Akademie in Wien Phil.-Hist. Classe, 43, 1863, p. 67 sq.; Baehrens, Poetae Latini Minores, iv, 1882, p. 10; Riese, Anthologia Latina, i, pt. 1, ed. 2, 1894, pp. 100, 102, 148, 213, 306; pt. 2, 1906, pp. 105, 134, 158, 159, 371).

In two other MSS.—No. 197, quarto, saec. x, pp. 281–289, and 198, quarto, saec. x, pp. 141–149—a long poem, "Haec praecepta legat," etc., is attributed to St. Columbanus (Scherrer, Verzeichniss, etc., pp. 72, 74), but Dümmler, who has edited it from these and other MSS., has proved that it is the work of Alcuin (Mon. Germ. Hist., Poetae Latini Aevi Medii, i, 1881, pp. 164, 275).

Three other St. Gallen MSS.—No. 141, quarto, saec. x, pp. 45–52, No. 921, a quarto paper MS. of saec. xv, and No. 927, a quarto paper MS. written in 1435, pp. 486–492, are said to contain the Instructio Quinta of St. Columbanus, "O vita quae tantos decepisti," etc. (Scherrer, Verzeichniss, etc., pp. 53, 346, 348), but this is probably a confusion with St. Augustine's Sermo de corpore et anima (cf. Seebass, Zeitschrift für Kirchengeschichte, xv, 1895, p. 368).

17. MS. No. 250.

A folio parchment MS., copied in the ninth century, fully described by Scherrer (Verzeichniss, etc., p. 92). Pages 112–114 contain a work attributed to St. Columbanus, "De Saltu Lunae," which was published from this MS. by Pere Gabriel Meier (Jahresbericht über die Lehr- und Erziehungs-Anstalt des Benediktiner-Stiftes Maria-Einsiedeln, 1886–87, p. 30; cf. also p. 9).[1] St. Columbanus' authorship has, however, been called in question by Bruno Krusch (Mon. Germ. Hist., Script. Rer. Meroving., t. iv, 1902, p. 20n.). This MS. has also been used by Dümmler (Mon. Germ. Hist., Poetae Latini Aevi Medii, ii, 1884, p. 568; cf. also Schenkl, Wiener Studien, i, 1879, p. 63n., Riese, Anthologia Latina, i, pt. 2, ed. 2, 1906, pp. 105, 154, 155, 161). This same work is also found attributed to St. Columbanus in two other MSS., which were apparently quite unknown to Père Meier—Zürich Kantonsbibliothek C 176 to be mentioned farther on and a MS. at Munich, Cod. Lat. 14569, fol. 26–28, saec. xi. (Catalogus Codicum Latinorum Bibliothecae Regiae Monacensis, t. ii, pars 2, 1876, p. 194.)

18. MS. No. 904.

This is the famous MS. of Priscian (Scherrer, Verzeichniss, etc., p. 319), so important for its Old-Irish glosses. It has been frequently studied (cf. Stokes and Strachan, Thesaurus Palaeohibernicus, ii, 1903, p. xix). Traube (Abhl. der K. B. Akad. zu München, 1891, Bd. 19, Philos.-Philol. Classe, Abth. 2, p. 373) has shown that it was written in the first half of the ninth century by some of the friends of Sedulius Scottus. On fol. 40 r° and v° are two poems which are said by Dümmler to be the work of Sedulius

[1] A copy of this valuable paper was very kindly given to me by Père Gabriel Meier at Einsiedeln.

Scottus (Neues Archiv, etc., 4, 1879, p. 319 sq.). They have been published by Traube (Mon. Germ. Hist., Poetae Latini Aevi Medii, iii, 1896, p. 238).

19. MS. No. 134.

A quarto parchment volume of 266 pages. It is made up of three distinct portions written respectively in hands of the tenth, thirteenth, and eleventh centuries (Scherrer, Verzeichniss, etc., p. 49). On page 134 sq. occurs, in an eleventh-century hand, the commentary of Joannes Scottus Eriugena on the Opuscula Sacra of Boethius. It was edited for the first time by Rand (Johannes Scottus, 1906, p. 4, ap. Traube, Quellen und Untersuchungen, etc., Heft. 2), who made use of this and the two following MSS.

20. MS. No. 268.

A quarto parchment MS., consisting of 168 pages, written in a ninth-century hand. According to Scherrer (Verzeichniss, etc., p. 101), it contains only the well-known grammatical work of Alcuin (ed. Froben, Alcuini Opera, tom. ii, Ratisbon, 1777, pp. 265–300); but Rand (Johannes Scottus, p. 98) has detected in it, written in a twelfth-century hand, the commentary of Joannes Scottus on Boethius mentioned in the preceding paragraph.

21. MS. No. 768.

A quarto parchment MS., consisting of 112 pages, written in a twelfth-century hand (Scherrer, Verzeichniss, etc., p. 254). On pages 9–58 occurs the same commentary of Joannes Scottus (Rand, loc. cit., p. 28) found in the two preceding MSS.

22. MS. No. 10.

A quarto parchment MS., consisting of 478 pages, written in a tenth-century hand (Scherrer, Verzeichniss, etc., p. 3).

P. 1–2: Blank.

P. 3: Hic sunt insignes sancti, etc. Sixteen hexameters by an Irishman named Dubduin. They were printed by von Arx (Geschichten des Kantons St. Gallen: Zusätze i, 1830, p. 20), by Keller (Mittheilungen der Antiquarischen Gesellschaft in Zürich, vii, 1851, p. 59 sq.) and by Dümmler (Neues Archiv, etc., 10, 1885, p. 341), cf. also Esposito (Hermathena, xiv, 1907, p. 526, and xv, 1909, p. 363).

P. 4–476: Liber Job. Proverbia. Ecclesiastes. Canticum Canticorum. Sapientia. Jesus Sirach; with the prologues of St. Jerome on Job, Proverbia, and Sirach.

P. 477–478: Blank.

Zürich.

There are two libraries in Zürich which contain MSS. of interest to students of Hiberno-Latin literature—the Cantonal Library and the Town Library. Unfortunately no printed catalogues of the MSS. in either of these libraries have as yet been published.

(*a*) Kantonsbibliothek.

The more important of the 1000 MSS. in this library have been carefully studied by Herr Jakob Werner, Professor of Mediaeval Latin Philology in the University of Zürich,[1] to whom I am indebted for much kind assistance.

1. MS. C. 176.

An eleventh-century MS., a full description of which has been made by Herr Werner.

Fol. 174 v°–175 v°: Sanctus Columbanus haec de saltu lunae ait: De lunari motatione dicturo non aliunde mihi sumendum videtur exordium, etc. . . . . amittere videtur.

This is the short tract attributed to St. Columbanus, also found in the St. Gallen MS., No. 250, described above.

2. MS. Hist. 28.

A ninth-century MS. obtained from the ancient monastery of Reichenau. A full description of it has been given by F. Keller (Mittheilungen der Antiquarischen Gesellschaft in Zurich, vi, 1849, pp. 37–68). Among other things it contains the Regula Monachorum of St. Columbanus and the Instructio Quinta attributed to him. This MS. was employed by Seebass for his edition of the Regula Monachorum (Zeitschrift für Kirchengeschichte, xv, 1895, p. 367).

3. MS. No. 72.

A quarto parchment MS. consisting of 416 pages, written in a tenth-century hand in single columns, with twenty-five lines to the page. There are a few marginal notes and some illuminated titles. This MS. formerly belonged to the ancient monastery of Rheinau.[2]

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[1] The Universities of Switzerland, like those of most Continental countries, are well provided with Chairs of Mediaeval Latinity and of Palaeography. Unfortunately the same cannot at present be said of our Irish Universities.

[2] Rheinau must be carefully distinguished from the more celebrated Reichenau. Rheinau or Augia Rheni is situated on a picturesque island of the Rhine, not far from the falls near Schaffhausen. Reichenau is a fertile island in the inferior part of the Lake of Constance. It was known as Augia Dives or Augia Maior. The monasteries at both places were much frequented by Irish monks in the middle ages. The Reichenau MSS. are now mostly at Karlsruhe. The majority of the extant Rheinau MSS. are in the Kantonsbibliothek at Zurich.

P. 1–411: Incipit Collectaneum Sedulii Hiberniensis in Apostolum. Antequam ad apostolica verba exponenda veniamus, etc., ... Finit Collectaneum Sedulii Scotti in Epistolas Pauli.

Ed. Migne (Patrol. Lat., 103, cols. 9–270).

P. 411–416: A few extracts from Saints Augustinus and Eucherius. The end of the MS. is lost. This MS. was studied by Hellmann (Sedulius Scottus, München, 1906, pp. 191, 196, ap. Traube, Quellen und Untersuchungen zur Lateinischen Philologie des Mittelalters, Heft 1), who has determined its relation to the other MSS. of this commentary of Sedulius Scottus. Hellmann, however, wrongly states this MS. to be preserved in the Zürich Stadtbibliothek.

4. MS. No. 73.

A quarto parchment MS., consisting of fifty-one numbered folios, measuring 31 cms. by 23·5 cms., written in single columns, with thirty lines to the page. It dates from the ninth and tenth centuries, being made up of several parts in different hands, and came from the monastery of Rheinau. There are some illuminated titles and coloured diagrams. Among other things it contains the work of Adamnan, De Locis Sanctis, and was collated by Geyer for his edition (Itinera Hierosolymitana, saec. iii–viii, 1898, pp. xxvii and xxxiv, ap. Corp. Script. Eccles. Lat. Vindob., tom. 39); consult also Geyer, Adamnanus, Abt von Iona, Theil ii., Program, Erlangen, 1897, p. 16).

Fol. 1 r°: In nomine dei patris et filii et spiritus sancti. Hunc codicem ego Reginbertus scriptor servorum dei servus, etc. Then follow twelve hexameters by the same Reginbertus:

Magno in honore dei domini genitricis et almae
Sanctorum quoque multorum quibus Auua fovetur, etc.

These verses have been printed by Dümmler (Mon. Germ. Hist., Poetae Latini Aevi Medii, ii, 1884, p. 424), who does not mention this MS., and also by M. Omont from a MS. copied by Reginbertus, formerly preserved in the Phillipps collection, and now probably at Berlin (Bulletin de la Société Nationale des Antiquaires de France, 1889, p. 133). Reginbertus, who died in 846, was the Librarian at Reichenau, under the Abbots Waldo, Heito, Erlbaldus, and Ruodhelmus (Cahier, Les Bibliothèques, p. 129, ap. Annales de Philosophie Chrétienne, 17–18, 1838; Dümmler, Mittheilungen der Antiquarischen Gesellschaft in Zürich, Bd. 12, Heft 6, 1859, p. 249; Dümmler, Poetae Latini Aevi Medii, i, 1881, p. 126, ii, 1884, pp. 303n., 417, 425). No less than forty-two MSS. were copied by him, or at his request, and presented to the monastery. Very few of these are now in existence. We still possess a catalogue of them drawn up by Reginbertus himself before the year 842, which has been printed several times (Ziegelbauer, Historia Rei Literariae

Ordinis S. Benedicti, tom. i, 1754, p. 569; Neugart, Episcopatus Constantiensis Alemanicus, t. i, pars i. 1862, p. 547; Becker, Catalogi Bibliothecarum Antiqui, Bonn, 1885, pp. 19–24). The Zürich MS. is, no doubt, identical with the one thus described: "In trigesimo libello habentur libri tres, quos Arculphus Episcopus Adamanno excipiente de locis sanctis ultramarinis designavit conscribendus, et quartus liber de eadem notatione est adiunctus. Quis autem fuerit, ignoramus; quem mihi Walafrid Frater me supplicante donavit." The personage here referred to is the well-known Walahfridus Strabus, Abbot of Reichenau from 842 to 849, and the "quartus liber de eadem notatione" is the so-called Itinerarium Antonini Placentini still found in the MS., as mentioned below.

Fol. 1 v°: Blank.

Fol. 2 r°–28 r°: Primus de locis Sanctis liber. Exorditur praefatio. Arculfus sanctus episcopus gente Gallus, etc., ... Explicit liber tertius.

This is the work of Adamnan found in a considerable number of MSS.

Ed. Geyer (Itinera Hierosolymitana, 1898, pp. 219–297).

Fol. 28 r°–29 v°; Incipit de virginitate Sanctae Mariae:

Virginitas felix quae partu est digna Tonantis,
Quae meruit dominum progenerare suum, etc.,

. . . .

Intrant sidereo vernentes lumine portas
Excipit hos proceres urbs patefacta poli.

Haec de versibus cccc Furtunati librorum xi ad Gregorium positis ad sanctorum mentionem sumpsimus.

These 86 elegiac verses are taken from a poem of Venantius Fortunatus (Liber viii, 3, 93–178, ed. Leo, Mon. Germ. Hist., Auctores Antiquissimi tom. iv, pars. i, 1881, p. 183). There is no mention of this MS. in Leo's edition.

Fol. 30 v°–43 v°: In another hand, also of the ninth century: Incipit libellus de locis sanctis extra marinis quae infra vel circa Hierusalem sunt, praecedente beato Antonino martyre. Ex eo quod a civitate Placentina egressus sum, etc., ... Explicit deo adiuvante.

This is the original recension of the Itinerary falsely ascribed to Antoninus Placentinus. It has been printed from this and other MSS. by Geyer (Itinera Hierosolymitana, 1898, pp. 159–191).

Fol. 44 r°–51 v°: In a hand of the end of the ninth or earlier portion of the tenth century: Militum eius unum solummodo lapidem, etc., ... vel obsessionem et ruinam suis adferunt.

The rest is lost. This is a fragment of Bede's work, "Quaestiones in libros Regum" (Bedae Opera Omnia, Coloniae, 1688, tom. iii, pp. 341–346).

This MS. gains additional interest from the fact that it contains an Old-Irish gloss, the word *mollis* being glossed as *slemon* or *selemon.* The same gloss is found in another MS. of Adamnan's tract, Parisinus 13048, also of the ninth century (cf. Geyer, Itinera Hierosolymitana, 1898, pp. xxxiiii and 225n.). I mention this here as neither of these MSS. is referred to in the work of Stokes and Strachan (Thesaurus Palaeohibernicus, 2 vols., 1901–1903).

In the second part of this paper I propose to deal with the MSS. in the Town Libraries at Zürich and Bern. The Bern MSS. are especially interesting. From one of them, now unfortunately mutilated, I hope to publish for the first time a large portion of the grammatical work of an Irishman, named Clemens Scottus, who filled a prominent post at the Court-School under Charlemagne's successor, Louis the Pious.

In conclusion, it only remains for me to record my thanks to those from whom I have received assistance in the course of the above work. In the first place, to Professor Kuno Meyer and Mr. R. I. Best, who have given me constant encouragement and sympathy, and secondly, to Professors Schneider of Basel, and Werner of Zürich, to Père Gabriel Meier of Einsiedeln, and to the Librarians of the Town Library at Schaffhausen, of the Monastic Library at St. Gallen, and of the Cantonal Library at Aarau, for the kindness with which they did everything to facilitate my researches among the MSS. under their care.

APPENDIX.

A.

Basel, MS. F.v. 33. Fol. 14 v°–19 r°.

[Sedulii Scotti Expositio Eusebii In Decem Canones].[1]

1. *Eusebius Carpiano fratri in Domino salutem.*[2] In superioribus beati Hieronimi in X canones evangeliorum argumentationes, ut potuimus, breviter explanavimus. Nunc vero Eusebii Caesareae Palestinae episcopi, qui primus ipsos canones in decem titulos ordinavit, de eisdem canonibus assertionem videamus.

2. Nam sequitur: *Ammonius quidam Alexandrinus, magno studio atque industria unum nobis pro quattuor evangeliis dereliquit.* In quo prorsus exordio ipsum Ammonium quem assecutus fuerat non parva laude prosequitur. Cum eo magno studio atque industria opus evangelicum non tam ad

[1] The title in square brackets has been added by myself. Cf. *supra*, p. 64.

[2] The words printed in italics are those of the old Latin translation of Eusebius, commented upon by Sedulius Scottus. In the MS. they are usually written in red ink.

sui nominis gloriam quam ad subsequentis saeculi utilitatem dereliquisse testatur. Cumque eum Alexandrinum fuisse commemorat hoc ad cumulum eius laudis pertinere quis dubitet. Constat namque urbem Alexandriam philosophorum nutricem ac sapientium magistram in divinis atque humanis litteris fuisse caeleberrimam. In qua praefactum virum et studio floruisse ac industria pervaluisse asserit. Inter studiosum vero et industrium hoc interest. Quod studiosus vocandus est qui ea quae ad animum nutriendum liberaliter atque ornandum pertinent inpensissime requirit. Industrius vero est qui ea quae per studium magnopere requisivit firma et indubitabili scientia inveniendo percepit. Unde industria quasi indostria vocatur quod intro struat atque omnia quae agit intus conspiciat.

3. Sed quo pacto unum pro iiiior evangeliis praedictus Ammonius relinquere potuit mox explanat cum dicit: *Namque trium evangeliorum sensus exceptos, omnes similes conventusque*[1] *Mathaei evangelio quasi ad unum congestos, adnexuit; ita ut eorundem, quantum ad tenorem pertinet lectionis, sequens iam stilus interruptus esse videatur.* Sensus autem huius loci talis est. Quod in quocumque secundum Mathaeum capitulo vel unus vel duo vel alii tres evangelistae in eodem vel consimili sensu concordant. Ipsorum vel unius vel duorum aut certe trium evangelistarum capitula cuilibet secundum Mathaeum capitulo subnexuit. Sed hoc non plus quam vii canonibus, qui sunt, primus, secundus, iii, iiii, v, vi, septimus, fecit. In quibus Mathaeus cum tribus aut duobus aut cum quolibet uno evangelista consonat. Quod [illegible] in ipsis capitulis evidentius ostendimus. Nam primum secundum Mathaeum capitulum sic exorditur: Liber generationis Iesu Christi filii David filii Abraham et reliqua. Huic ergo capitulo secundum Lucam quartum decimum in quo genealogia salvatoris contexitur sicut xiiii: Et ipse Iesus erat incipiens quasi annorum xxx et reliqua. Secundum Iohannem vero primum et tertium quintumque subiunxit. At vero secundo iuxta Mathaeum capitulo quod est: Omnes ergo generationes Abraham usque ad David generationes xiiii et reliqua nullum ex aliis evangeliis capitulum subnexuit. Quia nimirum solus Mathaeus ipsum capitulum narraverit.

Porro autem in tertio capitulo Christi autem generatio sic erat et reliqua, quia Lucas consimilia dicit secundum iuxta ipsum Lucam capitulum: Et respondens angelus dixit, Ego sum Gabrihel et reliqua, ei subiecit. Sicque per totum Mathaei evangelium secundum alios evangelistas eadem atque vicina capitula tali ordine interposuit, ut omnia Mathaeum capitula sine ulla ordinis perturbatione, hoc est secundum post primum tertiumque post

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[1] *Contextus* Vetus Latina Versio apud Fabricium Bibliotheca Graeca, ed. Harles, t. vii, 1801, p. 4[illegible].

secundum et cetera post praecedentia licet propter alia interposita capitula non continuatim tamen ordinatim ponerentur. Sumpta vero ex aliis evangeliis capitula interruptim quantum ad ordinem pertinet stilum haberent. Cum verbi gratia primo secundum Mathaeum capitulo non primum sed xiiiimum secundum Lucam capitulum subnexum est. Signanter autem dicit quod ipse Ammonius quasi ad unum congestos scilicet sensus adnexuit. Nam quamvis cata Mathaeum ipsum evangelium fuerat praetitulatum, non tamen re vera simpliciter unum sed quasi unum erat evangelium. Cum in eodem non solum secundum Mathaeum sed etiam secundum alios evangelistas et sensus et capitula ipse intertexuit. Quod tamen et aliter intellegi potest. Quod quasi ad unum id est sensum quemlibet in evangelio Mathaei congestos sensus ex aliis evangelistis adnexuit. Unde perspicuum est quia nec praefatus Ammonius X canonum titulos in evangelio notaverit neque ipsos canones ordinaverit. Sed postquam suum opus compositum videlicet evangelium sub certis capitulorum distributionibus dereliquerit, Eusebius Caesariensis episcopus in eodem opere septem concordantias quibus Mathaeus cum aliis evangelistis consonat atque octavum canonem quem nunc rectius decimum nominamus subtili consideratione repperit. Insuper etiam alios duos canones, id est octavum in quo Lucas et Marcus et nonum in quo Lucas et Iohannes consonant, in aliis perspicaciter evangeliis attendit.

4. Nam vide quod consequenter adiungitur: *Verum, ut salvo corpore, sive textu ceterorum hoc*[1] *est*[2] *evangeliorum propria et familiaria loca, in quibus eadem similiterque dixerint,*[3] *scire possis, ac vere disserere, accepta occasione ex praedicti viri studio, alia ratione X numero*[4] *tibi titulos designavi.* Causam reddit cur decem canonum titulos descripsit quatinus eadem et similia in quibusque evangelii locis absque ulla capitulorum ordinis interruptione sciri possint. Et nota quod per X canones eadem et similia non autem sola quae etiam propria dicuntur discenda esse testatur. Quia propter causam brevitatis proprietatem decimi canonis reticuit quam mox tamen in subsequentibus ostendit. Ob hoc autem titulos ipsos canones nominat quod eorum distincta congeries per titulorum praenotatos ordines denoscitur.

5. Quos quidem titulos sive canones propriis diffinitionibus describit cum subdit: *Quorum primus, quattuor in se continet numeros, in quibus similia ab universis, dicta sunt, Mathaeo, Marco, Luca, Iohanne. Secundus, in quibus tres, Mathaeus Marcus, Lucas. Tertius, in quibus tres, Mathaeus, Lucas, Iohannes. Quartus in quibus tres, Mathaeus, Marcus, Iohannes. Quintus, in quibus duo,*

[1] hic Fabricius. [2] est om. Fabricius.
[3] dixerunt Fabricius. [4] numerorum Fabricius.

Mathaeus, Lucas.[1] [*Sextus, in quibus duo, Mathaeus, Marcus.*][2] *Septimus, in quibus duo, Mathaeus, Iohannes. Octavus, in quibus duo, Lucas, Marcus. Nonus, in quibus duo, Lucas, Iohannes. Decimus, in quibus singuli de quibusdam*[3] *proprie scripserunt.* Quoniam vero in supradictis de decem canonum numero deque ipsorum ordine prout potui breviter diserui nunc eadem replicare superfluum duxi. Illud interea perquirendum est quare cum ipsos canones diffinit vitium soloecismi videtur incurrere cum dicit: Secundus, in quibus tres, Mathaeus, Marcus, Lucas. Tertius, in quibus tres, Mathaeus, Lucas, Iohannes, et reliqua. Cum usitatius et secundum artem loquendi rectius dicere poterat: Secundus, in quo iii, Mathaeus, Marcus, Lucas. Item tertius, in quo iii, Mathaeus, Lucas, Iohannes, et cetera similiter. Itaque sciendum est quod hic locus dupliciter explanari potest. Aut enim illud quod ait, in quibus, non relative sed infinite intelligere debemus. Ut sit sensus, secundus titulus est sive canon, in quibus hoc est, in quibuslibet seu in quibuscumque[4] capitulis tres evangelistae, Mathaeus, Marcus, Lucas concordant. Quod et de ceteris canonibus infinite intelligendum. Nam si in his proloquiis relativa locutio esset praecedenti singulari numero nonnisi singularem numerum continuo subiungeret ac diceret: Secundus, in quo iii, Mathaeus, Marcus, Lucas, et reliqua. Sed quia singulari pluralem numerum subiunxit dicens: Secundus, in quo iii, Mathaeus, Marcus, Lucas, manifestum est quia non relative sed infinite, ut diximus, ipsam pluralitatem protulit. Aut certe congruentius ex praecedentis nexilitate constructionis hanc difficultatem enodare possumus. Nam primum canonem principaliter his verbis diffinivit: Quorum primus quattuor in se continet numeros in quibus similia ab universis dicta sunt Mathaeo, Marco, Luca, Iohanne. Dehinc secundum canonem diffinire aggreditur cum subinfertur: Secundus, in quibus iii, Mathaeus, Marcus, Lucas. In quibus per zeugma sive **αποκοενου** id est a communi a superioribus continet numeros, repetendum est ut nobis plena sententia constare sic possit. Secundus continet numeros in quibus iii Mathaeus, Marcus, Lucas similia dixerunt. Namque per syllemsin ex eo quod dicta sunt dixerunt assumendum est. Eodemque tenore subsequentium canonum descriptiones per **κοενον** atque syllemsin excepto decimo canone qui tantum apokoenon suppletur conserve. Quod autem dicit primum canonem iiiior in se numeros continere non nihil quaestionis habet. Nam perspicaciter investigandum est cur quattuor numeros esse describat. In quo non nisi unus hoc est quaternarius numerus propter quattuor evangelistas eluceret. Sed ut huius modum quaestionis facilius absolvamus nos ad distinctam canonum congeriem et oculorum et

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[1] Marcus Fabricius.

[2] Verba in uncinis inclusa a Fabricio sunt omissa.

[3] quidam cod.

[4] Verba seu in quibus in codicis margine addita sunt.

mentis aciem flectamus. Itaque exordiis tramitum primi canonis conspectis quattuor numeri oppositorum sibi invicem capitulorum elucescunt. Octavum videlicet secundum Mathaeum et ii iuxta Marcum ac septimum secundum Lucam Xmumque secundum Iohannem. Sic et per omnia loca in primi canonis congerie quattuor oppositos capitulorum numeros incunctanter videbis. Similiter in secundi et tertii quartique canonis serie tres numeros capitulorum a laeva in dexteram sibi invicem oppositos esse perspicies. Licet in quibusdam locis non nisi duo numeri tibi oppositi repperiuntur, sicut in fronte tramitum secundi canonis apparet. In qua secundum Mathaeum Xmum[1] secundum Marcum VItum secundum Lucam eundem quomodo apud Mathaeum Xmum[2] capituli numerum pernotatum esse invenies, cum tres tamen evangelistae in ipsis duobus numeris qui sunt xv et vi tribus capitulis similia dixerint. Possumus autem et hos numeros aliter computare, ut quattuor numeros qui in primo canone continenter iiiior numerosos tramites in quibus multiplex capitulorum numeros describitur dictos esse intellegamus. Nam in primo tramite multiplex capitulorum numerus secundum Mathaeum pernotatur. Dehinc in secundo tramite alter capitulorum numerus secundum Marcum perscribitur. In tertio quoque tramite capitulorum numerus apud Lucam designatur.[3] Item postremo ordine iuxta Iohannem quartus capitulorum numerus exprimitur. Sicque ceterorum numeros canonum vel ternos vel binos sive quaternos pro diverso tramitis numero, in quibus multiplex capitulorum numerus conscribitur computare debemus. Sive igitur a laeva in dexteram, sive a summo ad imum in distinctum canonum seriem aciem oculorum direxeris, vel binos vel ternos vel quaternos capitulorum numeros designatos esse repperies. In quibusdam sane codicibus octavus canon ita diffinitur: Octavus, in quibus duo, Marcus, Lucas, cum aptius sit in[4] ipso octavo canone Lucas Marco praeponatur quomodo in nono id est Iohanni anteponitur.

6. *Et quidem subiectorum titulorum id est argumentum.* Subiectos titulos distinctas praetitulationibus canonum congeries usibusque subpositas dicit, quorum argumentum hoc est demonstrationem atque notitiam compendiose sed tamen obscure supra descripsit. Nam quamvis ipsorum numerum atque ordinem canonum ostendit nullam tamen rationem de ipso numero atque ordine reddidit.

7. Unde apte subditur: *Clara vero eorum narratio haec est.* Ut enim superius ipsos canones propriis diffinitionibus licet obscure descripsit, sic in subsequentibus eorundem utilitatem clara narratione demonstrat. Quid

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[1] Xmum cod. (with v written above m) [2] Xmum cod. (with a mark written above m)

[3] In tertio-designatur: Haec verba in margine codicis inferiore scripta sunt. [4] in in cod.

enim clarius est atque intelligendum facilius quam in evangelico volumine quemlibet canonem per minii colorem denoscere atque adpositum quodlibet capitulum ipsi canoni asscribere et reliqua.

8. Nam vide quod sequitur: *Etenim per singula loca evangeliorum quidam numerus videtur adpositus, paulatim incipiens a primo, deinde secundo, postremo tres,*[1] *et per ordinem librorum finem*[2] *usque progrediens.* Singula loca nominat quae sunt in evangelica voluminis corpore quorumlibet capitulorum capacia. Quibus locis capitulorum superscribendo adpositus est. Quique gradatim rationabili atque continuo numerorum ordine usque ad finem singulorum evangeliorum pertendit. Et notandum quod cum ipsum capitulorum numerum paulatim a primo incipere dicat, deinde secundo, non ait postremo a tribus licet id consequentia constructionis exigat. Sed maluit dicere postremo tres quod non sine subtilitate arithmeticae disciplinae posuit. Unum namque et duo principia et veluti quaedam semina sunt numerorum. Unum a quo omnes numeri alterum vero principium per quod universi numeri procreantur et incipiunt. Signanter ergo ait capitulorum numerum a primo incipere, deinde secundo, et non dicit postremo tribus. Non enim tria principium numerorum sunt, quomodo unum et duo. Quippe vero ternarius numerus totus sit atque perfectus habens principium et medium atque finem. Lege beati Augustini primum de musica librum.[3] Itaque post primum et secundum postremo iii esse in ordine dicit. In quo ex eo quod superius dixit, videtur adpositus, per syllemsin videntur adpositi, assumendum est ut plena sententia sic constet: postremo tres videntur adpositi. His autem verbis liquide ostenditur quod unumquodque evangelium quantum ad capitula pertinet non nisi suorum numerum capitulorum debet habere superscriptum. Nam cum dicit[4] per singula evangeliorum loca non quosdam numeros sed quendam numerum esse adpositum ipsumque a primo incipere, deinde a secundo et per ordinem numerorum usque ad finem librorum pertendere, hoc non nisi de propriis cuiusque evangelii capitulis intelligi potest. Non enim si numerus aliorum apud ceteros evangelistas capitulorum in uno quolibet evangelio adponatur, talem ordinem habere poterit ut paulatim a primo in fronte evangelii atque secundo incheet ac sine ordinis interruptione usque ad finem ipsius evangelii pertendat. Sed potius secundum Mathaeum verbi gratia primum capitulum,

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[1] tertio Fabricius. [2] ad finem Fabricius.

[3] Augustinus, De Musica, i, 12 (Migne, Patrologia Latina, 32, col. 1095). M. Dic itaque nunc, principium, medium, et finis, quo numero tibi contineri videantur. D. Arbitror ternarium numerum te velle ut respondeam: tria enim quaedam sunt, de quibus quaeris. M. Recte arbitraris. Quare in ternario numero quamdam esse perfectionem vides, quia totus est: habet enim principium, medium et finem.

[4] corr. supra scripta dicat.

iuxta Lucam quartum decimum secundum vero Iohannem et primum et tertium quintumque iuxta se capitulum sine continuata ordinis observantia habere pernotatum. At vero quod unum adpositum numerum cuilibet capitulo observata continuatione ordinis usque in finem cuiusque evangelii superscriptum esse pronuntiat. In hoc evidenter declarat quod unumquodque evangelium non nisi proprios suorum numeros capitulorum debet habere adnotatos.

9. *Itaque per singulos numeros suppotatio, per minii*[1] *ad*[2] *distinctionem invenitur incerta,*[3] *significans, cui decem,*[4] *titulis appositus numerus denoscitur.*[5] *Is*[6] *veluti siquidem primum, certum est in primo. Si vero secundum*[7] *in secundo, et eodem modo usque ad decem.* Dubium est utrum incerta praecedentibus an subsequentibus connectitur. Sed si praecedentibus copuletur talis sensus erit quod in evangelii volumine post capitulorum numeros incerta canonum supputatio rubicundo colore describitur. Ideo vero canonum supputatio incerta esse recte dicitur. Quia neque paulatim in fronte cuiuslibet evangelii a primo canone incipiens dehinc secundo ac per ordinem subsequentium canonum sine ulla interruptione usque ad decem progreditur. Sed modo tertius ante decimum modo decimus post quintum modo septimus ante decimum et ceteri ante vel post alios cannones sine certa ordinis observantia sparsim positi repperiuntur. Quae multiplex ordinis varietas usque ad ducentas formulas pervenit. Nam dum primus canon et sibi et aliis novem in evangelico volumine canonibus praeponitur decem varietas formulas efficit. Item dum idem et sibi et aliis praeponitur alias x varietates generat. Bis autem x in summam reductae xx fiunt. Nec dubitandum est quod ceteri novem canones dum singuli primo sibi dehinc aliis omnibus vel praeponuntur vel postponuntur xx novies variatas formulas efficere videntur. Licet non has omnes sed quasdam ex his varietates in ipso evangelio repperimus. Si vero incerta subsequentibus coniugatur facilis intellegentia patet. Quod canonum supputatio quae rubicundo colore describitur incerta capitula cuius canonis sint significet. Num si primum canonem ipsa per minium supputatio designet certum est ipsum capitulum in primo esse canone. Sin autem secundum canonem demonstret certum erit adnexum capitulum in secundo canone esse computandum atque ut ipse ait, eodem modo usque ad x canones singula quaeque in evangelio capitula cuius canonis fuerint. Per hanc supputationem certa ratione clarescent.

10. Sequitur: *Si igitur evoluto uno qualicumque de*[8] *quattuor evangeliis, cuilibet capitulo velis insistere et rescire, qui similia dixerint, et loca propria*

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[1] lineae Fabricius. [2] ad om. Fabricius [3] inserta Fabricius. [4] de decem Fabricius. [5] adsignetur Fabricius. [6] Is om. Fabricius. [7] secundum om. Fabricius. [8] cum Fabricius.

agnoscere singulorum, in quibus eadem sunt prolocuti eiusdem sensus, quem tenes, religens[1] *praepositum*[2] *numerum quaesitumque eum in titulo, quem demonstrat tituli subnotatio, continuo scire potueris*[3] *ex superscriptionibus,*[4] *quas in fronte notatas invenies, qui aut quot de his, quae inquiris, similia dixerint. Veniens etiam ad reliqua evangelia per eundem numerum, quem continent, videbis adpositos per singulos numeros, atque eos in suis propriisque locis similia dixisse repperies.* Illud primo notandum est quod haec narratio sive argumentatio ad novem tantum canones in quibus concordantia inter iiiior aut iii aut duo evangelistas cernitur non autem ad decimum canonem pertinere cognoscitur. Et quia haec narratio sua prolixitate simul et obscuritate implicita esse videtur prius nobis eam placet minutatim propter rudes quoslibet enucliare ac dehinc velut in pugillo brevi explanatione concludere. Si igitur, inquit, evoluto hoc est aperto uno quodlibet ex quattuor evangeliis cuilibet capitulo velis insistere, id est contra stare atque oppositis oculorum radiis ipsum capitulum conspicere. Sicque velis rescire rursum videlicet aliud quoque scire ac mente percipere. Qui vel quot evangelistae ipsi capitulo similia capitula vel sensa dixerint. Et si velis agnoscere loca propria singulorum quorum singulorum nisi capitulorum in quibus locis eadem sensa vel consimilia idem evangelistae praetulerint. Haec autem omnia continuo scire poteris. Primo quidem ex superscriptionibus ex canonum scilicet titulis superscriptis. Quos titulos in fronte atque exordio distincte canonun serie notos invenies. Et quid est quod per ipsos titulos cognoscere poteris? Illud procul dubio qui aut quot evangelistae de his sensis quae inquiris similia dixerint. Ita tamen illud denoscere valebis. Relegens tu hoc est in distincta canonum congerie iterum recitans. Quid est quod recitas? Eiusdem scilicet capituli atque eiusdem sensus quem in mente tenes propositum numerum id est ante in evangelio perspectum atque praecognitum, eumque postea numerum in titulo canonis subnotatio hoc est sequentis tramitis subscriptio demonstrat. Non enim canonum tituli subsequentes tramites capitulorum. Nam per canonum titulos qui aut quot evangelistae similia dicunt cognoscitur. Porro per subnotatos atque subsequentes tramites certus capitulorum numerus pernotatur, veniens etiam ad reliqua evangelia per eundem numerum. Id est ab ipsa canonum distincta congerie ad singulorum volumina evangelistarum per eundem numerum recurrens quia multiplicem capitulorum numerum quem sibi invicem esse oppositum in canonum congerie per distinctos tramites prius conspexisti. Ad reliqua evangelia ipso vario numero viam tibi praebente teque ad propria capitulorum loca ducente recurris. Quem varium capitulorum numerum continens in mente scilicet atque memoria colligens statim

[1] relegens Fabricius.
[2] propositum Fabricius.
[3] potes Fabricius.
[4] suprascriptionibus Fabricius.

eosdem capitulorum numeros quos ante in canonum subnotatis tramitibus conspexeras per singulos evangelistas hoc est per singula evangelia adpositos ac superscriptos esse videbis atque eosdem in suis propriisque locis evangelistas similia dixisse repperies. Sed ut in brevi quasi pugillo ceu promisimus totum huius argumentationis sensum concludamus tale est quod proloquitur. Nam postquam in evangelio ordinalem cuius libet capituli numerum cuiusque canonis sit ipsum capitulum ediscimus nos ad distinctam canonum seriem recurrere admonet. Quatinus ibi per praescriptos canonum titulos qui et quot evangelistae similia dixerunt primo cognoscamus. Dehinc ut ordinales capitulorum numeros et loca propria in quibus ipsa similia ab evangelistis sunt edita et subscriptis atque oppositis tramitibus intelligamus. Hisque cognitis postremo ad singulorum volumina per eosdem numeros capitulorum recurrentes ipsa propria loca in quibus similia ab istis evangelistis conscripta sunt repperiamus. Finit.

B.

Basel, MS. F. V. 33. Fol. 29 r°–31 v°.

Sedulii Scotti Explanatiuncula De Breviariorum Et Capitulorum Canonumque Differentia Et Connexione Deque Eorum Aequalitate Atque Inaequalitate Speculatio.[1]

1. Incipit breviarium cata Mathaeum. Nativitas Christi. Magi cum muneribus veniunt, et reliqua. Perquirendum nobis est quid inter breviarium quod a quibusdam brevis causa nominatur et capitulum atque canonem distet. His etenim tribus, quasi quibusdam clavibus, cuncta evangelici voluminis arcana reserantur. Nam sublatis breviariis capitulis et canonibus, omnia confusa erunt et ambigua, et quae sunt eadem, vel vicina, vel sola, et qui vel quot evangelistae in quibuslibet sententiis consonent, aut de quibus rebus edisserunt, hoc totum sine praedictis clavibus amphibolum erit. Itaque propriis differentiis haec tria ab invicem discernamus. Ergo breviarum est rerum in contextu evangelii narratarum subnixa et compendiosa diverso ad evangelium verborum stilo expositio. Capitulum vero est quaelibet in evangelio sententia seu narratio aliquem sensum vel ex parte vel ex toto exprimens in quolibet comprehensa canone. Porro canonem certa observatio seu titulus, quo cognoscitur quis vel qui et quot evangelistae unumquodque capitulum ediderunt. Ob quas vero causas haec tria reperta sunt diligentius intimemus. Nam breviarium ob hoc est repertum, quatinus ipsae res, quae in evangelico volumine narrantur, hoc praemisso atque considerato lucidius patescant, ut quod in evangelio quisque invenire desiderat, breviariorum

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[1] Cf. *supra*, p. 64.

consideratione, cum summa facilitate repperiat. Canones autem ob hanc causam notati sunt, quatinus ut supradiximus, eorum distinctione qui et quot evangelistae eadem vel vicina vel sola in evangeliis capitula dixerunt, agnoscatur. Sed capitulorum causa multiplex esse animadvertitur, de qua suo loco in sequentibus competenter disseretur.

2. Illud praeterea sciendum quod capitulum sine canone, et canon sine capitulo, per totum evangelii contextum esse non possunt. Nam haec duo sibi invicem inseparabiliter connexa sunt. Licet enim qualibet scriptorum neglegentia fieri potest, ut quodvis capitulum numerum sui canonis non habeat superscriptum, re tamen et veritate aliquo canone carere non potest. Cum necesse sit ut unus aut duo aut tres seu quattuor evangelistae ipsum capitulum pronuntient. At vero breviarium sine canone et capitulis superscriptis, licet non absque capitulorum sensu, consistit. Non enim in breviario qui vel quot evangelistae quemlibet sensum edisserunt, neque capitulorum numerus perquiritur; alioquin qui quomodo contextui evangelico sic et breviario uterque numerus canonum atque capitulorum scribendo adponeretur. Quod quia non agitur, manifestum est quod illud in breviario proprie discitur, ut quae in evangelii contextu diversis capitulis atque canonibus multiplici narratione exponuntur, ea in breviario, quasi quodam pugillo, brevi assertione demonstrentur.

3. Sed ut breviarium sine canone et capitulis consistit, sic et capitula sine breviario posita repperiuntur. Nam in exordio evangelii secundum Mathaeum, in quo ter XIIII, hoc est XLII, generationes describuntur, duo capitula duoque canones, tertius videlicet ac decimus canon, absque breviario includuntur. Siquidem in eo quod subsequitur, Christi autem generatio sic erat, et reliqua, initium breviarii exorditur. Nam ibi nativitas salvatoris exponitur. Cur autem non a principio XL et duarum generationum, breviarium evangelii secundum Mathaeum sumit exordium, perspicaciter investigandum est. Poterat enim tale breviarium, nulla obsistente ratione, sic constare, XL duarum generationum enumeratio, nativitas Christi, et reliqua; sed propter nativitatis dominicae excellentiam, idcirco ab ultima id est quadragesima secunda generatione seu nativitate salvatoris, exordium breviarii sumpsit. Nec mirum si in breviario sicuti quaedam in breve colliguntur, ita nonnulla causa brevitatis omittuntur, cum utrumque breviarii sit proprium; alioquin breviarium non erit breviarium. Et quia pro captu nostro breviter exposuimus quae ex his tribus sibi invicem connexa sunt, quaeque sine invicem inveniri possunt, nunc consequens esse videtur quatinus de illorum aequalitate (atque inaequalitate)[1] quaedam disseramus.

[1] Verba in uncinis inclusa in codicis margine scripta sunt.

4. Itaque sciendum est quod in evangelico contextu tria supradicta sibi invicem aequalia repperiuntur. Nam[1] octavum cata Mathaeum breviarium quod est: In navi eum dormientem excitant discipuli ut tempestatem sedaret. Et in terra Gerasenorum daemonia eicit. Unum capitulum hoc est LXVIIII[2] atque unum canonem scilicet duo in sese continere videtur. Unde manifestum est breviarium capitulum, capitulum canonem aequales terminos aliquando possidere. Sed horum trium aequalitas uniformis est. Inaequalitatis vero differentiae tres principaliter inveniuntur. Aut enim singula singulis aut singula binis aut bina singulis quantitate praeferuntur. Sed singula singulis tribus modis praelecta fiunt. Nam breviarium quamvis neque solum canonem neque solum capitulum sua magnitudine excellit. Item capitulum licet neque canonem tamen breviarium intranscendere invenitur. Canon quoque aliquando capitulum sed raro breviarium transgreditur. Quae omnia quisquis scire voluerit evangelicum volumen inspiciens facile repperiet.

5. Singula vero binis duobus modis praeferuntur. Nam licet capitulum canonem simul ac breviarium non transcendit, tamen aut quattuor breviarium capitulum atque canonem, aut quinque canon breviarium atque capitulum superat. Quod ut facilius[3] intellegatur quibusdam exemplis approbetur. Siquidem breviarium capitulo et canone lectius invenitur. Nam verbi gratia primum evangelii secundum Mathaeum hoc est: Nativitas Christi. Magi cum muneribus veniunt, et Ioseph ab angelo per visum ammonitus cum puero et matre eius in Aegyptum fugit. Infantes interficiuntur. Tres canones hoc est quintum septimum decimumque canonem. Quattuor etiam capitula tertium scilicet et quartum quintum quoque aut sextum capitulum conplectitur. Item canon breviarii et capituli metas transcendit. Quoniam secundus canon septimum iuxta Lucam breviarium quod est Lairi filiam dum iret resuscitare mulierem a profluvio liberat puellam vivificat, et aliquam octavi breviarii partem quattuorque capitula id est LXXXV et LXXXVI et LXXXVII et LXXXVIII ordine continuo conprehendit. Porro capitulum licet breviarii terminos transcendere invenitur. Non tamen cuius libet canonis formam transgreditur. Quia nimirum omne in evangelio capitulum necesse est ut in aliquo canone sit conclusum. Sed quod dicimus aliquo exemplo nos approbemus. Itaque LXXXVIII secundum Iohannem capitulum in decimo canone computatur. Nec eius terminos excedit. Quod prorsus capitulum et tota cum breviarium hoc est Iesus interrogatus principium se esse respondit quod omnis peccator servus sit et quod Iesus ante Abraham sit. Caecum ex nativitate curat. A noni breviarii primam particulam id est de ianua et ovili

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[1] Sic corr. superscr.; Non cod. [2] Sic corr. superscr.; LXVIII cod. [3] facius cod.

in se concludit. Tertia inaequalitatis differentia qua bina singulis quantitate praeferuntur ultimo in loco ad discutiendum restat. Haec autem sit duobus modis. Nam quia breviarium simul et capitulum canonis terminos transcendere nequeunt aut VI breviarium et canon aliquod capitulum aut VII capitulum et canon aliquod breviarium sua quantitate transcendunt. Nam breviarium simul et canon capituli metas supergrediuntur. Si quidem decimum secundum Matthaeum breviarium quod est XII apostolos praemittit cum omni doctrina ac dicit quod non venit pacem mittere in terram sed gladium multa capitula concludit. Necnon II canon in ipsis primordiis non unum sed duo capitula comprehendit. Itemque capitulum et canon breviarii terminos transeunt. Si quidem LXXXVIII secundum Iohannem capitulum decimumque canon eidem capitulo adpositus octavum breviarium quod supra commemoravimus sua quantitate transcendunt.

6. Horum itaque trium id est breviarii et canonis atque capituli modi inaequalitatis licet usque ad Xmum pertendere videantur, tamen quia in evangelio nec breviarium solum absque capitulo canonem neque solum sine canone capitulum et neque capitulum canonem transcendit neque etiam capitulum canonem simul ac[1] breviarium excellit, neque breviarium simul et capitulum canonis terminos transcendere possunt. In breviario et capitulo atque canone septem solum modo inaequalitatis modi in evangelio repperiuntur. Quae omnia si quis iiiior evangeliorum volumen perspicaciter inspexerit ex superexscriptione breviariorum canonum quoque atque capitulorum adnotatione incunctanter cognoscet. Illud quoque sciendum est, quod cum canones et capitula aliquando in principio, aliquando in medio, nonnumquam etiam prope finem cuiuslibet sensus adnotentur, breviaria nonnisi in primordialibus sensuum locis exordiuntur. Unde evenit ut ipsa breviaria saepe in principio, aliquando in medio, nonnumquam etiam prope finem capitulorum, sed tamen in principio sensuum, exordia sumant.

7. Postremo animadvertendum est quod haec tria breviarium scilicet capitulum canon alia in se tria hoc est eadem et vicina atque sola sensa contineant quae singula quattuor species habent, quae sunt praecepta mandata testimonia exempla. Unde quidam egregius doctor has quattuor species distinguens: Quattuor, inquit, evangelicae doctrinae praecipuae formae sunt, praecepta mandata testimonia exempla. In praeceptis iustitia in mandatis caritas in testimoniis fides in exemplis perfectio consistit. Praecepta sunt ut est illud: Tunc Iesus praecepit discipulis suis in viam gentium ne abieritis et reliqua: hoc est devertere a malo. Mandata sunt ut: Mandatum novum do vobis ut diligatis invicem, hoc est facere bonum et caritatem implere.

[1] Sic corr. in margine; a cod. [2] Sic cod.

Testimonia sunt quae in ore duorum vel trium testium stant, ut est illud: Iohannes testimonium perhibet de me, sed habeo testimonium maius Iohanne. Pater ipse qui in me manet testimonium perhibet de me, et ipsa opera quae ego facio testimonium perhibent de me, et testimonium perhibeo veritati. Exempla vero sunt quae Iesum imitantur dicentem: Discite a me quia mitis sum et humilis corde et reliqua. Estote perfecti sicut pater vester caelestis perfectus est. Et alibi exemplum enim dedi vobis ut et vos faciatis aliis. Has quattuor qualitates psalmigraphi versus concinant dicentes: Praeceptum Domini luci dum illuminans oculos. Et alibi laetum mandatum tuum nimis quia qui diligit proximum totam legem implevit. Item testimonia tua intellexi et testimonium Domini fidele. Item iudicia Dei vera iustificata in semet ipsa quae nobis exempla recte iudicandi praemonstrant. In his iiiior hoc est praeceptis testimoniis exemplis mandatis timor fides spes caritas includuntur. Timore namque incipimus, fide servamus, quod incipimus spe erigimur, caritate consumamur.

IV.

ARCHAEOLOGICAL EVIDENCE FOR THE INTERCOURSE OF GAUL WITH IRELAND BEFORE THE FIRST CENTURY.

BY GEORGE COFFEY.

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A PAPER on some monuments of the La Tène Period, which I had lately discovered in Ireland, and which were the first of that class known in Europe, was read before the Academy in 1903.[1] These interesting stones (three) were there described and fully illustrated in detail. I may recall a few general observations made.

It has been a habit of mind with English archaeologists to regard the periods in Ireland as later than those in Britain and the styles as derived therefrom.

This theory is based on the assumption that Ireland, lying more remote from the Continent than Britain, was less within the reach of Continental influences in early times. I had, as I remarked, combated this view elsewhere.[2] Many Bronze Age types in Ireland contradict it. The geographical argument must be used with caution. Trade does not always follow the lines of nearest geographical approach. Even in early times it is chiefly determined by the objects sought, and by the positions of meeting centres or markets. The frequent intercourse between Ireland and Gaul in early Christian times—fifth to seventh centuries—was mentioned. Intercourse by way of the Loire was recognized. We hear of the first Irish Christians at Auxerre, at Autun, at Luxeuil; and Irish trade was known at Nantes in the sixth century. This was probably an old way long in use. In Roman times Ireland was believed to be between Britain and Spain, and is mentioned by Tacitus as "favourably situated as regards the Gallic Sea."

The stones, which are from different parts of the country, were of the same general period; but one I thought might be late, approaching 400 A.D.; the other two were certainly earlier, and one of them I definitely ascribed to La Tène II, both from the border of fret-pattern on the base, and the free scroll-forms of the general ornament: the trumpet-ends not yet being a

[1] Proc. R. I. A., vol. xxiv., Sect. C, p. 257.

[2] Journal R. S. A. I., vols. xxiv.-xxvii. "Origins of Prehistoric Ornament in Ireland." See also "Irish Copper Celts," Journal of Anthropological Institute, vol. xxxi., p. 265, and "Copper Halberts," Proc. R. I. A., vol. xxvii., sect. C, p. 94. See especially p. 111.

a separate motive. This may perhaps be somewhat early; it may be coming to a transition to La Tène III. It may be compared with the pattern on the shields from the Thames and the River Witham[1] attributed to La Tène II.

That the La Tène style was distributed in Ireland before the Christian period I had held to be probable, chiefly on the ground that the derived La Tène ornament of early Christian times presumed an extensive use of that style in the preceding period. These stones went far to confirm that opinion, and may be claimed as showing that the La Tène style had taken a deep root in Ireland before the Christian period, and was not to be accounted for by trade or raid from Britain.

Last year Professor Zimmer, who does not appear to be acquainted with my papers, wrote an important article upon the ancient trade connexion of West Gaul with Ireland.[2] He sums up in a passage the prevailing error to which I have referred:—"This erroneous view is widespread, even in learned circles that ought really to know better; and during the past decades it has proved baneful for many problems of Irish and British archaeology. Now, this erroneous view is quite naïvely and openly expressed, and brought forward as the *ultima ratio* for unproved statements; now, as a self-evident truth, it forms the basis of scientific theories of present-day investigators of repute; nay, examined closely, it turns out the sole mainstay for such theories."

He gives numerous instances of early trade-relations between West Gaul and Ireland. Leaving upon one side the well-known intercourse between Ireland and France and Spain in the sixteenth to the eighteenth centuries, he proceeds to examine various evidence of Ireland's connexion with West Gaul from the time of Giraldus Cambrensis (born 1147) back to Tacitus. He mentions at length the expulsion of St. Columbanus from Luxeuil in the sixth century, and quotes, from the high authority of the Life, an almost contemporary MS., the passage "Reperta ergo navis quae Scottorum commercia vexerat, omnem suppellectilem comitesque recepit"—an indication this of the direct trade with Ireland.[3] He gives instances from the same time of the Gaulish wine-traders carrying their wares up the Shannon as far as the centre of Ireland. He then gives the passage in Tacitus quoted by me in my paper, "The Origin of Prehistoric Ornament in Ireland," as to the position, size, climate, and population of Ireland as compared with Britain,

[1] Horae Ferales, Plates xiv. and xvi.: B.M. Guide. Iron Age, p. 93.

[2] Sitzungsberichte der Königlich Preussischen Akademie der Wissenschaften, 1909, pp. 363 and 364.

[3] As Prof. Kuno Meyer points out, it is a long-established fact that "Scotia, down to the tenth century at least, was never used of Scotland, but always meant Ireland." See Transactions, Cymmrodorion Society, 1895–6, p. 60.

and argues from this passage that a lively trade must have existed between Gaul and Ireland at that period.

Professor Zimmer concludes that a brisk direct export and import trade connexion existed in the first century between Ireland and the West Gaulish ports at the Loire and Garonne mouths.

We may quote the following from among Professor Zimmer's concluding remarks on this portion of his argument:—"The present investigation has, indeed, its own object; but it pursues besides that of partly supplementing now, by facts, a later investigation which will expose the credulousness and short-sightedness which lie at the root of the dogma of the immigration of the Gaels to Ireland by way of Britain; and I suppose I may at least claim, from what has been proved up to the present, that the view referred to should not be brought into the field against me as a proof of an intermediary rôle played by Britain." (p. 380.)

As this point is important, I may be permitted to mention that, as far back as 1895, I had reached on archaeological grounds a similar conclusion. When discussing the passage in Tacitus, I concluded: "But putting aside preconceived ideas based on the relative positions of the two islands with respect to the Continent. . . . taking into consideration the belief then existing that Ireland lay between Britain and Spain, which seems to imply a southern branch of trade with Ireland, as distinguished from the cross-channel trade with Britain and Gaul; . . . looking at the map of Europe, we can readily understand that, to ships from the south, Britain would appear to lie north of Ireland. . . . The cross-channel trade between Gaul and Britain was in the hands of the Veneti, and it is probable that a sea-going trade from the more southern parts of Gaul and probably Spain, would be directed to the south-west of Britain and to Ireland."[1] It thus appears that Professor Zimmer has reached a similar conclusion. He handles the passage in Tacitus in a striking and novel way, and has supplemented it by giving much evidence of definite details which his great knowledge of ancient Irish literature renders of much importance.

The tales included in the ancient literature of Ireland are too often regarded as romancers' inventions, and dismissed with a superior smile as unworthy of the attention of serious historians. But there have always been people in Ireland who have paid attention to these ancient tales; and now that a more critical spirit has at length been brought to bear upon them by archaeologists and scholars, such as Sir John Rhys, Professor Ridgeway, and Professor Meyer, they have been shown to contain many important and

[1] Journal Royal Soc. of Antiquaries of Ireland, vol. xxv., p. 27.

reliable details on the "History of Ireland," though mixed with fabulous matter. One of the most interesting tales is the story of the return to Ireland of Labraid Loingsech with an army of Gauls, about 300 B.C., from which time I am inclined to date the general use of iron weapons in Ireland, though some iron weapons may have reached the island before. This tale has been critically examined with regard to the Gauls by Professor D'Arbois de Jubainville in an admirable paper, in the "Revue Celtique," vol. xxviii., where the chief incidents are told.[1]

Two somewhat different versions have come down to us from before the twelfth century. One, of which we have several more or less full copies, is translated by Whitley Stokes from the fullest copy in the "Book of Leinster," a MS. of the twelfth century. (Zeitschrift für Celtische Philologie, Band III., s. 1.) The other from the Scholia of the Amra Choluimb Chille, also translated by Whitley Stokes from a twelfth-century MS., "Revue Celtique," vol. xx., p. 30. There are also several other texts of this version mentioned by him. Though there are differences in the stories as told in the two versions, the main facts with which we are concerned substantially agree.

Cobthach Coel Breg, having murdered his brother and nephew, secured the supreme kingship. Ultimately Moen, his grandnephew, subsequently called Labraid Loingsech (the exile), took refuge in Brittany amongst the men of Menia, identified by M. D'Arbois de Jubainville with Menapia.

The King of Menapia gave his friendship to Labraid, who was made known to him as the son of the King of Ireland; and in time sent him back to recover his kingship. He returned with a number of Gauls in 300 ships, and landed on the east coast of Ireland.

This is very interesting, as M. D'Arbois identifies the men of Menia with the Gauls of Menapia established on the Continent; for the Irish did not pronounce the letter *p*: so Mena(p)ia becomes Menia. The word 'Menia' occurs in an important fifteenth-century vellum MS. in the British Museum (Egerton, 1782). In others the passage was not understood and probably corrupted. Thus Menia became Morca; and we are told how Labraid went eastward till he reached the Island of the Britons and the land of Armenia. The expression *tir fer Menia*—'land of the men of Menia'—becomes easily *tir Armenia*; and Menia was sometimes corrupted into Morca (see D'Arbois de Jubainville).

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[1] Reprinted in the Introduction to M. D'Arbois' translation of the Táin:—"Enlèvement du Taureau Divin et des Vaches de Cooley. La plus ancienne épopée de l'Europe occidentale."—Livr. i., Paris, 1907. As these pages were passing through the press, M. D'Arbois de Jubainville passed away in the fulness of years, an irreparable loss to Celtic studies which he did so much to foster both in France and in these countries. The translation of the Táin, of which only a portion has appeared, occupied the last few years of his life.

The Menapii are shown by Ptolemy (second century), as M. D'Arbois points out, located on the south-eastern side of Ireland, about Wexford in Leinster. They were no doubt portion of the Menapia, a people of Belgic Gaul. In the time of Ptolemy the Brigantes, a similar people, are placed slightly to the south of them in Ireland.

The date of the destruction of Dind-ríg and death of Cobthach is fixed by the Four Masters at 542 B.C. There appears to be some error about this date, though a dindšenchas of Leinster supports it, stating it was 500 years before the birth of Christ that it took place. But in the copy of the story of Labraid, translated by Whitley Stokes, already referred to, from the Book of Leinster, and from other texts of this version, the date is given as 300 B.C.[1] Another passage puts it at 307 B.C.

In an estimate of thirty years for a generation, from the date of Ptolemy son of Lagas, who appears to be contemporary with Ugaine grandfather of Cobthach, M. D'Arbois fixed 216 B.C. for the massacre of Dind-ríg. The counting of thirty years to a generation is too high, considering the fact of the murders, so we can say some time in the third century as a sufficient date.

The coming of the Gauls with iron lances soon became a fixed belief: the explanation of Laigin (Leinster), where the Gauls were settled, was in this manner usually explained; the references to it are very definite.

Thus, at the conclusion of the Orgain Dind-ríg in the Book of Leinster, the scribe writes: "Labraid . . . brought many foreigners with him [to Ireland], to wit, two thousand and two hundred foreigners, with broad lances in their hands, from which the Laigin [Leinstermen] are so called."[2]

In the version of the story in the scholia of the Amra Choluimb Chille it is said with equal definiteness:—"Then the exile seized the sovranty of Ireland; and he was the first to make broad blue lances [laigne], whence the Laigin [Leinstermen] are named."[3]

We find also in the dindšenchas of Leinster this constantly referred to in similar words. The prose accounts give some poems as authorities, presumably somewhat earlier. Two from the Book of Leinster will be sufficient; but there are many allusions to Labraid and the lances scattered through the literature and tales.

[1] On errors of dates in the Four Masters see the Rev. Dr. MacCarthy's Todd Lectures, Lect. II., p. 185, also Lect. III., pp. 281 and 301, in which he goes fully into the subject.

[2] Zeitschrift fur C. P., vol. iii., p. 14.

[3] Revue Celtique, vol. xx., p. 433.

Thus in Lagin I. :—

From the day he was slain (this is sooth)
even Cobthach Cael, with his thirty kings,
till the birth of the Son of Mary
is five hundred years ever pure.

. . . .

There came on the march to that slaying
Labraid and thirty hundred of the Dub-Gaill
in their battle-harness, warlike and staunch,
with their deep-blue lances.

From those lances thenceforth
were the men of Leinster called the Spearmen;
at the hand of the Dumb Exile, with heavy disaster,
by these lances Cobthach Cael was slain.

In Lagin II. :—

Labraid the Exile (full his number),
by whom Cobthach was slain at Dindrig.
came with a lance-armed host over the sea-water;
from them Lagin was named.

. . . .

Two and twenty hundreds of the Gall
came oversea having with them broad lances;
from the lances that were carried there—
thence the men of Lagin get their name.[1]

Among the iron spear-heads found from time to time throughout the country, there are some which are regarded by most collectors as the immediate successors of the bronze spear-head. Their often unsightly or fragmentary state causes them to be neglected and thrown aside by the amateur. They may, however, be generally distinguished from the Norse or Danish spear-heads also found in the country; and the La Tène character of some of them is clearly marked. I think we are justified in regarding fig. 1 as an example of the broad blue lances from which Leinster took its name. It is 13 inches long, and must have been $4\frac{1}{2}$ inches broad; the exact place of finding is not recorded, but it was found in Ireland, probably during the Shannon excavations. Fig. 2 is a good La Tène spear. It was found at Corofin, county Clare, and is the property of Mr. Mark Pattison; the

[1] Edward Gwynn, the Metrical Dindshenchas, part ii., R.I.A. Todd Lecture series, vol. iv., pages 51 and 53.

borders of the small openings or double eyes in the blade are inlaid with bronze; and it has a sort of fret-form round the base. Some narrow spears are also known which cannot be assigned to a definite period; their La Tène aspect is apparent; and they are probably not later than the first few centuries A.D. Fig. 3, found in the River Boyne, is an example of these. It has some eye-centres at the base of the blade, set some with red and some with yellow enamel; also the fine long spear, fig. 4, found in the bed of a stream at Mulloughmore, county Roscommon.

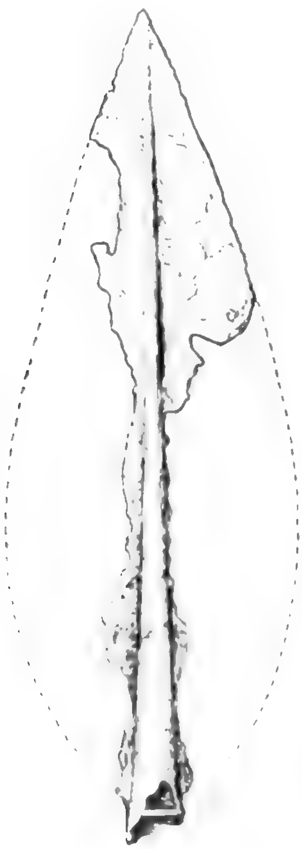

Fig. 1
La Tène Spear-head, Ireland ($\frac{1}{3}$).

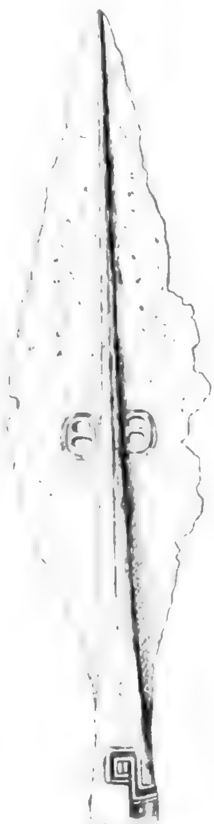

Fig. 2.
Corofin, Co. Clare ($\frac{1}{2}$).

Fig. 3.
River Boyne ($\frac{1}{4}$).

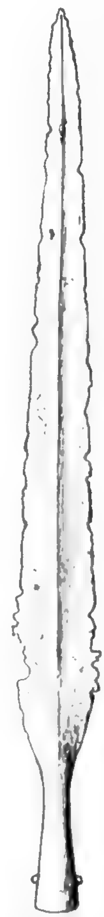

Fig. 4.
Mulloughmore, Co. Roscommon ($\frac{1}{4}$).

The remarkable La Tène crannog of Lisnacroghera, county Antrim, has yielded quite a series of objects consistently La Tène in character. These include four sword-sheaths; three are at Belfast; and one from the Green-well collection is in the British Museum: iron spear-heads and "door-handle" butts; also several small objects. One of these when found was attached to the shaft of a spear 8 feet long, which was furnished at the top with a ferrule of bronze upon which was displayed a kind of Greek fret-pattern prepared for enamel; the spear-head was missing; but Mr. Wakeman, who, with Canon Grainger, obtained it on the spot from the person by whom it had been exhumed, considers that the large iron spear-head figured in his paper was it (Journal R.S.A.I., vol. xvi., p. 392). It measures about 16 inches in length, and the breadth of the blade 2 inches. This discovery would seem to contradict the guess in the British Museum Guide to the Iron Age (p. 147), which is disposed to consider these door-handle butt-ends of spears as having been the linch-pins of chariots rather than the butt-ends of spears.

Mr. Knowles has in his collection from Lisnacroghera several bronze butt-ends of spears, also a fragment of a slender twist gold torc. There are also several smaller spear-heads found there like fig. 5, which was found at Carrick-on-Shannon.

FIG. 5.—Carrick-on-Shannon (½).

The date of the finds can hardly be later than La Tène II. It is to be regretted that the crannog was not properly excavated, and that the discoveries were left to the chance finds of the turf-cutters, and so much scattered. They may indicate the landing of a body of Gauls direct from the Continent. The Brigantes settled in the north of England, about Yorkshire and Lancashire, were probably a branch of the Brigantes whom Ptolemy locates at Bregans on the east of Lake Constance. The Brigantes of the south of Ireland were probably another branch coming, as I think, directly from the Continent. We must disabuse our minds of the old notion that the movements of the Celtic peoples always took place as a hydrostatic wave filling up the neighbouring parts. This idea is derived from the error, on which Professor Zimmer comments so forcibly, which regards all Continental influences in Ireland as given through Britain. When Caesar defeated the Helvetii, and turned back the survivors to their old lands near Lake Geneva, from which they had advanced on their march as far as Autun, the whole nation was setting out on a long journey to new lands in the west, and had burnt their homes and the corn which they could not take with them, and had *made arrangements for passing through the intermediate lands.*

Three bronze horns (fig. 6) were found at Cork last year, below the old river bottom, in making some works in the park. They are about 9 inches long, and consist of three funnel-shaped straight tubes of bronze; their points are smooth and neatly rounded. Their mouths have a flange and rivet-holes in it: two are sloped across at an angle; the third is straight. They have fine riveting down the back, and one is turned in the figure to show this. When found, the centre one was said to have been joined to one of the others by the small piece seen attached to it. Round the mouths of each is a band of La Tène ornament, the characteristic form of which cannot be mistaken. The absence of any dividing mark or trumpet-end in the space where the curves expand inclines me to place them not later than the first century B.C., if so late. Their exact use is a little uncertain. I have written to some of the most eminent archaeologists in Europe who are well acquainted with the chief collections of La Tène objects; and they suggest that they were the horns of a helmet like those on the helmet found in the Thames (fig. 67, p. 88, in the British Museum Guide to the Iron Age). I agree with this; it may have been a helmet or head ornament arranged somewhat like fig. 6.

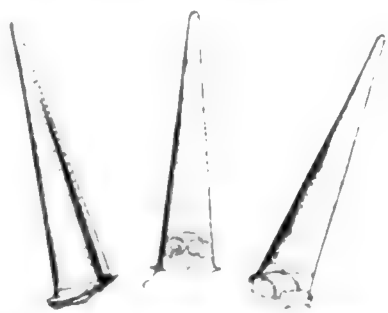

Fig. 6.—La Tène horns found at Cork.

The pair of bronze bits and bronze head-stalls—as the latter are called—from Roscommon present good La Tène ornament. They show the distribution of La Tène finds throughout the country, though many of the horse head-stalls, of which there are numerous examples, seem to be later. Professor Ridgeway, "Origin and Influence of the Thoroughbred Horse," p. 492, has given the best suggestion of the use of these curious objects. He considers them to be rein guides for chariots, similar to those attached to the chariot found at Thebes, and now in the Archaeological Museum at Florence.

The number of trumpets found in Ireland is quite astonishing; but they mostly belong to the end of the Bronze Age. There are, however, three bronze trumpets of the La Tène period: the ornament on the disc of one is certain and fairly early. It was found in a bog on the borders of Lough-na-shade, near Armagh. The other trumpets have spiked ornament round their ends, and in several cases have been found in numbers of two and three together. There were several discovered in the Dowris find, in the same find as bronze spears and other objects but none of iron; so the date is approximately certain, and they seem to have preceded and led into the La Tène period. Some of these trumpets have a long, straight tube, which fits to the narrow end of the curved portion; the upper end of this tube has also four rivet-holes, to which another tube or mouthpiece may have been fixed. This form, with a straight tube and curved end, is the *lituus* of the Romans.

FIG. 7.—Cornu and Lituus, from a bas-relief at Aquila. First century B.C.

The Romans are believed to have adopted this form of trumpet from the Etruscans, who were in contact with the Celtic tribes of Gaul from an early period. Polybius, describing the defeat of the Celts by the Romans at the battle of Telamon, B.C. 225, speaks of the "innumerable horns and trumpets" of the Celts (Gaesatae, Insubres, Taurisci and Boii).

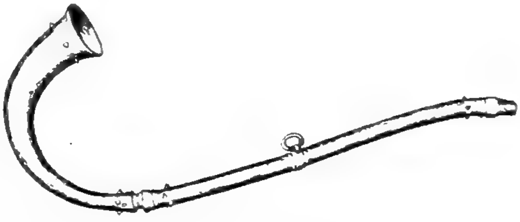

FIG 8.—Trumpet in two parts found with six others near Tralee, Co. Kerry.

A bronze lituus, found in an Etruscan tomb at Cerveti, is preserved in the Vatican Museum; and representations of similar trumpets occur on other Etruscan tombs. Several of the Irish horns are open at both ends, and have rivet-holes at the narrow end; they are probably the curved portions of trumpets of this form, of which the straight tubes are lost, though possibly some other form of attachment may have been in use.

If these trumpets are supposed to be in any way connected with those mentioned by Polybius, though the Irish horns are no doubt much earlier, the great number of them, their form, and their well-nigh complete absence from Britain, may indicate a movement of Celtic people from Northern Italy by the Rhone Valley across Gaul to the south and east of Ireland before the time of Tacitus by the way suggested by Professor Zimmer.

This was an old route, and probably known back into the Bronze Age.

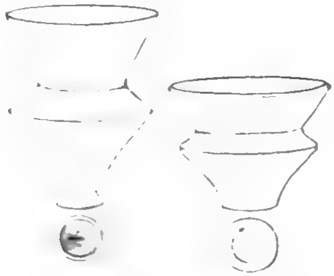

Fig. 9.
Marne. Greenhills, Co. Dublin.

I may add that the shape of certain sepulchral urns found near Dublin recalls the early La Tène pottery from the Marne district, though the ornament is different, and no correspondence of dates is assumed. The straight and angular lines of the wide funnel-shaped mouths and sides narrowing towards the bottom, which is recessed with an annular foot (suggesting a metal model), may be noticed: but it would take me too far to go into this question more fully in the present Paper.

We see, therefore, that the result of the archaeological conclusions in this Paper hardly supports the statement commonly made in all school-books, that the Gael came to Ireland through Great Britain; but they strongly support Professor Kuno Meyer's contention to the contrary, in his Paper on the "Brython and Gael," in the Cymmrodorion Society's Transactions, 1895–96.

V.

SCANDINAVIAN OBJECTS FOUND AT ISLAND-BRIDGE AND KILMAINHAM.

By GEORGE COFFEY and E. C. R. ARMSTRONG.

Plate IV.

Read February 14. Ordered for Publication February 16. Published May 24, 1910.

In vol. x. of the Proceedings of the Royal Irish Academy, 1866–69, there is a report of a paper read December 10th, 1866, by Sir William Wilde, Vice-President, "On the Scandinavian Antiquities lately discovered at Islandbridge, near Dublin."

The report states that "Sir William Wilde, Vice-President, brought under the notice of the Academy an account of the Antiquities of Scandinavian origin, lately found in the fields sloping down from the ridge of Inchicore to the Liffey, and to the south-west of the village of Islandbridge, outside the municipal boundary of the city of Dublin, where, there was reason to believe, some of the so-called Danish engagements with the native Irish took place. These antiquities consisted of swords of great length, spearheads, and bosses of shields, all of iron; also iron knives, smiths' and metal smelters' tongs, hammer heads, and pin brooches, &c. Of bronze there were four (pair) very beautiful tortoise-shaped or mammillary brooches found, likewise some decorative mantle pins and helmet crests of findruin, or white metal; beams and scales of the same material, and leaden weights, decorated and enamelled on top, and in some cases ornamented with minerals."

A further description of some of the objects follows and some remarks upon the pattern of the swords.

The question as to the conditions of the find was next considered, and the report goes on:—

"The circumstances under which the osseous remains and the accompanying relics were found were well worthy of consideration. The surface of the great pit from which the macadamizing material of Dublin was being procured, which was about twenty feet in section, consisted of a layer of dark, alluvial soil, varying from eighteen inches to two feet in depth. Upon the gravel bed on which it rested were found several skeletons; and among their bones, both above and below them, were discovered the different articles referred to. It would appear that they were worn by or were in the possession of the persons to whom these skeletons belonged; but there was no evidence of 'interment' having taken place; and, from all the attendant circumstances, the investigator was left to believe one or other of two suppositions: the first was, that the bodies were buried in all the panoply of war, with their weapons, offensive and defensive, and their armour, decorations, tools, and implements upon them—either hastily after a battle, or according to the usage of the people to whom they belonged—which latter was not only unlikely, but, from the shallow surface of the soil covering them, most improbable. The other and most likely conjecture was, that these Scandinavian invaders were killed in battle or some sudden skirmish, and lay there on the lightly covered gravel field, on the south side of the Liffey, until the birds of prey picked their bones, and the weeds, grass, and soil accumulated over them during the last eight or nine hundred years."

The report gives a list of the articles found, which included five complete iron swords, much corroded, but with handles, and a decorated sword-handle, six spear-heads, four shield-bosses, a white metal helmet-crest, several knife-blades, a sickle-like hook, hammer-heads, shears, and tongs, several large-headed nails, and other pieces of iron, together with sharpening stones, spindle-whorls, and various articles of household economy. There were also found two pairs of scales, ten decorated weights, mantle pins, brooches, jewelled studs, a miniature battle-axe of white metal and an ornamented bronze strap buckle. In all about seventy-eight specimens, together with a large quantity of human bones, but no perfect skull.

Illustrations in the text are given of the decorated sword-hilt, the white metal helmet-crest, five of the weights, the miniature battle-axe, one portion of a tortoise-brooch, and a portion of the bronze strap.

It is forty-four years since Sir William Wilde's account was published; and Mr. Coffey had long wished to get the objects arranged and published. The principal ones had never been illustrated, and were so covered with rust that the ornamented sword-hilts were quite concealed. The importance of the find as the largest collective one of Norse or Danish objects found in Ireland, as well as the fact that the conclusions arrived at in Sir W. Wilde's paper seemed to require reconsideration, suggested a full publication of all the objects, together with those found at Kilmainham and the neighbourhood. The recent appointment of an assistant to Mr. Coffey rendered this more feasible, and all the objects of these finds are now fully displayed in the Museum.

Sir William Wilde's list of the antiquities procured in this find commences with the swords, which are described as "Five complete iron swords, much corroded, but with handles; also a decorated swordhandle. They are numbered 2356, ——7, ——8, and ——9, and also 2360 and ——61, in the New Registry."

The identification of the swords has been rendered somewhat difficult, as in the New Register, 1866, the numbering of the swords and sword-hilt are somewhat different from that mentioned in the paper. The numbers run 2356, 2357, 2358, 2359, and 2391. No. 2360 is a spear-head, and 2361 a shield-boss.

Mr. Wakeman, while working in the Museum, labelled seven swords as having been found at Island-bridge. Of these seven only one (No. R. 2356 and Wk. 20) has a registered number attached to it; but three others have been identified by measurement with the numbers 2357, 2359, and 2391, in the Register. No. 2358 is stated in the Register as being 33 inches long. Wk. No. 15, which is $31\frac{3}{4}$ inches long, agrees in all the other measurements and description with No. 2358, and seems to be the sword which has lost a little of its length.

These seven swords are numbered:—

1. R. 2356. Wk. 20. Single-edged. Total length, $35\frac{7}{8}$ inches. Length of blade, 30 inches.
2. R. 2357. Wk. 16. Double-edged. Total length, 36 inches. Length of blade, $29\frac{1}{2}$ inches.
3. R. 2358. Wk. 15. Double-edged. Total length, $31\frac{1}{2}$ inches. Length of blade, $24\frac{7}{8}$ inches.
4. R. 2359. Wk. 23. Single-edged. Total length, $33\frac{1}{2}$ inches. Length of blade, $27\frac{1}{8}$ inches.
5. R. 2391. Wk. 21. Double-edged (broken into three parts). Total length, $38\frac{1}{8}$ inches. Length of blade, $31\frac{1}{4}$ inches.

Wk. 17. Double-edged (bent and broken in two parts, pommel and point missing). Total length, 30 inches. Length of blade, $25\frac{1}{2}$ inches.

Wk. 22. Double-edged. Total length, $35\frac{1}{2}$ inches. Length of blade, $30\frac{1}{8}$ inches.

It would therefore appear that seven swords were found in the neighbourhood of Island-bridge; but that only five had come in at the time of the publication of the paper. In addition to these there is the decorated sword-hilt No. 2361 described and figured by Sir W. Wilde, and an iron sword-handle mentioned in the Register No. 2390, which has not yet been identified.

Previous to the swords found at Island-bridge there is a sword entered in the Register in 1860, and described as having been found with other objects at Kilmainham, and presented by Mr. William Young.

There is a reference to the Minutes of the Academy, vol. iv., p. 152. The reference is in the Academy Proceedings, vol. iv., p. 219. It runs—"Nov. 13th, 1848. The Secretary read . . . a letter from Mr. Richard Young of Islandbridge, accompanying specimens of ancient Danish weapons, discovered by workmen in excavating near the terminus of the Great Southern and Western Railway. They consisted of a sword, much larger than has been yet found, and a smaller weapon of the same kind, together with an iron spear or pike-head, and a number of iron arrow-heads."

As no numbers referring to the new register were attached to the swords labelled by Mr. Wakeman as having been found at Kilmainham, it has not been possible to identify this sword.

The next reference in the Register, 1861, is to two swords, a spear-head, a shield boss, a stilus, and animal, and metallic remains found at King's-bridge Terminus by Mr. George Miller, and presented to the Academy by the Directors of the Great Southern and Western Railway. In vol. vii. of the Academy's Proceedings, p. 376, the donation is mentioned thus: "Read a letter from George M. Miller, Esq., announcing a donation of some osseous remains and antiquities, found in the works of the Great Southern and Western Railroad, near the King's-bridge Terminus."

These two swords are presumably among those labelled by Mr. Wakeman as found at Kilmainham and presented by the Directors of the Railway.

The spear-head has been identified as Wk., No. 25.

There are six swords labelled by Mr. Wakeman as having been found in a cutting of the Great Southern and Western Railway at Kilmainham, and presented by the Governors of the Hospital and Directors of the Railway; and they are numbered as follows:—

Wk. 7. W. 89. 352 D. Double-edged (broken into three parts). Total length, $36\frac{5}{8}$ inches. Length of blade, $30\frac{1}{2}$ inches.

Wk. 2. W. 90. 351 D. Double-edged (broken into three parts). Total length, $32\frac{3}{8}$ inches. Length of blade, $26\frac{1}{2}$ inches.

Wk. 8. Single-edged. Total length, $35\frac{3}{4}$ inches. Length of blade, $28\frac{3}{4}$ inches.

Wk. 31. Single-edged, $32\frac{3}{8}$ inches. Length of blade, $26\frac{3}{8}$ inches.

Wk. 10. W. 92. 356 D. Double-edged (bent over). Total length, $37\frac{1}{2}$ inches. Length of blade, $31\frac{1}{2}$ inches.

Wk. 9. W. 93. 355 D. Double-edged (bent over). Total length, $35\frac{1}{2}$ inches. Length of blade, 30 inches.

Wk. 6. W. 87. 350 D. Double-edged (broken). Total length, 28 inches. Length of blade, 22 inches.

Wk. 5. W. 88. 349 D. Double-edged (broken into three parts). Total length, $36\frac{1}{2}$ inches. Length of blade, $30\frac{5}{8}$ inches.

One more sword is labelled as having been found at Kilmainham and purchased from Mr. Thomson; it is numbered Wk. 14; and the total length is 29 inches, and length of blade $23\frac{3}{4}$ inches.

The next lot consists of six swords, one of which is labelled by Mr. Wakeman as having been found in Kilmainham Cemetery, and the others as found at or near Kilmainham. They are numbered as follows:—

Wk. 13. W. 78. Double-edged (broken into two parts). Total length, $30\frac{1}{8}$ inches. Length of blade, 25 inches.

Wk. 11. Double-edged. Total length, $33\frac{7}{8}$ inches. Length of blade, $28\frac{3}{4}$ inches.

Wk. 3. Double-edged. Total length, $38\frac{7}{8}$ inches.

Wk. 33. Double-edged. Total length, $35\frac{7}{8}$ inches.

Wk. 1. Single-edged. Total length, $35\frac{1}{8}$ inches. Length of blade, $29\frac{1}{8}$ inches.

Wk. 12. Single-edged. Total length, $28\frac{7}{8}$ inches. Length of blade, 23 inches.

There are also the upper portion of a sword-pommel (Wk. 41. P. 943), the quillon of a sword (Wk. 44), and part of the handle of a sword (Wk. 42), all labelled as found in the neighbourhood of Kilmainham.

Finally, we come to six swords labelled by Mr. Wakeman as having been found probably at Kilmainham: they are numbered:—

Wk. 34. Double-edged (broken into two parts). Total length, $39\frac{1}{2}$ inches. Length of blade, $33\frac{1}{4}$ inches.

Wk. 35. Double-edged. Total length, $35\frac{1}{2}$ inches. Length of blade, 29 inches.

Wk. 36. Single-edged. Total length, $33\frac{1}{2}$ inches. Length of blade, 27 inches.

Wk. 37. Double-edged. Total length, $35\frac{1}{4}$ inches. Length of blade, $28\frac{3}{4}$ inches.

Wk. 38. Doubled-edged. Total length, $32\frac{1}{4}$ inches. Length of blade, $26\frac{1}{2}$ inches.

Wk. 39. Double-edged. Total length, $21\frac{1}{2}$ inches. Length of blade, 16 inches.

There is also a portion of sword-pommel (Wk. 40) which is labelled by Mr. Wakeman as having been found with a human skeleton (feet towards the east) in a grave near the Liffey, probably at or near Kilmainham.

We have then twenty-eight complete swords and several portions of swords found in the Island-bridge and Kilmainham district. Of these six are single-edged; and of the remaining twenty-two double-edged swords, several are broken, and three are bent. This must have been done at the time of the interment. The form of the swords can be seen in fig. 1, which shows an unusually long "sax" or single-edged sword (Wk. 20), and a double-edged sword (Wk. 7).

Description of Swords.

The hilt of bronze described by Sir William Wilde, No. 2361, is very fine; and sword-hilts analogous to this are rare. The handle portion of bronze, which is inlaid with chevrons of white metal or silver, terminating in small circles, is beautifully wrought. Fig. 2 will show the pattern.

Plate IV. No. 1 (Wk. 21, R. 2391) is the hilt of a double-edged sword of the ordinary Norse type: it was found at Island-bridge. It is broken into three parts, and measures 38½ inches in length. The ornamentation is of the form of many silver strips beaten into groves in the iron, with a piece of twisted silver wire between the upper and lower portion of the head: compare Rygh, "Norske Oldsager," p. 71.

Fig. 1.—Wk. 7. Wk. 20.

Fig. 2.—Decorated Bronze Sword-Hilt (½).

Plate IV. No. 2 (Wk. 15, R. 2358), also from Island-bridge, shows the same type of hilt; but the silver strips are prolonged into a pattern at each side; it has lost the silver wire between the two portions of the head: it is broken, and the upper portion of the blade is missing: it measures 31½ inches in length.

Plate IV. No. 4 (Wk. 3), from Kilmainham, differs slightly in the shape of the upper part of the head; the silver is ornamented by a sort of chequer pattern, and bound by several silver wires which go over the head in two places. The quillon is bound above and below by a single strand of twisted

ERRATUM.

Page 113, lines 14, 24, *for* "HARTOLFA," *read* "HARTOLFR."

" line 29 and foot-note, *for* "A," *read* "R."

wire. It seems almost identical with the hilt figured by Du Chaillu, The Viking Age," vol. ii., p. 67, fig. 788. It measures 38⅞ inches in length.

Plate IV. No. 3 (Wk. 33), from the cemetery of Kilmainham, is the finest sword of the period in the collection, and one of the finest swords in any museum. The hilt is heavier and larger than usual, in order to balance the long blade. It is richly gilt and decorated with small silver circles. Silver wires go over the head; and the lower part of the head and the quillon are ornamented at the centre and edges with decorated bands. The decoration will be best understood by examining the illustration. It measures 35⅞ inches in length.

Plate IV. No. 5 (Wk. 5), from Kilmainham, is a remarkable hilt. The upper portion of the head, which is smaller than in the hilts just described, is divided into five lobes, with silver wire between each; the lower portion is decorated with a kind of meander pattern, which is repeated on the quillon. The upper surface of the guard bears the name HARTOLFA.[1] It is broken into three parts, and measures 36½ inches in length. A sword-hilt of very similar shape and decoration, with the name HLITHER engraved in the same place, the upper surface of the guard, is figured by Rygh, "Norske Oldsager," No. 511. It was found in 1864 in a tumulus at Gravraak, Melhus, Norway. No indications of damascening or the names of armourers were apparent upon the blades, such as are known upon swords of the period; but examination for these was not attempted, as the blades had been covered with a thick coating of paraffin wax to preserve them, and as little as possible was done to disturb this. Many of the ornamented parts were quite hidden by rust. Thus the sword with the name HARTOLFA on the quillon was so covered with rust that when Mr. Wakeman was working at these objects, he says this sword "is said when found to have been inscribed with the letters HARTOLF. Of this lettering, if it ever existed, no trace at present remains." The careful cleaning of the sword has made this lettering, with the exception of the final A, now quite plain. The damascening of the blades of the Viking swords, which has been thought to imply an Eastern origin for them, is not the true damascening, and is called "false damascening" by Lorange; and the swords are considered to be mostly derived through the North-West of France, and the districts of the Rhine and north of the Danube. (See "Den Yngre Jernalders Svaerd," by A. L. Lorange, of the Bergens Museum, where the subject of the origin and damascening of the swords is fully gone into.)

The superiority of the Scandinavian arms was recognized by the Irish. The ancient author of the "War of the Gaedhil with the Gaill" (p. 53), speaking of the indescribable oppression and suffering inflicted on the Irish,

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[1] We are indebted to Professor Carl Marstrander, of the School of Irish Learning, for drawing our attention to the final A.

attributes it to the excellence of the Dane's corselets, and "their hard, strong, valiant swords;[1] and their well-rivetted long spears"; besides their bravery and their valour.

We next come to the spear-heads found at Island-bridge. In Sir William Wilde's paper six are mentioned as having been found. These are entered in the new Registry, and have been identified. Mr. Wakeman labelled four more spear-heads as having been found at Island-bridge; and one more is mentioned in the old Registry, making eleven spear-heads in all, which appear to have come in at different times. They are numbered as follows:—

Wk. 1. Measures 14½ inches in length.
Wk. 2. R. 2365. Measures 12 inches in length.
Wk. 3. Measures 11½ inches in length.
Wk. 4. R. 2366. Measures 10¼ inches in length.
Wk. 5. R. 2372. Measures 16 inches in length.
Wk. 6. R. 2371. Measures 19¼ inches in length. (Fig. 4.)
Wk. 7. R. 2373. Measures 11 inches in length. (Fig. 4.)
Wk. 8. R. 2360. Measures 14 inches in length.
Wk. 10. D. 305. Measures 15¾ inches in length.
Wk. 24. D. 303. Measures 8¾ inches in length.
D. 368. Measures 16½ inches in length.

Three spear-heads and a portion of the socket of a spear-head are labelled as found in the cutting of the Great Southern and Western Railway

[1] The native swords found in crannogs and throughout the country are small and light (fig. 3), and must have been of little effect against the great swords of the first-comers from the north until the arms were in time more equalized. The origin of the type of some of the swords which broaden to a triangular point has not yet been discovered. There are many of these light swords in Ireland which

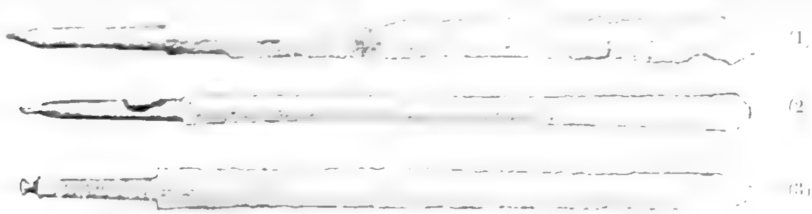


Fig. 3.—Irish Swords (⅛).

No. 1 found near Toome Bridge.
No. 2 found in Ireland, exact locality unrecorded.
No. 3 found in Dunshaughlin Crannog.

appear to be contemporary with the other crannog swords. As showing how little things were understood in the time the Island-bridge find was described, it may be mentioned that Dr. Todd, in a note in his introduction to the "War of the Gaedhil with the Gaill," says that "The Irish swords of the period were short, and of bronze The Danish swords were long, and of steel." Iron had long been known, and the bronze swords belong to the prehistoric period.

at Kilmainham. Of these only one spear-head, and the socket, have so far been identified. These are numbered:—

Wk. 25. R 427 : 1861. It measures $14\frac{3}{4}$ inches in length. (This is the spear-head mentioned on p. 110.)

Wk. 28. Socket measures 3 inches in length.

Next come six spear-heads, labelled as found at Kilmainham, and purchased from Mr. Thomson. They are numbered:—

Wk. 11. Measures $11\frac{1}{4}$ inches in length.

Wk. 12 and 16. Measure $14\frac{1}{4}$ inches in length.

Wk. 17. Measures $13\frac{1}{4}$ inches in length.

Wk. 18. Measures $7\frac{3}{8}$ inches in length.

Wk. 20. Measures 13 inches in length.

Finally, we have four spear-heads, labelled by Mr. Wakeman as found at or near Kilmainham; and one found at Kilmainham, from the Petrie collection. These are numbered:—

Wk. 14. This spear is much bent; it measures $19\frac{1}{2}$ inches in length.

Wk. 15. This spear is also bent; it measures 12 inches in length, and is illustrated, fig. 4.

Wk. 19. It measures $9\frac{1}{2}$ inches in length.

Wk. 21. It measures $12\frac{1}{4}$ inches in length.

P. 941. It measures $12\frac{1}{4}$ inches in length.

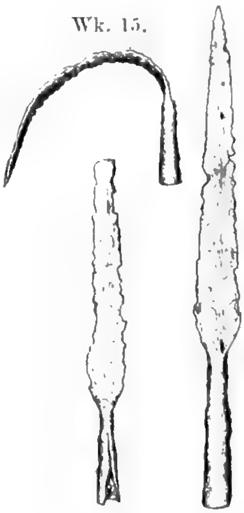


FIG. 4.—Spear-heads.

We have therefore 22 complete spear-heads found at Island-bridge and Kilmainham.

The illustrations of these spear-heads will show the general type; they have a somewhat flat midrib, and vary considerably in length.

We now come to shield-bosses. "Four umbos, or shield bosses," are mentioned in Sir William Wilde's paper as having been found at Island-bridge. Four bosses are mentioned in the new Register; and Mr. Wakeman labelled three bosses, apparently included in these. The numbers are:—

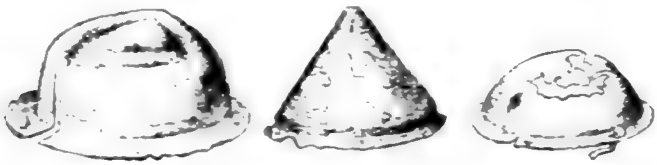
Wk. 2. R. 2361 (fig. 5). Measures $3\frac{3}{4}$ inches in diameter, and $2\frac{1}{2}$ inches in height. The rim is $\frac{3}{4}$ inch deep.

Wk. 3. W. 1. Fragment; the rim measures $\frac{3}{4}$ inch.

Wk. 4. W. 42 (fig. 5). Measures 3 inches in diameter, and 2 inches in height. The rim is $\frac{5}{8}$ inch deep.

R. 2362. Measures $3\frac{7}{8}$ inches in diameter, and 3 inches in height. The rim is $\frac{3}{4}$ inch deep.

Three of these bosses are in a fair state of preservation; the other, Wk. 3, is a mere fragment. They consist of three parts, a flat rim which served to fasten the boss to the shield, a cylindrical portion rising from the rim, and the round or pointed top. The flattish round type, with projecting rim, is shown in the illustrations (fig. 5, Wk. 2 and 4), and, as can be seen by comparing them with fig. 5, Wk. 17, which is drawn from one of the bosses found at Kilmainham, it differs from the latter, which are much more pointed in shape. It has been suggested that these latter were the ends of quivers, but this is very doubtful.



[illegible] Wk. 17. [illegible]

Fig. 5.—Umbos.

Mr. Wakeman labelled thirteen bosses as found at Kilmainham, and presented by the Governors of the Hospital and Directors of the Railway. These are numbered:—

Wk. 1. Measures 3½ inches in diameter, and 2½ inches in height. The rim is incomplete.

Wk. 5. Measures [illegible]½ inches in diameter, and 1½ inch in height. The rim is incomplete.

Wk. 6. Measures 3⅝ inches in diameter. Broken away at the top.

Wk. 8. Measures 3¼ inches in diameter, and 3¼ inches in height. The rim is incomplete.

Wk. 9. Measures [illegible] inches in diameter, and 2¼ inches in height. The rim is incomplete.

Wk. 10. Measures 3½ inches in diameter, and 3 inches in height. The rim is incomplete.

Wk. 11. Incomplete at base. Height, 3½ inches. The rim is incomplete.

Wk. 12. Measures [illegible] inches in diameter, and 2¼ inches in height. The rim is incomplete.

Wk. 13. Measures 3¼ inches in diameter, and 2¾ inches in height. The rim is incomplete.

Wk. 15. Measures $3\frac{1}{8}$ inches in diameter, and $2\frac{3}{4}$ inches in height. The rim is incomplete.

Wk. 16. Measures $2\frac{7}{8}$ inches in diameter, and 3 inches in height. The rim is incomplete.

Wk. 17. (fig. 5). Measures $3\frac{1}{8}$ inches in diameter, and $3\frac{1}{8}$ inches in height. The rim is incomplete.

Wk. 18. Measures $3\frac{3}{8}$ inches in diameter, and $2\frac{3}{8}$ inches in height. The rim is incomplete.

In addition to these five bosses, six were labelled as found in the neighbourhood of Kilmainham. They are numbered :—

Wk. 20 and 20A. Incomplete fragments.

Wk. 21. Measures $4\frac{3}{4}$ inches in diameter, and $2\frac{3}{4}$ inches in height. Rim incomplete.

Wk. 24 and 25. Incomplete.

Wk. 26. Measures $3\frac{1}{2}$ inches in diameter, and $2\frac{1}{4}$ inches in height. Rim incomplete.

We have therefore four of the round and eighteen of the pointed bosses, making twenty-two in all, found at Island-bridge and Kilmainham.

Figure 6 shows one of two iron axe-heads found in the cutting of the Great Southern and Western Railway, and presented as the swords and spears. These axe-heads are the ordinary Norse type of fighting-axe. No special edge-piece is apparent on these axes, as on those later axes of the same type, which are seen on the Bayeux Tapestry. The axe appears to have been the principal fighting-weapon of the Vikings; and it was borrowed from them by the Saxons, who are represented on the Bayeux Tapestry fighting with axes. These axes are probably of native Norse make. As Lorange says, in the finds of the stock of travelling smiths that have been made in different countries no swords have been found, but only objects of domestic use, for which the native iron according to the Scandinavian authors was used.[1] The fighting-axe appears to be a development of the old working-axe.

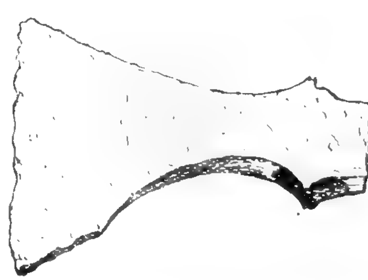


Fig. 6.—Axe-head. Wk. 13 ($\frac{1}{4}$).

Twenty-six iron tools of various kinds have been identified as found at Island-bridge. Some of them are mentioned in Sir William Wilde's paper.

[1] Lorange, Den Yngre Jernalders Svaerd, p. 37.

They include a smith's pincers (fig. 7, R. 2393), smith's tongs (fig. 7, R. 2392), sickle (fig. 7. R. 2367), the upper portion of pair of shears, the blades of which are wanting: otherwise they are similar to those figures by Rygh, No. 442*a*: hammer-heads: one is illustrated (fig. 7), portion of a bridle-bit, knife-blades, spear-butt, spindle-whorls, and an iron stud, with other small pieces of iron which appear to have formed portions of other tools. It is interesting to notice how little the type of many of these tools has altered down to the present time.

At the railway cutting at Kilmainham, forty iron tools and pieces of iron are described as having been found at different times. They consist principally of knife-blades, two of which are illustrated (Wk. 2 and Wk. 3, fig. 7).

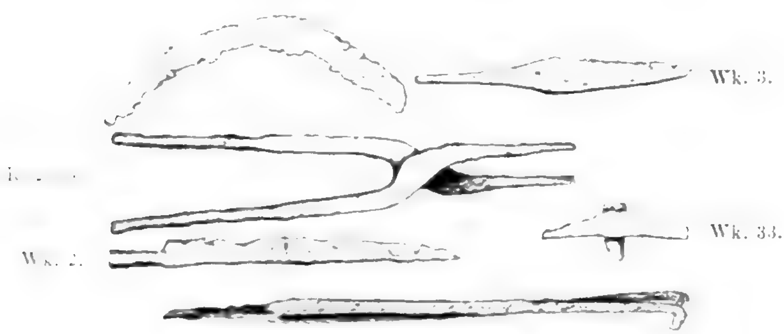


Fig. 7.—Tools (½).

We now come to a description of the objects connected with the trading side of the Vikings' life.

Two scales were found at Island-bridge and two at Kilmainham. The cross-beams of three of these scales are jointed, enabling the scales to be closed and conveniently carried about (fig. 8). The scales found at Island-bridge were fully described by Sir William Wilde, and our figure will show the form; the inside of the scale-pans (six) are brightly tinned. The weights found at Island-bridge are ten in number. Six are circular; and the rim of each is capped with a decorated disc let into it, and weighted below with lead, probably according to the number of grains or ounces it represented. Five are illustrated by Sir William Wilde, which are reproduced here

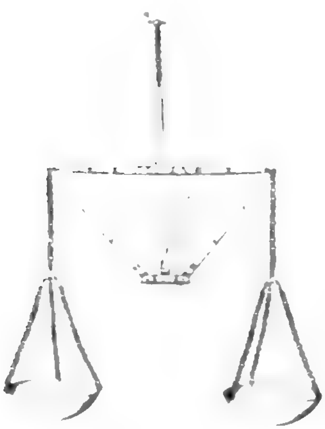


Fig. 8.—Scales. R. 2398 (½).

(figs. 9–13), and all are fully described by him. The tops of some of them are richly decorated with enamel and glass; but one is only an iron stud, evidently the base or central portion of a weight. For a discussion of the values of the weights, which appear to be divisions and multiples based on the old Norse ore, see Ridgeway, "Origin of Metallic Currency and Weight Standards," Appendix C, p. 401.

FIG. 9 (1/1).

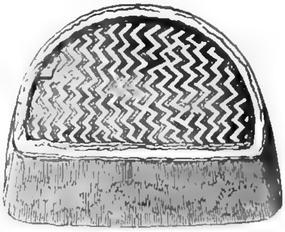


FIG. 10 (1/1).

FIG. 11 (1/1).

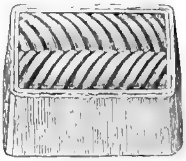


FIG. 12 (1/1).

FIG. 13 (1/1).

The four pairs of bronze tortoise-shaped brooches found at Island-bridge are all of the same type and almost similar in pattern, and are very like Rygh's fig. 647. That figured by Sir William Wilde, and reproduced here (fig. 14), will be sufficient to show their general character; but each pair shows minute differences. One may have been originally tinned or coated with white metal, traces of which can still be seen. The brooches belong to a regular and well-dated series, being an early type of the Carlovingian period. They give a probable date to the principal objects of the find of about 825 A.D. All the objects of the find, though more or less Norse in appearance, and of the same period as dated by the brooches, must not be assumed to be of the same date or from the same interment; the dates for some of them may extend over half a century and more.

FIG. 14.—Brooch (2/3).

The supposed helmet-crest figured by Sir William Wilde (No. 2372) is composed of bronze, coated with white metal, supposed to be findruine;

Fig. 15 ([illegible]).

Fig. 16 ([illegible]).

the spirals on the limbs shown in the cut are not repeated on the other side. It was evidently intended to stand upright, as its base is pierced alternately on each side with a vertical hole (fig. 16). The small axe is coated in a similar manner (fig. 15); it measures $5\frac{5}{8}$ inches in length; its lower end, of which it has lost a portion, is square.

Eleven glass beads were found at Kilmainham, with iron weapons; two of them are dark blue, with spirals and lattice-patterns of lighter blue, and the largest is made of light green glass, with a number of small circular holes on its external surface, into which were placed studs of yellow enamel. At Kilmainham a large boss of black glass (fig. 17) for calendering or smoothing linen was found, with Danish weapons. A similar glass boss is figured by Rygh (No. 446). It was found in a tumulus in Norway.

Fig. 21 ([illegible]).

[illegible]

Fig. 17 (⅓).

Fig. 19 ([illegible]).

Fig. 20 ([illegible]).

A number of small wooden beads, covered with thin glass, joined together in straight lengths of four and five, were found at Island-bridge (fig. 18). The manufacture of these beads is very peculiar; the base is wood and very fragile; they are covered with a thin coating of glass. They are probably

Roman, using the word "Roman" in a general sense, though similar beads do not seem to be known. Fig. 19, probably a needle-case, found at Island-bridge, is a plain tube of white metal. Needles have been found inside such tubes in Norway. Fig. 20 is the stylus which was discovered, with other objects, near Kingsbridge terminus, and presented by Mr. G. M. Miller. (See p. 110.) It measures $8\frac{1}{2}$ inches in length, and is of bronze coated with white metal.

The brooch (fig. 21) was found at Island-bridge subsequently to the publication of Sir William Wilde's paper. It is richly gilt, and has a setting of amber. It has evidently been cut round one side, probably from a larger ornament, when the pin and catch at the back appear to have been fitted to it.

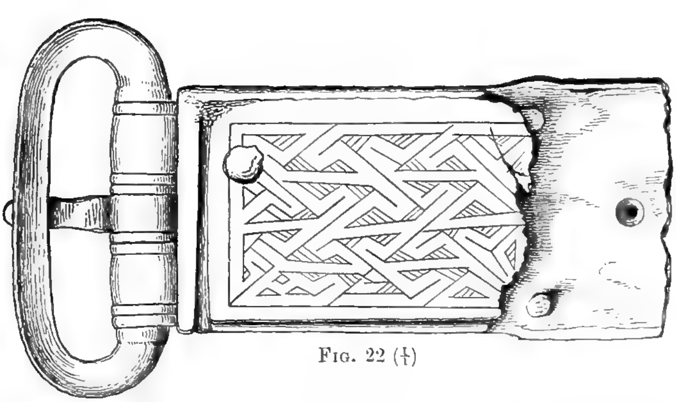


FIG. 22 ($\frac{1}{1}$)

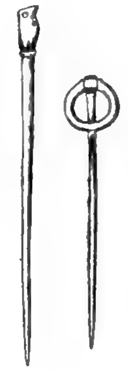


FIG. 23 ($\frac{1}{3}$).

Among the other objects found at Island-bridge are the buckle figured by Sir William Wilde (fig. 22), some fragments of buckles and mountings possibly from a sword scabbard, and three bronze pins (fig. 23 shows two); nearly all these have been tinned or coated with white metal, which seems to have been a favourite practice at that period. Sir William Wilde mentions some arrow-heads as having been found; some small knives and scraps of iron may have been thought to have been such, but no certain arrow-heads are to be seen among the objects now existing.

It will be observed from the foregoing descriptions that these Danish objects were distributed over the Kilmainham area, as a glance at the map will show that Island-bridge, the Railway terminus cutting, and the Royal Hospital are practically one district, being about half a mile in extent.

Sir William Wilde's conclusion, which has been quoted above, would seem to require more evidence to support it. It must be remembered that at the period to which the Island-bridge find is probably dated by the brooches the Norse had been settled in Dublin for a few years, and probably had a burial-place on the banks of the Liffey to the west side of their settlement: the locality from this running north was known as Fingal, from the Norse occupation. We must also recollect that at the time Sir William Wilde described this find, it was a common notion that weapons being found at a place always denoted a battle; but archaeology has advanced greatly since that time.

After a battle birds of prey are not the only scavengers; the bodies of the slain would have been almost certainly despoiled by the enemy, supposing their friends were unable to bring them off. On the other hand, there are many points which seem to indicate that we have to deal with a burial-place, and that the objects found were placed with the dead. The graves were those of both men and women: the brooches and the beads, which are rare in men's graves, probably belonged to the latter, also the needle-case and the spindle-whorls.

The three bent swords (fig. 24, Wk. 9) could not have been bent by the finders, as the iron would have snapped across, as it would at present if any attempt was made to straighten them; the one of them which is so broken across was probably snapped since the find was made, in an attempt to straighten it. The bending may have been due to a survival in certain exceptional cases of an ancient and widely distributed rite of breaking or injuring objects placed with the dead.

Wk. 9.
Fig. 24.

M. Salomon Reinach, who has handled this subject at length in a memoir on the sword of Brennus in "L'Anthropologie,"[1] has shown how the widespread error, accepted almost without reserve by modern historians, that the Gaulish iron was worthless, rested on the text of Polybius, and arose from that author, who wrote at a time later than the events to which he referred, and did not understand the rite, having condemned the bad iron of the Gaulish swords as the cause of the number of these bent and twisted swords which had been found. M. Reinach mentions that bent and damaged swords have been discovered in Normandy, Champagne, in the valleys of the Rhône and Rhine, in Switzerland, in the north of Italy, in Hungary, and, in Denmark, in the Island of Bornholm. Such swords are also found in grave-mounds in Norway; and examples are figured in Du Chaillu's "Viking Age," and other works.

All the objects of this important find have now been published for the first time, including those figured by Sir William Wilde. Owing to the circumstances of the find, some of the objects may be mixed with others of rather later date; but most of the weapons belong to the period representing the first coming of the Norse to Ireland.

[1] "L'Anthropologie," 1906, pp. 343 *et seq.*

COFFEY AND ARMSTRONG - SCANDINAVIAN SWORDS (

VI.

AN IRISH HISTORICAL TRACT DATED A.D. 721.

By JOHN MAC NEILL, B.A.

Read April 11. Ordered for Publication April 13. Published July 15, 1910.

CONTENTS.

ABBREVIATIONS.

A = the Irish synchronistic tract headed "A" in Todd Lecture Series (Royal Irish Academy), vol. iii., p. 278.
B = the Irish synchronistic tract headed "B," *ib.* p. 286.
Z = the Irish synchronistic tract quoted in this paper from
BB = the Book of Ballymote (R.I.A. facsimile), and
Lecan = the Book of Lecan, ms. in Royal Irish Academy.

1. Introductory.

The Irish Synchronisms represent the earliest essays to construct the history of Ireland before St. Patrick. The origin of the Synchronisms has been well explained by the late Dr. Bartholomew MacCarthy in one of his Todd Lectures.[1] They were written in imitation of St. Jerome's Latin version of the Chronicon of Eusebius. Dr. MacCarthy brings forward evidence to show that one of the synchronistic tracts printed by him, the tract which he designates by "A," "may date from the end of the sixth century." In a later work, he writes of this tract that it "was composed towards the end of the sixth century."[2] The text dealt with in the present paper represents an original composed early in the eighth century. Two sections of it are quoted by Dr. MacCarthy. The remainder may have escaped his notice by reason of the peculiar form in which the document has been preserved.

I have called this document Z. It does not appear to exist anywhere as a whole. Separated portions of it are embodied in the versions of the *Lebor*

[1] R. I. A., Todd Lecture Series, vol. iii., pp. 244, 245.
[2] Annals of Ulster, MacCarthy's Introduction, vol. iv., p. cix.

Gabála and *Flaithiusa Hérenn* contained in the Book of Ballymote and the Book of Lecan. These portions when brought together are seen to form a continuous and homogeneous text. So complete is the continuity that in one place in the Book of Ballymote the opening sentence of the excerpt has for its subject a pronoun having reference to a personal name of which the last previous mention is found four pages back.

Owing to the loss of several leaves in each MS., the text of Z is not complete either in BB or in Lecan; but fortunately all that is missing in one appears to be supplied in the other. Two of the sections, V. and VI., are contained in both MSS.

The present paper deals chiefly with the earlier portion of the text. In the sections quoted and translated, I have omitted long lists of oriental kings in which no reference to Ireland occurs. I have indicated such omissions in the customary way.

The later sections of the text embody an account of Irish matters which are within the period of contemporary records or border closely thereon. Of these sections, I have quoted only those parts which establish the date of compilation. The remaining parts demand separate study and fall outside of the scope of this paper. To edit the text in its entirety will be a necessary part of the work of producing a complete edition of the early versions of the "Book of Invasions"—a work of such importance to the study of Irish and British origins that one wonders why it has been hitherto neglected.

The original of Z was written in the year 721. So far as I am aware, no other document containing the general framework of Irish legendary history exists of earlier date than the eleventh century. Z is thus a text of the highest critical value as showing how the historical legend grew and developed in succeeding centuries. A large development will be seen to have taken place in the legend of the Sons of Míl, i.e. in the origin-legend of the Gaelic people. According to Gilla Coemáin, writing in the eleventh century, the Gaels conquered Ireland about 1545 B.C. According to Z, this conquest took place no earlier than 331 B.C.[1]

Z, in fact, supplies a solvent by means of which we are enabled to eliminate a large element of medieval elaboration and invention, and to obtain a nearer and clearer view of the genuine outlines of Irish primitive tradition.

For some British archaeologists it appears to be almost a settled doctrine that the Gaelic Celts reached Great Britain and Ireland in the beginning of

[1] See Zimmer, *Nennius Vindicatus*, p. 186. The relations of A and Z to the Irish sources of Nennius may deserve investigation.

the Bronze Age, that is to say, perhaps a thousand years before any Celts are known to have reached the coasts of Gaul and Spain. This theory has long seemed to me to be chiefly sustained by the scaffolding that surrounds it. I do not know how far it may have been suggested by the claims to remote antiquity put forward on behalf of the Gaelic people in Ireland by their medieval historians. At all events, it is not irrelevant to point out that the writer of Z, the oldest known document which assigns a period to the Gaelic conquest of Ireland, is content to claim for that event a date no more remote than the time of Alexander the Great. To my mind, it has neither been proved nor shown probable that any Celtic people had settled in Britain or Ireland before the Celts were already far advanced in the use of iron. While I attach no precise importance to Z's date for the Gaelic immigration—the method by which that date was determined will be shown in further analysis—I consider it reasonable to think that the migrations to Ireland came in natural sequence from the occupation of the Atlantic seaboard by the Celts, and may not have begun earlier than the fifth century B.C.

2. Textual Extracts with Translation.

I. (BB 21 β 28).

I cind .ccc. bl. iar ndilind ro gab Parrtholon Er*inn*, no d*no* amar aderam bos t*r*eabhsad a sil .l. bl. ar .u.c. condasealgadar *Con*cheind go na terno neach di[a] claind ana beathaigh t*r*icha bl. iarsin gan duine beo a nEr*inn*.

At the end of 300 years after the Flood, Partholon took possession of Ireland, or else, as we shall further relate, his race dwelt [here] 550 years until the Dogheads slew them, so that not one of their posterity escaped alive. For thirty years thereafter, there was no one alive in Ireland.

[Then follows an account of certain prediluvian immigrants to Ireland—Capa, Laighne, and Sluasad, and again Cessair and her company.]

II. (BB 23 α 29).[1]

Ocus nir gabh neach do chloind Adham re ndili Er*inn* *acht* sain. Ba fas tra Eriu fria re .ccc. bla. *con*as-torr*acht* Parrtholon. no da bl. ar mile ⁊ is fir eissein. doig is .lx. bl. ba slan do

And no one of the race of Adam before the Flood took possession of Ireland but these. Now Ireland was vacant for the space of 300 years until Partholon reached it; or rather 1002 years, and

[1] I give this section in its order, but regard it as forming no part of the original tract. Its object is to amend the earlier reckoning. For Mac Carthy's translation and emendations, see Todd Lect. iii., p. 262.

Abraham in tan ro gabh Parrtholon Eriu 7 da bl. xl.[a] 7 ix. c. o Abraham co dilind suas .i. lx. aissi Abraham frisin .lx. sin *con*adh .c.= ī. c. sin frisna .ix.c. *con*adh mile 7 da bl. fairsin *con*ad follus assin conadh da blia. ar mile o dilind co tiachtain Parrtholon a nEr*inn*. Ocht mbla. .l. 7 se .c. 7 da mili o tosach domain co tainig Parrtholon a nEr*inn*. ui. c. bl. 7 da mili acht di bl*iad*ain da easbaigh o Adam co hAbraham.

that is true. For Abraham had completed 60 years when Partholon occupied Ireland, and there are 942 years from Abraham backwards to the Flood, i.e. the sixty of Abraham's age in addition to the former sixty, which makes [102?] besides the 900, making 1002 years, so that it is evident therefrom that from the Flood to the arrival of Partholon in Ireland is 1002 years. 2658 years from the beginning of the world till Partholon came to Ireland. 2600 years all but two from Adam to Abraham.

III. (BB 26 *a* 7).

In n-aes thanaisdi d*no* o dilind co hAbraham is da bl. xl. 7 ix. c. bli*ad*an a fad sidhein 7 i cind .lx. bl. iarsin ro gabh Parr*tholon* Er*inn* .l. ar .u.c. o thi*acht*ain Parr*tholon* a nEr*inn* co tamleacht a muindtire. [Here follows a synchronic list of eastern rulers without reference to Ireland, down to 26 *a* 25.] in lx.° anno etaitis Abraham ro ghabh Parr*tholon* Er*inn*. [Synchronic list continued to 26 *a* 34] .l. ar u.c. bl. do bhi sil Parr*tholon* a nEr*inn*. . . . . . [26 *a* 37] Reimheas .xui. righ do righaib in domain do chaith sil Parr*tholon* a nEr*inn*. . . . . [26 *a* 44] Pelocus adho[1] fo .u. *no* tri bl. tricad 7 xii. bl. dib a comhfhlaith*ius* re sil Parr*tholon* .i. co tamhleacht muindteiri Parr*tholon* 7 a tri deg dibh 7 Eire fas ingean Phelocis .uiii. mbl. conadh da bl. xx. sin bheos 7 Eiri fas. Athosa 7 Saimiraimmis a dha hainm na hingene sin. Poilipoiris xxx. bl. 7 ix. mbl. dho a righe in doma[i]n in tan tanig Neimeadh a nEr*inn* na .ix. mbl. 7 in bl. ar .xx. isiat sin in tricha

The second age of the world then from the Flood to Abraham, 942 years is the length thereof, and 60 years thereafter Partholon took possession of Ireland. 550 from Partholon's arrival in Ireland to the death of his people by plague[2] . . . . In sexagesimo anno aetatis Abraham Partholon occupied Ireland. . . . . For 550 years the race of Partholon was in Ireland. . . . . It was the time of 16 kings of the kings of the world that Partholon's race spent in Ireland. . . . . Belocus [reigned] five times five years, or thirty-three years and twelve years thereof in co-sovereignty with Partholon's race, i.e. till the destruction of Partholon's people by plague[3]; and during thirteen years thereof Ireland was empty. The daughter of Belocus [reigned] eight years, so that that is 22 (21) years so far in which Ireland was empty. Atossa and Semiramis are the two names of that daughter. Balepares [reigned] 30 years, and was 9 years in the kingship of the world when Nemed

[1] *Read* a. u. (*mistaken for* a. ii.).

[2] "The second age . . . plague" is evidently interpolated. See sec. i.

[3] "Till . . . plague" interpolated.

bl. ro bai Eiri ig fas.[1] O ro indsimar tra do Cheassair 7 do Parr*tholon* gu leir 7 dia comaimsearaibh o Adham co dil*inn* 7 o dil*inn* co hAbraham 7 o Abraham co Neimheadh go fhis comaimsearreachta gach righ do ghabh in domun frisin re sin. 7 is fearr duind indisin do Neimhead 7 dona righaibh rena re.

came to Ireland. The 9 years and the 21 make the 30 years for which Ireland was empty. Since we have told now of Cessair and of Partholon thoroughly, and of their synchronizings from Adam to the Flood and from the Flood to Abraham, and from Abraham to Nemed, explaining the synchronism of every king who ruled the world during that time, it is better for us to tell of Nemed and of the kings in his time.

IV. (BB 27 β 20).

Da fhicheat bl. 7 se .c. o gein Abraham co tiachtain Neimidh in nEr*inn* .i. in lx. ro chaith Abraham co tiachtain Parrtholon in nEr*inn* 7 in .l. ar. u.c. aibh ro bai sil Parr*tholon* in Er*in*n 7 in .xxx. ro bai Eriu ig fas *con*ad iadsin na da .xx. 7 na .ui. c. bl. o Abraham co Neimeadh. Da bl. im*morro* 7 .lx. 7 u.c. 7 mile o dilind co tiacht Neimeadh a nEr*inn*. Tricha bl. 7 ii.c. tra o thainig Neimeadh a nEr*inn* gu toghail tuir *Con*aing. Poilipoiris ro bai in airdrige in doma[i]n in tan tainig Neimidh asin Sceithia a nEr*inn* xxx. bl. aireimheas 7 ix. bl. do ir-righe reimh Neimeadh[2] . . . . . (β 40) Secht mbl*iadn*a tra o thamleachta muindtiri Parr*tholon* gu toghail Trae[2] . . . . . (β 45) Et Tonus *Con*coler *nó* *Con*aeler .xx. bl. Ise sin tiuglaith Asardha. Sarrdanapallas a ainm gregdha do shuimh chuigile do chuaidh *con*dhearrnaidh cailleach de conroloise fein i teinidh. cccc. 7 lxx. bl. o thainig Neimidh in nEr*in*n co for*bha fla*ithiusa* Assardha 7 iiii. rig dheg fria sil Neimidh. Mili 7 cc. 7 íí. xx.

640 years from Abraham's birth to Nemed's arrival in Ireland, i.e. the 60 that Abraham lived until Partholon's coming to Ireland, and the 550 that Partholon's race lived in Ireland, and the 30 in which Ireland was empty—these make the 640 years from Abraham to Nemed. 1562 from the Flood to Nemed's arrival in Ireland.[3] 230 years from when Nemed came to Ireland till the destruction of Conaing's tower. Balepares was in the sovereignty of the world when Nemed came from Scythia to Ireland. 30 years was his reign, and he was 9 years king before Nemed. . . . Seven years from the destruction of Partholon's people by plague to the destruction of Troy. . . . And Thonos Concolerus, 20 years. He is the last Assyrian sovereign. Sardanapalus was his Greek name. He took to spinning with a distaff, so that he became an old wife and burned himself in a fire. 470 years from when Nemed came to Ireland till the end of the Assyrian sovereignty, and 14 kings during [the time of]

[1] *The incorrect insertion of* ig *before* fas *is interesting as an indication that the modern* a'fás = ag fás *dates back as far as the fourteenth century. The mistake is repeated in* IV, 6, *so cannot be fortuitous.*

[2] Lists of Assyrian kings are here given.

[3] This section so far is given by Mac Carthy, p. 263.

fot flaith*iusa* na nAssarda 7 se[1] righ tricad ro bhadar frisin re sin ut dixit poeta.

Da xx.[it] da .c. gan chair·
mili ni breg do bl*iadnaib*
fad a flaithis bha brigh bhalc·
re re na n-ocht righ trichad
Madh o. c. bl*iada*[i]n Nin nair·
ro ghabhsat riagail sograid[2]
mili gidh mo meadh[3] namma·
da .c. 7 xl.

Iar flaith*ius* Assarrdha ig Cichloiscibh ro bai .i. c. bl. doibh 7 ui. righanda dibh risin re sin Marsebia 7 Lapita Ensiopa Iiorithia Antiobla Pentisilia d*no*. Innistear cheana isin stair Dariat Pentisilia do bh*eith* illeith na Troianda ig catughadh fria Gregaibh go ndorcair la Pirr mc. Aichir Masse Tutaineis ro bhi in n-aimsir toghla Troi is a comaimsir frisna hAssarrdaibh ro bhai. Pentisilia ag na Cichloisethibh ria no[4] ro thoghladh in Trai. Flait*hius* Meadh ba he in t-ardflaithius a ndiaidh na nAsradha .i. ocht righa ro bhadar dibh nae[5] mbliadhna .l. 7 cc. fad a flaithiusa ut dicitur.

Nae mbl*iadn*a .l. da. cet·
re riagladh[6] ni himirbreg
fod flatha Meadh brigh co mblaidh·
re re ocht righ do righaibh.

Nemed's race. 1240 [years was] the duration of the empire of the Assyrians, and 36 [or 38] kings there were during that time, ut dixit poeta:

Two score, two hundred, without fault,
a thousand, it is no lie, of years
the length of their sovereignty that was a solid strength
in the time of the thirty-eight kings.
If it be [reckoned] from the first year of noble Ninus
that they held the rule of high degree,
a thousand only, though it be the greatest number(?),
two hundred and forty.

After the empire of the Assyrians, the Amazons had it i.e. 100 years for them and six queens of them during that time, Marsebia and Lapitha, Ensiopa, Iiorithia, Antiobla, Penthesilea. It is told, however, in the history of Dares that Penthesilea was on the side of the Trojans warring against the Greeks, till she was slain by Pyrrhus son of Achilles. If it was Tautamus that lived in the time of the Sack of Troy, he was contemporary with the Assyrians. Penthesilea [reigned] among the Amazons before Troy was sacked. The sovereignty of the Medes was the supreme sovereignty after the Assyrians,[7] i.e. eight kings there were of them. 259 [?] years was the duration of their realm, ut dicitur:

Two hundred and fifty-nine years,
according to rules, it is no falsehood,
the length of the reign of the Medes, a power with fame,
during the time of eight kings.

[1] "*no* ocht" written over "se." [2] *Read* rográid. [3] *Read* méd, mét.
[4] *Read* resiu? [5] "*no* .u." written over "nae." [6] *Read* re (= fri) riagla?
[7] Meaning that the Amazon kingdom is not reckoned as a "world-kingdom."

Arbait in .c. righ dibh ocht. mbl. xx. do. Suffonus xxx. b. do. Is ina re ro bhai tiughfhlaith Asarrdha .i. Sardanapallus 7 Madidus. xxx. bl. is *na* re rug Salmnasar cetbroid .x. treibi. Cardicias .xiii. bl. 7 Deachus .iiii. b. l. do. Isindala bl. xxx. a righe cath Leithead Lachtmaidhe i nDail Riada indorchair Starnd m*ac* Neimidh re Conaind m*ac* Faebair i cind .uiii. mbl. iarsin toghail tuir *Con*aind 7 dicur cloindi Neim*idh* a hEr*inn* .c. bl. 7 xl. do fhlaithius Meadh tarthadar sil Neim*idh* ceit*hr*i .c. bl. 7 lxx. ro chaithsead do flaithius Asardha 7 se dec *nó* xiii. righ ar Asardhaibh 7 se rigna na Cichloisce 7 u. righ do righaibh na Meadh ro chaitheasdair cona shil in Er*inn* isiad sin tra in xxx. 7 na dha .c. ro badar sil Neimhidh in Er*inn*. Deochus u*ero* u. bl. no a .iiii. l. i righi 7 Eiriu fas. Fraortes .xx. iiii. bli*adn*a Cir atreas uiii is*ed* a re ro bai Nabhgodon im mBhabiloin 7 Astiagheis uiii. mbl. xx go-ro-n-ait*hr*igh Cir m*ac* Dair m*ac* a ingene fein. Is na re ro loisc Nabhgodon fa dho Ier*usal*em. Ise sin thra fhlaithius Meadh .xu. b. 7 xxx. d. 7 Eri fas in fhlaithius dar eis Meadh ag na Gallagdaibh ro bai 7 ni hairimhtear am*al* ardfhlaithius it*ir* sen .i. Nabgodon. a xiii. 7 a m*ac* .i. Ebelimordach. xuii. mb. 7 a ua Negusar .xl. 7 a iarmua Labasairdech .ix. missa 7 a indua Ballasdair xuiii. bl. Cuig righ sin do Ghalladagaibh 7 c. bl. 7 na .u. bl. deg 7 na ceit*hr*i xx. ro bhadar Meadha i righi 7 Eiri fas 7 na .u. bl. 7 in c. ro bhadar na Galladagdha isiad sin na .c. bl. ro bai Eri fas o thoghail tuir *Con*naind co loingis Fear mBholg.[1]

Arbaces, the first king of them, 28 years for him. Sosarmus, 30 years for him. In his time lived the last ruler of the Assyrians, i.e. Sardanapalus. Mamycus, 30 years. In his time Salmanassar carried off the first captivity of the Ten Tribes. Cardaces, 13 years, and Deioces, 54 years for him. In the 32nd year of his reign, the battle of Lethet Lachtmaige in Dal Riada, in which Starnn son of Nemed was slain by Conann (or Conaing) son of Faebar. Eight years later, the destruction of Conann's tower and the expulsion of Nemed's race from Ireland. 140 years of the empire of the Medes, the race of Nemed lasted. 470 years they spent of the Assyrian empire; and [the time of] sixteen or thirteen kings over the Assyrians, six queens of the Amazons, and five kings of the kings of the Medes, he [Nemed] and his race passed in Ireland. Those are the 230 years that Nemed's race was in Ireland. Deioces was 55 or 54 years reigning, Ireland being empty; Phraortis 24 years; Cyaxares 8 — it was [for] his time that Nabuchodonosor was in Babylon; and Astyages 28 years until his own daughter's son, Cyrus son of Darius, deposed him. It was in his time that Nabuchodonosor twice burned Jerusalem. That then is the empire of the Medes, 45 (?) years, Ireland being empty. After the Medes, the sovereignty was held by the Chaldeans, and that is not accounted at all as a supreme empire; i.e. Nabuchodonosor 13, and his son Evilmerodach 17 years, and his grandson Neriglissor 40 and his greatgrandson Laborosoarchod 9 months, and his great-great-grandson Balthassar 18 years. That makes five

[1] The numerals in this section must be wrongly transcribed in several places.

kings of the Chaldeans and 100 years; and the 95 years that the Medes reigned, Ireland being empty, and the 105 years that the Chaldeans reigned, make up the [two] hundred years that Ireland was empty from the destruction of Conann's tower to the voyage of the Fir Bolg.

V. (BB 31 β 38.)

Et da .c. bl. do bhi Eri fas o thoghail thuir *Con*aind cu tangadar Fir Bholg. Comaimseardhacht righ in domain andso fria righaibh Fear mBholg .i. a ndeireadh fhlaith*iusa* na nGallagdha tra tangadar Fir Bolg a nEr*inn* .i. a tiughlaithsidhe ⁊ is do tarfas dornn gan righidh ig sgribeand ⁊ iss*ed* ro scribh mane techel ⁊ faires .i. umir ⁊ tomhus ⁊ foghail ⁊ is fair ro thoghail Cir m*ac* Dair i*m* mBaibiloin ⁊ ro marb Ballastair ⁊ ise Cir ro leg i*n* mbroid do Er*usal*em iar mbeith doi .lxx. bl. a ndaire Flaith*ius* P*ers* tra a ndiaidh na nGallagdha .i da righ dec ro gabastair dhibh. trica ⁊ da .c. bl*iad*an doibh .i. sil Elaimh m*eic* Sheimh m*eic* Nae Laimida ba sloindidh doibh gu P*er*sus m*ac* Ioib ⁊ P*ers* im*morro* osin amach. Cir m*ac* Dair a ceidrigh siden tricha bl*iad*an do gunorchair la Scitheagdhaibh. gu tri .c. mile uime ⁊ isse sin rug m.l. mile[1] do broid Ier*usal*em a Babhiloin ⁊ u.[1] castair oir ⁊ mile[1] castar n-airgid a lin. Cambaseis m*ac* Cir iarsin .uii. mbl. co ros marbsat a dhruithe fein ⁊ Eoch*aid* m*ac* Eirc i righe nEr*enn* in tan sin ⁊ isiad sin na uii. mbl*iadn*a xxx. ro badar Fir Bolg a nErinn .i. ocht mbl*iadn*a[2] flaith*iusa*. Cir m*eic* Dair gosin seachtmadh bl.

And 200 years was Ireland empty from the destruction of Conann's tower till the Fir Bolg came. The following is the synchronizing of the kings of the world with the kings of the Fir Bolg. At the end of the sovereignty of the Chaldeans the Fir Bolg arrived in Ireland. He [Balthassar][3] was their last prince, and to him was shown a hand without an arm writing, and what it wrote was *mane thekel phares*, i.e. number and measure and division; and over him Cyrus son of Darius captured Babylon, and he slew Balthassar. And it was Cyrus who let go the captives (*lit.* captivity) to Jerusalem when they had been 70 years in bondage. The Persian empire then after the Chaldeans, i.e. twelve kings of them reigned. Their time was 230 years, i.e. the race of Elam son of Shem son of Noah. Elamites was their description until Persus son of Jove, and Persi thenceforward. Cyrus son of Darius, their first king, reigned 30 years till he was slain by Scythians, with 300,000 of his followers. And it was he that brought the 50,000 of the captives of Jerusalem out of Babylon, and 5,000 vessels of gold, and many thousand vessels of silver, such was

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[1] *Read as in Lecan.* [2] *Read* ó chét bliadain.

[3] The omission of the name shows that the compiler of the Leabhar Gabhála had a continuous text of Z which he broke up into sections. Balthassar is the last king named in the preceding section. Four pages of BB intervene. The Lecan scribe noted the omission and re-inserted the name.

flatiusa Campesis *meic* Cir 7 ina ochtmadh bl. tangadar t.d.d. a nEr*inn* 7 daradsat cath Moige T*ur*eadh dFheraibh Bolg 7 ro marbad and Eoch*aid* m*ac* Eirc.

their number. Cambyses son of Cyrus thereafter, 7 years, until his own druids slew him, Eochaid son of Erc being king of Ireland at that time. And those are the 37 years that the Fir Bolg were in Ireland, i.e. from the first year of the reign of Cyrus son of Darius till the seventh year of the reign of Cambyses son of Cyrus. And in his eighth year the Tuatha Dé Danann arrived in Ireland and fought the battle of Mag Tured with the Fir Bolg, and in it Eochaid son of Erc was slain.

Lec. 23 *a*, *β*. Comaimsirad rig in dom*uin* inso fri rigaib Fer mBolcg. a nd*er*idh flatha na Call. u (?) tancatar Fir Bolcg a nEr*inn*. Ballastar a tiugflaith side is do doarfas in dorn ce*n* rigidh i*con* sg[ri]bind 7 is*ed* ro scrib mane techel 7 phares .i. numir 7 tomus 7 fod a lin is fair ro toglastar Cyir mc. Dair Babiloin 7 ro marbastar Ball. Ise Cyr ro leicestair in mbrait do Iar*usal*em iar mbeith doib .lxx. b. i ndoiri Flaithius Pers tra a ndiaidh na Medh xii ri dib hi fl*aithius* xxx. bl. 7 cc. doib. Sil da*no* Elaim mc. Sem mc. Noi iat 7 Elamite dogairdis dib co P*er*sius mc nIoib. P*er*s ohsoin amach. Ba se in cetri dib Cyr mc. Dair .xxx. bl. do. co tor*chair* la Scithecdaib co tri cetaib mile uimi. Ise thucc in l. mile do brait Ier*usal*em o Baibil*oin* .i. u. *m* lestar n-oir 7 ilmile lestar n-argait. Campases mc. Cyr iar sin .uiii. bl. co ro marbsat a druidi fein 7 Eoch*aid* mc. Eircc hirrigi .H. intan sin. Is iat sin na uii. mbl. xxx^at^. ro batar Fir Bolcg inH. O.c. bl. fl. Cir mc. Dair cusin uii^ad^. bl. tancatar Tuath. D.D. inher*inn* 7 doratsat cath Muighi T*ured* do Feraib Bolcg 7 ro marbsat Eoch*aid* m*a*cc Eircc.

VI. (BB 36 *a* 12.)

Comaimseard*acht* righ in domain re .t. d. d. and seo sis. P*er*sa ro bhadar i righe in tan tangadar t. d. d. a nEr*inn* isin blia*dain* deidenaigh flaith*iusa* Campaseis mc. Cir mc. Dair tangadar *no* na ochtmadh blia*dain* tangadar. [Here follows a list of the Persian kings, with the length of their reigns, without reference to Ireland.] (36 *a* 29) *Et* Dairius mor mc. Arsabi .ui. bl. ISe tiughlaith na P*er*s 7 ise thug tri catha do Alaxandir mc. Pilip 7 ro thuit sium la hAlaxandair isin chath fo dheoidh. ISe Alaxandair ro thaffaind F*or*and

The following is the synchronizing of the kings of the world with the Tuatha Da Danann. The Persians were ruling when the T. D. D. came into Ireland; in the last year of the reign of Cambyses son of Cyrus son of Darius they came, or in his eighth year they came. . . . And Darius the Great, son of Arsames, 6 years. He is the last ruler of the Persians, and it was he who fought three battles with Alexander son of Philip, and he fell by Alexander in the final battle. It was Alexander that drove Pharaoh Nectanebis from the

Nechtinebhus a righi Eigipte is do sidhen ro bo cliamain Milidh .i. Goladh a ainm. Tainig sein a hEigipt o ro haithrighadh F*or*and .i. Milidh 7 a bhean .i. Scota ingean F*or*aind 7 tainig co Heaspain 7 ro chosain Easpain ar eigin. ISe F*or*and Neachteinibus .in. u^ad^. righ .xl^at^. *no* .xxx. iar F*or*and Cingciris ro baidheadh imMuir Ruaidh. iiii. b. deg 7 ix. c. fat a flaith*iusa* na Forand o Fhorand Cingc*er*is co F*oran*n Neachtenibus. Ro raindeadh tra flaith*ius* Alaxan*n*dair a tri randaibh .xxx. dia eis 7 ro dhearrsenaigh ceat*hra*r dib uile. Potolameus mc. Lairghi i nEighibht 7 imMaigidondaibh Pilip *no* a mc. a nAssia Bhig Antigon im mBabiloin Brutus Siliuчus nicroin Potolameus a ndiaidh Alaxandair .xl. b. A ndeireadh fhlaithiusa Alaxandair tangadar mc. Mileadh a nEri*n*d .i. bl. iar marb*ad* Dair do 7 i tosach a innsaighe 7 a righi tainig Milidh do*chum* nEaspaine .u. bl. dAlaxandair i righi in tan tangadar mc. Mil*ed* a nEr*inn* 7 doradadh cath Taillteаn andorc*ra*dar t. d. d. cona rignaibh. Coig bli*adn*a dErimhon i righi in tan adbath Alaxandair im mBaibiloin 7 isiat sin na dha .c. bl. ro badar .t. d. d. a nEr*inn*. On bl. deighenaigh flaith*iusa* Campeses mc. Cir co forbha fhlaithiusa Dair ae*n*blia*dain* Campases Tairpeis .u. bla. xxx^ad^. Serseis xx. blia*dan*. Artarserses xl. blia*dan*. Xerxses. da mis. Sodogenos .uii. misa. *Et* Dairius xix. b. Asferus. xl. Artarserses Ochi. tricha. Arius Ochi .iiii. bl. Dairius mor .ui. bl. ISiad sin na da .c. b. *acht* tri bl. nan-easbaig ro badar t. d. d. a nEr*inn*. Gaidhil a nEr*inn* 7 Gr*ei*c i n-airdrigi in domаn.

kingship of Egypt—it was to him [Pharaoh] that Míl was son-in-law, whose [proper] name was Goladh. The latter came away from Egypt when Pharaoh was dethroned, i.e. Míl, and his wife, i.e. Scota daughter of Pharaoh, and came to Spain and conquered Spain by force. Pharaoh Nectanebis was the 45th or 35th king after Pharaoh Cingciris, who was drowned in the Red Sea; 914 years was the duration of the empire of the Pharaohs from Pharaoh Cingciris to Pharaoh Nectanebis. Alexander's empire was divided into 33 portions after him, and four men of [the rulers of] these excelled them all: Ptolemy son of Lagus in Egypt and in Macedonia, Philip or his son in Asia Minor, Antigonus in Babylon, Brutus Seleucus Nicanor (?). Ptolemy, in succession to Alexander, 40 years. At the close of Alexander's reign the sons of Míl came to Ireland; i.e. a year after he slew Darius, and in the beginning of his invasion and of his kingship, Míl came to Spain. Alexander had reigned 5 years when the sons of Míl came to Ireland, and the battle of Tailtiu was fought, in which fell the T.D.D. with their queens.[1] Erimon had reigned 5 years when Alexander died in Babylon. And these are the 200 years the T.D.D. were in Ireland, from the last year of the reign of Cambyses son of Cyrus to the end of the reign of Darius: Cambyses, 1 year: [Darius son of Hys]taspes, 35 yeors; Xerses, 20 years; Artaxerxes, 40 years; Xerxes, 2 months; Sogdianus, 7 months; and Darius, 19 years; Assuerus, 40; Artaxerxes Ochus, 30; Darius Ochus, 4 years; Darius the Great, 6 years. Those are the 200

[1] "Their three kings and their three queens," Lecan.

years all but three that the T.D.D. were in Ireland. The Goidil in Ireland and the Greeks in the high-kingship of the world.

Lec. 26 *a*, *β*. Comaimsiradh righ in domain fri Tuaith. D.D. annso sis. Perssa robatar in airdrighi in domain intan tancatar Tuath*a* D.D. inH. isin bl. dedenaigh flatha Campases mc. Cir mc. Dair tancatar. [List here as in BB.] Dairius Magnus mc. Arsabei .ui. bli. ise tiugfl- na P*ers* ise thucc na tri catha do Alax-. mc. Philip 7 ro marb Alax-. esseomh isin cath deigdenach. Ise Alax-. ro thafaind Forann arrighi Eigip*te* is do ro bo cliamain Galom .i. Mil*id* a ainm 7 tanic s*id*e a hEigipt 7 a ben Scotta i*ngen* Nectanib*us* co Hespain 7 ro chossain ar hīn. *Et* ise Forann Nectenibus in xlu. ri iar Forunn Cineris ro baidhedh imMuir Ruaidh .xiiii. bl. 7 ix. .c. fott a fl*ath*a o Forunn Cineris co Forunn Nech*tani*bus. Rorannad fls. Alax-. i trib rannaib xxx[at]. dia eis ro derscaidh iiii *ur* dib uili .i. Potolom*eu*s mc. Lairce in Eigipt. Ardiachius Pilippus imMaicidhondaib. Antighonus i mBabiloin. Bruttus Siliuccus isin Aissia Bhic. Potolom*eu*s indiaidh Alax. xl. bl. Indeiredh flatha Alax tancatar mc. Mil*ed* inh-. .i. da bl. iar marbad Dair do 7 hitossach a indsaighthi 7 a rige tanic Mil*id* doc*hum* nEspane. Cuic bl. do Alax-. arrigi in tan tancatar mc. Mil*ed* inh-. 7 doradad cath Tailltin hi torc*ra*tar Tuath D. D. immo trib rigaib 7 immoa teora rignaib. Coic bl. do Herimon irrigi in tan adbath Alax-. i mBabiloin conid iat sin in .cc. b. robatar t. d. d. inh-. On bli. deidhenaigh fl. Campases mc. Cir co f*or*ba flatha Assar 7 Dair Aenbl-. Camp*ases*. Tarpess xxxui .bl. Serses. xx. b. Artars*erses* .xl. b. Xerx*es* .u. mis. Soghodianus .iiii. mis. Dairius .xix. b. Asferus .lx. b. Artarser*ses* Occus .xxx. Airius .iiii. b. Dairius Magnus .ui. b. Isiat sin in .cc. bl. *acht* na .iii. bl. robatar. t. d. d. inh-. Gaidil in h-. 7 Gr*ei*c in airdrigi in domain 7 ar na huilib gab*alaib* rogab Eirin o thossach co d*er*idh. Finit.

VII. (BB 44 *a* 49.)

A cind x. mbl*iad*an iar mbas Alaxandair mc. Pilip atbath Erimon. Ag toiseachaib Alaxandair ro bai in t-ardflaithius andsein.[1]

"At the end of 10 years after the death of Alexander son of Philip, Erimon died. Alexander's generals held the supreme rule at that time."

VIII. (Lecan 27 *β*.)

Cs. cade tairthud[2] fir mc. Mil-. nī. Cenel fil i sleib Armenia .i. Hib*er*i a sloindiud Boi ri amra occo .i. Milidh mc. Bile mc. Nema. Bui s*id*e hicosnum fl*aithiu*sa fria brathair athar fri Refelair mc. Nema 7 doluidh lu*cht* .iiii. mbarc f*or* longas 7 .ii. lano*m*na dec cech bairce

Question, what is the true origin of the Sons of Mil? It is not difficult. A race there is in the mountain of Armenia, Hiberi they are named. They had a famous king, Míl son of Bile son of Nem. He was contesting the sovereignty with his father's brother, Refel-

[1] The remainder of the synchronism falls within a lacuna of several missing pages of BB, and the continuation is taken from the Book of Lecan. It will be noted that there is no break in the sequence.

[2] Prof. K. Meyer supplies *tairthed .i. adbar*.

7 am*us* for*c*raid*ech* ce*n* mnai. Ba thuisech amra occo .i. Ucc 7 Occe Lotar f*or* muir Chaisp amach for in oician imechtrach 7 dolotar timchull na hAissia sairdes co hinis Dep*re*phane. iii. mis doib i*n*nti iii. mis aile for fairrce co ria*cht*atar co Eigipt fo deoig Hi cind uii. mbl. l.[st] ar ccc. ar mile iar c. gabail Er. do P*har*thalon. Hi cind im*morro* xiiii. mbl. ar dcccc iar mbadhudh F*or*aind a Muir. R. rosiacht[at]ar Eigipt. Pharo Nectanabus ba ri Eigipte in tan sin 7 ise sin in u. cadh ri. xl. iar F*or*and Cincriss ro baidhedh im Muir Ruaid. [Here follows a list of the Pharaohs.]

air son of Nem, and he went into exile with the manning of four barks, and twelve married couples to each bark, and a soldier over and above without wife. Two famous chiefs they had, Ucc and Occe. They went upon the Caspian Sea, out on the outer ocean, and came round Asia southeastward to the island of Taprobana. They were three months there and three months more on the sea, till at length they reached Egypt, at the end of 1357 years after the first taking of Ireland by Partholon, at the end too of 914 years after Pharaoh's drowning in the Red Sea they reached Egypt. Pharaoh Nectanebis was then king of Egypt, and he is the 45th king after Pharoah Cincris, who was drowned in the Red Sea. . . .

IX. (Lecan 27 β, 28 *a*.)

Nechtanebis Pharaoh xuiii. b. ise ba ri Eig*ipte* ar cind Mil*ed* mc. Bile cona longais 7 fuair failte occa fri re .uiii. mbl. 7 dob*eir* a ingin .i. S[c]ota do. *Et* ba si sin aimsir laidh Alaxand*air* Mor mc. Pil. isind Aissia 7 ro thairb*ir* in Eigipt fo reir 7 ro indarb Pharo Nectanebus a hEig*ipt* inn Ethiop 7 ro dichuir Artarserses ar tus. fecht aile in Eigipt Cumdaithir iarum cai[t]hir rig in Eigipt la hAlaxan*dair* Alexandria a hainm. Et discailt*er* flaithius dilis ind Eigipt annsin. 7 gabait G*reig* forta*m*lus innte 7 is hic G*rec*[aib] Alaxan*dria* ro bui fl*aithius* o sin amach. Conid annsin tainic Mil*id* a hEigipt dochum a chenecoil fein. Finit.

Nectanebis Pharaoh, 18 years. It is he that was king of Egypt on the arrival there of [*lit.* in front of] Míl son of Bile, with his fleet [or party of exiles]; and [Míl] was hospitably kept by him for eight years, and [Pharaoh] gives his daughter Scota to him. And that was the time when Alexander the Great, son of Philip, went into Asia, and brought Egypt to submission and banished Pharaoh Nectanebis from Egypt into Ethiopia, and he first dethroned Artaxerxes at another time in Egypt. Afterwards, a city of kings in Egypt is built by Alexander, Alexandria its name. And the native sovereignty of Egypt is then broken up, and the Greeks take headship there, and the Greeks of Alexandria held the sovereignty thenceforward. So it was then that Míl came from Egypt to his own kindred.[1] Finit.

[1] Perhaps the Iberi of Spain are taken here to be akin to the Iberi of the Caucasus.

X. (Lecan 34 *a* 1.)

Comaimsirad rig Herind fri rigaib in domain moir annso. Herimon tra in oenbl. ro gab rigi 7 Alaxanndair airdrigi in domain 7 ro marb Dairius Mor mc. Arsabi. i cinn .u. mbl. iar sin bas Alax. 7 r[o] gabsat a thoisig in domun da eis xl. b. Deich mbl. iar mbas Alax. atbath Herimon. uiii. b. iar sin Muimne 7 Luigne 7 Laigne .x. b. iar sin do Hiriel mc. Herimoin. Isindara bli. dec flatha Eithireoil mc. Hireoil .f. mc. Herimoin atbath in toisech dedenach di m*uintir* Alax. i. Potolom*eus* mc. Large. Xuiii. b. tra ro bui Eithirel hi comfl. 7 Philodelphus. xxxuiii. b. 7 is chuice tucadh in sept*uag*in*ta* ro chettindtae in chanoin a hebra i ngreicc lx̃x̃x heb*raide* lin a scriptore.[1] Fichi b. ro bui Philodelphus hi comrige 7 Conmael mc. [*sic*] xxx. b. do Chonmael p*os*t hirrighi 7 eu*er*gites .xuii. b. i comfl*aithius* friss Conmael p*os*t xiii. b. Philopator .xuii.[2] b. in coicedh ri do Greccaib hi comfl*aithius* fri Conmael 7 a .u. hi comfl. fri Tig*er*nm*us* Ise Philopator tra ro marbastar .lxx. mile do Iudaigib ind aimsir Tigernmais. Finit.

This is the synchronism of the kings of Ireland with the kings of the great world. In the same year Herimon[3] took the kingship and Alexander the high-kingship of the world, having slain Darius the Great, son of Arsames. At the end of five years thereafter, Alexander's death; and his generals took [the sovereignty of] the world after him for 40 years. Ten years after Alexander's death, Herimon died. Eight years after that, Muimne and Luigne and Laigne. Ten years after that [were spent in kingship] by Hiriel son of Herimon. In the twelfth year of the reign of Eithirel son of Hirel Fáith son of Herimon, died the last general of Alexander's people, Ptolemy son of Lagos. Eithirel was 18 years in co-sovereignty with Philadelphus [who reigned] 38 years, and to him were brought the seventy who first translated the Canonical Scriptures from Hebrew to Greek. Seventy(?) Hebrews(?) was the number of its writers. Twenty years was Philadelphus in co-kingship with Conmael son of . . . .; 30 years for Conmael afterwards in kingship, and Euergetes 17 years in co-sovereignty with him. Conmael afterwards, 13 years, Philopator, 13 years, the fifth king of the Greeks, in co-sovereignty with Tigernmas. It was Philopator who slew 70,000 of the Jews in the time of Tigernmas. Finit.

XI. (Lecan 41 *a* 17.)

Comaimseradh rig in domain 7 gabal nEr*enn* ro scribus a tosa*ch* in libair ota flaith Nin mc. Peil ro gab rigi in domain

"The synchronism of the kings of the world and of the conquests of Ireland I have written in the beginning of the

[1] *Read* lxx. hebra lin a scriptore. [2] *Read* xiii.

[3] Here the passage containing the statement about the battle of Taltiu is contradicted.

ar tus cusin coicedh ri do G*re*ccaib 7 o Parr*tholon* mc. Sera d*no* ro gab Erind ar tus iar ndilind cusin coiced blia. flatha Tigernmuis mc. Foll*aig* ro gab rigi nEr*enn* co cenn .c. blia. ut alii aiunt. Is ferr dunn d*no* co sgribam comamserad nacin f*or* leith annso.

book, from the reign of Ninus son of Belus who first took the kingship of the world to the fifth king of the Greeks, and from Partholon son of Seir also who first took Ireland after the Flood to the fifth year of the reign of Tigernmas son of Follach who took the kingship of Ireland till the end of [i.e. throughout] 100 years *ut alii aiunt.* It is better for us now that we write the synchronism on a separate sheet here."

The succession of the "Greek" rulers is then resumed at Philopator (see end of VIII) and continued to the time of Julius Caesar. From him the Roman "kings of the world" are continuously enumerated down to the reign of Leo III, who is declared to be contemporary with Fergal son of Mael Dúin, king of Ireland.

Then the writer returns to the synchronization of the Roman emperors with the kings of Ireland but on a different plan from the preceding section. Instead of taking the dynasties reign by reign, he takes them by centuries, naming the emperors and the Irish kings in each century. The centuries are reckoned from the accession of Julius Caesar (i.e. from the battle of Pharsalia), 48 B.C., until the mission of St. Patrick is reached. From this event the reckoning by centuries begins anew. The periods are[1]:—

1.	To the	12th	year of	Claudius	A.D. 52
2.	,,	14th	,,	Antoninus Pius,	151
3.	,,	1st	,,	Claudius II,	268
4.	,,	18th	,,	Constantius II,	354
5.	,,	last	,,	Theodosius I,	450

Theodosius I is confused with Theodosius II, who died in 450. Here a fresh start is made in the reckoning, leading—

6.	To the	1st	year of	Patrick in Ireland,	A.D. 432
7.	,,	5th	,,	Justinian,	531
8.	,,	20th	,,	Heraclius,	629

Last comes a period of 84 years, calculated to the date of writing of the original tract.

[1] The end of the third century is miscalculated. Perhaps the writer unwittingly substituted the first year of Claudius, 268, for the first of Valerian, 253. The other and smaller errors may be due to variations in chronography or to a misreading of the Roman numerals. The A.D. reckoning does not appear in the tract. A.D. dating appears not to have displaced the older methods in Ireland until the ninth century Mac Carthy, Introduction to *Annals of Ulster*, vol. iv., p. xciv).

The closing passage is as follows (43 *a*):—

Ceithri bl. lxxx. on xx b. fl. Heracli co f*or*ba fl. Leomain 7 ix.[1] r. frisin re sin .i. Hercolonas Constantin fls. Heracli Constantius fls. Constantini Iustinianus Minor Leofus Tiberius Iustinianus Minor it*er*um Pillipiccus Anastasius f*ili*us Teoth. T*er*cii[2] Leo T*er*tius. Ceithri bl. lxxx. on. x. bl. fl. Domnaill cosin tres bl. Fergail mc. Maili Duin 7 x. r. f*or* Er*inn* frisin re sin .i. Domnall Conall Cell*ach* Blathm*ac* Diarmait Sechnusach Cenn Fail*ad* Loings*ech* Congal Fergal fodesin. Oenbl. ar xxx[it]. ar cccccc[3]. insin .o. c. bl. fl. Iuil co f*or*bo fl. Leonis T*er*cii. Ceithri ri. lxxx. for Romanchaib frisin re sin. Noi .lx. im*morro* for Herind frisin re sin co fl. Fergail mc. Maili Duin ri Er. 7 M*ur*ch*ad*a mc. Find[4] .r. Laigen 7 Cathail mc. Finnguine .r. Mumun.

84 years from the 20th year of the reign of Heraclius to the end of the reign of Leo, and 9 (11) kings during that time, viz. [Heraclius,][5] Heracleonas, Constantinus filius Heraclii, Constans filius Constantini, [Constantinus filius Constantis,][5] Justinianus Minor, Leontius, Tiberius, Justinianus Minor iterum, Philippicus, Anastasius, Theodosius Tertius, Leo Tertius. 84 years from the 10th year of the reign of Domnall to the 3rd[6] year of Fergal son of Mael Dúin, and 10 kings over Ireland in that time, viz. Domnall, Conall, Cellach, Blathmac, Diarmait, Sechnusach, Cenn Faelad, Loingsech, Congal, Fergal himself. That is 631 (771 ?) years from the first year of the reign of Julius to the end of the reign of Leo III. 84 kings over the Romans during that time. 69 over Ireland during that time till the reign of Fergal, son of Mael Dúin, king of Ireland, and of Murchad Maen (?) king of Leinster, and of Cathal, son of Finnguine, king of Munster.

3. The Middle-Irish Redactor of Z.

Here follows immediately a very lengthy poem of Flann Mainistrech, headed "Do fl*ath*aib in domain moir annso," "This is of the Rulers of the Great World." The opening quatrain is—

Reidig damh a De do ni*mh* · co hemigh a n-i*n*nissin
uair nach co felgn*im* iar fuin · seancus degrig in do*mh*ain.[7]

The poem is a metrical list of "the kings of the world," commencing like

---

[1] *Read* xi. [2] Some corruption or omission occurs here. [3] Probably "dcclxxi" misread as "dcxxxi." [4] Probably "main," the epithet in Flann's poem, misread as "mein." The father of Murchad was Bran. [5] Omitted, owing to similarity of the adjacent names. [6] Probably "12th," xii, not iii. [7] Flann here borrows the opening words of a poem by Dublitir Ua Huathgaile LL 141 β (BB 7 β):

Redig dam a De do nim · co hemid ni indeithbir
érniud mo chesta is gnim glan · corop espa ollaman.

Z with the foundation of the Assyrian dynasty, and ending like Z with Leo III. In fact, Flann's list is taken direct from the synchronism, even to the extent of naming the Irish rulers contemporary with Leo.

The concluding quatrains are as follows (Lecan 48 β):—

On chetblia*dain* Iuil ros gab· co cetriagail tres blia*dan*
fiad ga*ch* sluagh co ndaithe a ndal· at cuadh fl*aithe* na Roman.
Co flaith fir ro gab Temraig[1]· do ruacht a*n*nalad aml*aid*
is Murchadha maen[2] co mudh· is Cathail cai*m* a Caissiul.
Cach flaith failte os gairbri glain· fris raite airdri in domain
o Nin co Leomain na clann[3]· ros rim int eolas[4] aenflann.
Flann feidbind rom ben brig breath· fer leigind min Mainistrech.
ro gle triana gnim a guth· re cach rig do reidiugud. R.
Concobur clannmin na cneadh· Aed Gairbith Diarmait Durgen
Donnchad da Niall ce*n* sni*mh* sneidh· righ na re sin co ro reidh. R.

"From the first year that Julius took it [i.e. the worldkingship], with [his] first rule, a stress of years (?), in the presence of every multitude with the keenness (?) of their assemblies, I have recounted the rulers of the Romans.

"To the reign of the man who took Tara, the chronicling has thus arrived, and of Murchad Maen (?) with dignity, and of Cathal the comely in Cashel.

"Each ruler of gladness over clear . . . . who was called high-king of the world, from Ninus to Leo of the weapons, Flann alone, the wise man, hath numbered them.

"Flann, sweet of word, the strength of judgments hath sounded[5] him, the gentle lector of Monasterboice, his voice through his work hath made clear the explanation of each king's time.

"Conchobor, of gentle kin, of the wounds [in battle], Aed, Gairbith, Diarmait Durgen, Donnchad, two Nialls, without petty sadness, [are] clearly the kings of that time."[6]

Of the five concluding stanzas in Flann's poem, the second and third prove that Flann had a version of Z before him as he wrote. The language of Z is Middle-Irish, without any traces of transcription from an Old-Irish original. Flann became known traditionally as an author of synchronisms. He is one of the earliest writers of Middle-Irish. The spellings of unfamiliar names in his poem exhibit often the same errors as in Z. All these facts taken together point to Flann as the redactor of Z.[7]

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[1] *Read* Co flaith Fergaile i Temraig (?) "to the reign of Fergal in Tara." [2] *Read* Maîn (?) *and so probably for* mc. Find *above, since his father was Bran.* [3] *Read* lann (?). [4] *Read* eolaid. [5] *I suppose* benaim *to be used as if the object were* cloc "*a bell.*" [6] Conchobor Ua Mael-Sechnaill, king of Meath, 1033–1073; Aed Ua Conchobuir, k. of Connacht, 1033–1067; Gairbith Ua Cathusaig, k. of Brega, 1045?–1061; Diarmait (son of Maelnambó), k. of Leinster, 1042–1072; Donnchad (son of Brian), k. of Munster, 1014–1065; Niall (son of Eochaid), k. of Ulaid, 1012–1062; Niall Ua Néill, k. of Ailech, 1036–1061. Flann died in 1056. The poem may be dated about 1060.
[7] See note at the end of this paper.

4. The Date and Original of Z.

Flann did not modernize Z from an Old-Irish original. Had he done so, he would have made no greater changes than would have been necessary to make the document intelligible to other Irishmen of learning in his time; and consequently many of the Old-Irish forms of the original would have been preserved. The tract therefore was originally written in Latin. Some of its Latin phrases are still preserved.

The date at which the original was compiled is very precisely indicated. The compiler believed himself to be writing in the ninety-fourth year from the accession of Domnall son of Aed, i.e. 721.

This date is confirmed by further criteria which the tract supplies. Its concluding portion names three kings reigning in Ireland. The king of Ireland was Fergal son of Mael Dúin, the king of Leinster was Murchad, and the king of Munster was Cathal son of Finnguine.[1]

Fergal reigned from 710 to 722. In the latter year he was defeated and slain in the battle of Almain by Murchad king of Leinster.

Murchad reigned from 712 to 727.

Cathal reigned from 712 to 742.

The contemporary Byzantine emperor is named. He is Leo the Isaurian, who reigned from 718 to 741.

The only years common to the four reigns are 718–722.

There remain two textual difficulties:—(1) The final year, the date of writing, or a date previous to writing, is twice indicated as the end (*forba*) of the reign of Leo. (2) It is once indicated as the third of Fergal. With regard to the first difficulty, it is to be pointed out that the last year of Leo, 741, was (*a*) 112 years—not 84 years—later than the twentieth of Heraclius; (*b*) nineteen years later than the death of Fergal; (*c*) fourteen years later than the death of Murchad; (*d*) that, if the end of Leo's reign were really in the writer's mind, he would probably have named the succeeding emperor, and would almost certainly have named contemporary kings of Ireland and of Leinster. Hence there can be no doubt that the Middle-Irish translator misread his Latin original. The year 721, the ninety-fourth from Domnall's accession, was the fourth of Leo, and may have been written *iu*^{m}, and taken to indicate *mortem* or *ultimum*. It was the twelfth year of Fergal, and xii may have been read as iii. The Roman numerals are a continual source of misreadings in Irish MSS., and often

[1] Nowhere else in the tract are provincial kings named. This indicates that the kings of Munster and Leinster are named as contemporary with the writing of the tract. Flann imitates this method of dating in his poem, naming seven kings.

present great difficulties to the modern transcriber. The textual discrepancies, then, cannot be held to invalidate the common period of the four reigns, 718–722, as the utmost range of date for the composition of the synchronism.

Synchronism Z is thus shown to be an eleventh-century version of one of the oldest known documents of early Irish history and historical legend.

The particulars of the chronology and also of the reigns appear to have been tampered with in several places, doubtless with a view to bringing the account into closer accord with later teachings. But the achievement of such a design would have involved the reconstruction of almost the entire tradition; and the meddler, having done some mischief, desisted without either undoing or completing it, and drew up B as a substitute for Z. (See concluding note.)

5. The Chronological Basis of Z.

The framing of Z is as follows:—

IRISH EVENT.		CONTEMPORARY WORLD-PERIOD.
Coming of Partholon,	. . .	300 years after Deluge.
End of Partholon's race,	. .	850 ,, ,, ,,
Coming of Nemed,	. . .	880 ,, ,, ,,
End of Nemed's colony,	. .	1110 ,, ,, ,,
Coming of Fir Bolg,	. . .	Beginning of Persian Empire.
Coming of Tuatha Dé Danann,	.	Usurpation of the Magi.
Coming of the Gaedhil,	. .	Beginning of Alexander's Empire.

The last three pairs of contemporary events supply the clue to the method of the synchronist. He had before him the Eusebian world-history with its epochs. He had in his mind the traditional or legendary epochs of prehistoric Ireland. These latter had no chronology. No trace of a native Irish chronology has been anywhere discovered. The synchronist followed the simple plan of making the Irish periods coincide exactly with the world-periods.

It will appear that the Magian conspiracy, which raised the impostor Smerdis for a few months to the throne of Cambyses, is a rather minor event against which to date the invasion of Ireland by the Tuatha Dé Danann. In my opinion the inclusion of this pair of events in the scheme [illegible] the refinement. That the Tuatha Dé Danann in genuine Irish tradition, aside from the theorizings of the schools, were no race of [illegible] immortal and divine, inhabiting the Celtic Otherworld [illegible] Celtic gods; that their conquest of the Fir Bolg or Irish aborigines is but a duplication of their traditional victory over the hostile god-race of the Fomori; all this has been long established quite conclusively by the great antiquary and historian who, within these last few weeks, has ceased to live among us, except in his achievements and in his inspiration, D'Arbois de Jubainville.[1]

Notwithstanding that the Tuatha Dé Danann were not a race of men, their story was intimately blended with the story of the Irish Celts. A place had to be found for them. They could not come later than the Gaedhil, their worshippers. They could not come earlier than the aborigines, for then they would be separated from the Gaedhil, and would appear to have been worsted by an alien people. They could only come between. The synchronist had already planned that the Fir Bolg period should coincide with the Persian world-kingdom. He looked down through the Persian dynasty for an appropriate break at which the Tuatha Dé Danann could be introduced. The only such break was the temporary usurpation of Smerdis, and it sufficed.

The artificial character of this arrangement is emphasized by its effect on the scheme. It assigns 37 years to the Fir Bolg, and 197 to the Tuatha Dé Danann—figures worth noting, as we shall afterwards see. Eight reigns of the Fir Bolg are compressed into the 37 years. The 197 of the Tuatha Dé Danann contain only seven reigns.

This disposition points to a yet older version of Z than Flann's original. Of the five invasions, there are two which still do not coincide with definite world-periods. We should have expected to find that coincidence in the oldest version; and we shall see whether any traces of it have been preserved elsewhere. Omitting the Tuatha Dé Danann, there are four great legendary invasions or settlements of Ireland. In the world-history of the synchronists, there are also four great world-kingdoms in continuous succession down to the Roman Empire—the Assyrian, the Median, the Persian, and the Greek. The last two are accounted for in Z as we have it. There should have been a document, older than Z, in which the coming of Partholon coincided with the foundation of the Assyrian Empire, and the coming of Nemed with the foundation of the Empire of the Medes.

6. Z Compared with other Synchronistic Accounts.

According to Synchronism B, Ninus, the founder, as was believed, of the Assyrian monarchy, began to reign 21 years before the birth of Abraham. Keating, relying on some Irish computation, not now in evidence, teaches that Partholon came to Ireland 22 years before the birth of Abraham. The

[1] For the silence of Nennius about the Tuatha D. D., see *Nennius Vindicatus*, pp. 221, 222.

difference is that which frequently arises from a confusion of *n* years with the *n*th year. Dr. MacCarthy, indeed, in his translation, has corrected the 21 of B to 22, in accordance with the Eusebian chronicle. Keating connects his date for Partholon's arrival with the doctrine that the event took place 300 years after the Flood, and this is precisely the unamended teaching of Z. There must, then, have been an early synchronism, akin to Z, which laid down that Partholon came to Ireland in the first year of the Assyrian world-kingdom.

It only remains to show that Nemed's colony was regarded as contemporaneous with the Median dynasty. According to Z (IV), Nemed came to Ireland 1562 years after the Flood. According to B, the Assyrian monarchy began 300 years after the Flood, and lasted 1240 years. Thus the Median world-kingdom should have begun 1540 years after the Flood. This brings Nemed's arrival within 22 years of the beginning of the Median period. This difference will be accounted for if we suppose that originally the Assyrian sovereignty was taken to have lasted 1240 years, not from its foundation, but from the birth of Abraham, or what is the same thing, from the beginning of "the Third Age of the World"; for Ninus founded the Assyrian kingdom 21 or 22 years before this epoch.

We have thus sufficient indications of the existence of an ancient synchronism arranged on this basis.

1.	Coming	of	Partholon	=	beginning	of	Assyrian world-kingdom.
2.	,,	,,	Nemed	=	,,	,,	Median ,,
3.	,,	,,	Fir Bolg	=	,,	,,	Persian ,,
4.	,,	,,	Gaedhil	=	,,	,,	Greek ,,

The most striking feature of this scheme is the late period assigned to the Gaelic conquest of Ireland. On that point Z does not waver. With many reiterations, the Gaelic immigration is timed against the world-sovereignty of Alexander the Great. In this respect, too, Z does not stand alone.

7. The Doctrine of A.

In the light of our analysis of Z, Dr. MacCarthy's synchronism A will repay inspection. Dr. MacCarthy regarded A as a very ancient document, as old as the sixth century. If this be so, and I see no reason to dispute it,[1] A, which is written in Middle-Irish, must also have had a Latin original. Indeed, like Z, but still more copiously, it preserves many phrases in the original Latin.

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[1] MacCarthy's proper inference should be that A is founded in part on a very ancient document; and so, too, with regard to his finding that "the *Annals of Innisfallen* are the most ancient body of [Irish] chronicles we possess." Todd Lect. iii., p. 369.

In A's computation, Partholon came to Ireland 1002 years after the Flood, or in 1957 B.C. (this date, we have seen, was introduced as an emendation into Z). His people remained in Ireland 1000 years, until 957 B.C. Nemed came to Ireland in 925 B.C. We are not told how long his colony lasted, and there is no mention of the Fir Bolg or the Tuatha Dé Danann. In the Book of Invasions, Nemed is the ancestor of the Fir Bolg, the Irish aborigines. Possibly, then, the author of A identified the coming of Nemed with the coming of the Fir Bolg. Possibly, too, he saw no necessity for fixing the immortal race of the Tuatha Dé Danann in his chronological framework. At all events, he says nothing about an end of Nemed's colony or about any other invasion from their time until the time of the Gaedhil.

A next tells how the sons of Míl came to Ireland, 440 years after Exodus, i.e. in 1071 B.C., according to A's reckoning. This statement is an obvious interpolation, for it makes the Gaelic invasion not only earlier than the arrival of Nemed, 925 B.C., but even earlier than the end of Partholon's colony, 957 B.C.; and the text says that when Partholon's colony died out, Ireland was empty of inhabitants for 32 years.

Having mentioned "the taking of Ireland by the sons of Míl," the synchronism adds, "from the taking of Ireland to the sack of Troy, 328 years"; and, later on, "from the taking of Ireland to the time of Cimbaeth, 1202 years." When these dates are worked out, they show that, in each instance, "the taking of Ireland" has been substituted for "the passage of the Red Sea by the Israelites." Hence it follows that the sons of Míl have no proper place in A and should be eliminated.

Next among Irish events is the foundation of the Ulidian kingdom of Emain Macha. This event took place in 307 B.C. Then comes the ancient original of the well-known statement in Tigernach: "The tales and histories of the men of Ireland are not known and are not authentic till the time of Cimbaeth son of Fintan." The men of Ireland are the Gaedhil. According to A, then, the history of the Gaedhil begins with the foundation of the Ulidian kingdom. That being so, we can understand how the legend of Míl could find no place in A except by an inept interpolation.

Then follows a detailed account of the Ulidian dynasty from its foundation to the death of Conchobor mac Nessa, A.D. 24. No other dynasty is mentioned during this time. Perhaps the author held that Emain was the capital of Ireland in those days, and that the Ulidian kings ruled the island. At all events, he was certainly a partisan and adherent of the Ulidian tradition, which consistently ignores the legend of Míl and of the Irish monarchy vested in his earlier descendants.

The duration of the Ulidian dynasty is from 307 B.C. to A.D. 24—331 years. This at once suggests the date of Alexander's world-kingdom, 331 B.C. We conjecture that a shifting of 24 years has been made, perhaps by a redactor who had the doctrine of Z before him and desired to give the priority to the sons of Míl. There was some shifting of dates, certainly, for the foundation of Emain is first placed in the 18th year of Ptolemy, 24 years after Alexander became king of the world, and again "33 years from the beginning of the sovereignty of the Greeks." When we turn to B, we find our conjecture amply confirmed; B says: "Alexander, first king of the Greeks, 5 years, and Cimbaeth, son of Fintan, in his time."

A says that Conchobar reigned 60 years: but the terminal dates assigned, from the 15th year of Octavius to the 10th of Tiberius, allow only 50 or 51 years. Here is the same difference as in the foregoing paragraph, 9 years, indicating an emendation interpolated and not strictly carried out. A poem on the Ulidian dynasty (LL 21β) gives 50 B.C. as the date of Conchobor's accession:

> Cethri chēt bliadna brassa ad fét cach súi senchassa;
> fot a flatha na fer ngaeth ó Choncobur co Cimbáeth.
> Cethri chēt coíca bl*iadna* ad fét cach súi saerchialla
> cia nós fēgaid fri gnīm gaeth cor gēnair Cr*ist* iar Cimb*aeth*.

> "Four hundred lively years each master of antiquity tells,
> the length of the wise men's rule from Conchobor [up] to Cimbaeth.
> Four hundred and fifty years every master of liberal mind tells,
> if ye look to a wise work, till Christ was born after Cimbaeth."

Thus there is good evidence of an early doctrine which made the Ulidian dynasty, from Cimbaeth to Conchobor, exactly fill up the 331 years from Alexander's conquest of the Persians to the commencement of the Christian era. Since A presents a much less developed legend than Z, I think it must be earlier in origin, and that in its original form it must have suggested the plan of equating world-periods with Irish periods, which Z preserves in a modified form. The original of A may therefore well have been drawn up in the sixth or early seventh century.

8. Z the Foundation of Later Chronological Schemes.

Irish historians did not long remain content with the view that the Gaelic occupation of Ireland was no more ancient than 331 B.C. The dates assigned grew gradually more and more remote. Dr. MacCarthy quotes a number of them (p. 246): 544, 1066 (?), 1071, 1229, 1569. The Four Masters will have it that the Gaedhil reached Ireland as early as 1700 B.C. As a rule, the later the historian, the earlier his date for this event.

Notwithstanding these discrepancies, the later accounts of prehistoric Ireland find the source of their chronology in Z.

The redactor of the Leabhar Gabhála in the Book of Leinster assigns a much earlier period to the Gaelic conquest than Z, but preserves the Fir Bolg period of 37 years and the Tuatha Dé Danann period of 197 years, as in Z.

Synchronism B puts the Gaelic conquest at 1229 B.C.—nine centuries earlier than in Z—but has a Fir Bolg period of 35 years and a Tuatha Dé Danann period of 197 years.

Gilla Coemáin's chronological poem (MacCarthy, "Todd Lectures," pages 151–157) requires as early a date as 1545 B.C.—twelve centuries before Alexander—for the Gaelic conquest, but has a Fir Bolg period of 37 years and a Tuatha Dé Danann period of 197 years.

Keating (Irish Texts Society, vol. iv., pp. 196, 225) assigns 36 years to the Fir Bolg and 197 to the Tuatha Dé Danann.

Evidently, then, the Cyrus-Cambyses-Alexander chronology of Z lies at the root of the school-made histories of prehistoric Ireland. The Z version of the legend of Míl and his sons is thus the oldest version now known. One broad conclusion follows with certainty, Gilla Coemáin's long list of 136 monarchs of Ireland before St. Patrick's time is for the most part the product of medieval invention. The earlier section of the Irish genealogies, constructed in harmony with that list, must also be in the same degree artificial. Probably the materials in each case were collected largely from traditional sources; but the structure bears the same relation to genuine Irish tradition as a modern edifice built out of the stones of Clonmacnois might bear to the ancient monastery.

NOTES.

I. *Partholon.*—This is not a Gaelic name. It appears again in Flaithiusa Hérenn (BB 43 *a* 13), where the pedigree of Cruithne, eponymous ancestor of the Cruithni or Picts, is "Cruithne mc. Uige mc. Luchta mc. Parrtholon"; in the Irish Nennius (BB 203 *a* 13) "Cruithne mc. Cinge mc. Luchtai m. Parrthalan." In the same tract (206 *a* 34) the name is also Parthai, genitive of Partha. Even if we suppose the scribe to have substituted the more familiar name Partholón for Partha as ancestor of the Picts, we could not well disconnect the two names. The ending -lón may represent -launos or -vellaunos; but if so the long vowel would indicate that the Irish borrowed the name from Cymric with a Cymric pronunciation. Such a borrowing would also account for the initial P. Can Parth- be a Pictish equivalent of the Cymric Pret- , Irish Cruth- = *Qret-, Qrit- (Ogham Qritti, Lugu-qrit), whence Cruithni? It seems to recur as eponym of the

Part-rige people who, though they inhabited an extreme western region in Ireland to the west of Loch Mask, retained the letter p in their speech and were, therefore, probably not of Gaelic origin. The neighbourhood of Tuam was inhabited by a Pictish race, the Sogain, until the ninth century; and some of the same race were subject to the rulers of Ui Maine long afterwards. I am, therefore, inclined to believe that the Partrige were Picts, that Partha, ancestor to the Picts, supplied their eponym, and that the story of Partholon is a legend of the Picts, symbolizing perhaps the antiquity of their race and its overthrow in Ireland. It will be observed that in Z (I.) the race of Partholon is destroyed, not by pestilence, but by a hostile race, the Conchinn or Hound-heads (perhaps High-heads, *i.e.* the tall folk, for con- = cuno- may give either meaning). The writer promises to tell more about this event. But in the tract as it now exists, the story of the pestilence is briefly substituted (II.). Here we have additional proof of late tampering.

IV. *Nemed.*—I have failed to discover any consistent reckoning among the various periods assigned to the beginning and end of Nemed's colony. At least two distinct accounts, based on different chronologies, are here combined in one: for it is twice stated that Nemed's arrival was 470 years before the end of the Assyrian Kingdom; it is twice stated that his colony lasted for 230 years; and it is twice implied that it overlapped the period of the Medes, who follow the Assyrians. The Irish quatrains quoted in this section show interpolation, since they cannot have belonged to the original of Z.

VIII. *Mil.*—We have here the oldest known version of the legend of Míl, and the vast difference between this and the later forms of the legend, which are typified in Keating's narrative, shows how the story of prehistoric Ireland developed in the early Christian period. There is little in the legend of Míl, early or late, that bears the semblance of Celtic tradition. In almost every detail it shows the work of the penman and the Latinist. The ancient Irish writers searched their Latin authors for names that would suggest an origin for the Irish.[1] The writer of this story hit upon the name Iberi, not the Iberi of western Europe, but the Iberi who dwelt south of the Caucasus, and with whom the Romans came in contact under Pompey and again under Trajan. The resemblance of this name to Hiberio and Hibernia was all that could be desired. Later writers substituted the Scythi for the Iberi because Scythi resembled Scotti.[2] They introduced Breogan from Irish tradition as

[1] The map of "Orbis terrarum secundum Eratosthenem et Strabonem" in Spruner's Atlas Antiquus (Gothae, MDCCCL.) shows clearly the material on which the story of the migrations of the Gaedhil was founded.

[2] This substitution already appears at the end of the eighth century in Nennius.

a new grandfather for Míl, and seizing on a passage in Orosius they connected Breogan with Brigantia, and gave "ostium Scenae" an undefined location in Irish topography. Mag Breogain was a plain in east Munster, inhabited by the Muscraige Breogain. Except the Iberi, nearly all the features of the legend in Z are retained but differently placed in the later versions. The present version may have been already invented before the seventh century, for S. Columbanus of Bobbio, in two of his letters, uses Hiberi as a name for the Irish.

Comparison of the spellings of names in the Hieronymo-Eusebian chronicle (H) with the spellings in Z, B, and Flann's poem, Lecan 43β (F):—

H	Z	B	F
Armamithres	Armit*er*es	Armimentes	Armament*er*es
Mamylus	Maiminitus	Maimintus	Mamitidus
Manchaleus	Macholius	Masailius	Machalius
Ascatades	Ascaidias	Ascaitias	Ascathias
Atossa	Athosa	Ahosa	Athoss
Semiramis	Saimiraimmis	Asaimiraimis	Samiramis
Balepares	Poilipoiris	Poilipoiris	Polip*ar*is[1]
Sosares	Sosaires	Sossairses	Susp*ar*es[1]
Lampares	Lampades	Lampaires	Lampades
Panyas	Proeminias	Piamineas	Pan*n*anias
Sosarmus	Soparrdis	Suffardus	Sophardus
Mithreus	Metralis	Metaralnius	Metralius
Tautamus	Tutanes	Tutanes	Tutanes
Teutaeus	Flethius	Flaithius	Fletius
Eupales	Calafares[2]	Lapales	Lampaleis
Laosthenes	Lanteis	Lauistentes	Lustines
Peritiades	Perifianis	Peridioidis	Parathathis
Ophrataeus	Offrailus	Ofratolus	Affratulus
Tuonus	Tonus	Tomus	Tonus
Arbaces	Arbait	Aarbatus	Arpait
Sosarmus	Suffonus	Sogafanes	Susfonius
Mamycus	Madidus	Maidius	Madius
Cardaces	Cardicias	Cairdisis	Ardeichias
Deioces	Deochus	Diones	Teochus
Cyaxares	Ciratreas	Cirasserses	Ciraxerses

[1] In each of these words the syllable *par* is represented by a *p* with the stem crossed (= *per*) and with *a* overwritten (= *ar* or *ra*), so that it is possible to read *perar*.

[2] Here *xxx.* = *triginta* precedes, and probably the final *-ta* read as *-ca* has been added to the misread *Lapales* = *Eupales*. For the misread *l* see also *Mithreus*, *Teutaeus*, *Ophrataeus* in H.

These lists prove that the material of H passed through one and the same hand before it issued in Z, B, and F. Since Z is a Middle-Irish redaction of an eighth-century document, and since the conclusion of F is taken direct from Z, there can be no reasonable doubt that Flann of Monasterboice, reputed author of synchronisms and inscribed author of F, was also the Middle-Irish redactor (and part-corruptor) of Z. It is also highly probable that, having failed by interpolations, omissions, and alterations, to make Z conformable to the views of his school, Flann set to work afresh and produced B, using the Eusebian material which he found in Z as his warp, but weaving into it the Irish names and chronology accepted by his own school. The origin of some of the misspellings in Z, B, and F can be traced to misreadings of archaic Irish writing. In comparing these lists, due allowance must be made for the freedom or negligence of transcription after the time of Flann.

I have to thank Professor Kuno Meyer for a number of corrections and suggestions.

VII.

THE EARLIEST PRINTING IN DUBLIN, IN THE IRISH, LATIN, GREEK, HEBREW, FRENCH, ITALIAN, SAXON, WELSH, SYRIAC, ARMENIAN, AND ARABIC LANGUAGES.

By E. R. McC. DIX.

Read 11th April. Ordered for Publication 15th April. Published July 16, 1910.

Introduction.

It may be of some interest to place on record the earliest printing of classical, European, and Oriental languages in Dublin; and this paper is an attempt to do this in a preliminary way.

When citing Talbot Baines Reed as my authority, I quote from his "History of the Old English Letter Foundries," with Notes, London, 1887 (E. Stock), a standard work on the subject.

Irish.

The first type (other than the ordinary Roman type) used in Dublin was that for the purpose of printing in Irish, and is known as the Elizabethan fount of Irish type. It was used in 1571 to print the well-known Catechism and a poem; and there is evidence that it was also used to print a proclamation; and subsequently it was used to print an edition of the New Testament, 1602–3, and the Prayer Book, in 1608–9; Bedell's "A B C," in 1630, etc. But this fount, it is well known, was very defective in representing the Gaelic characters. The letter "a" in it was simply indicated by an *italic* "*a*" and not by a Gaelic "ᴀ". There are, in fact, nine Roman and two italic letters in the fount. I beg to offer as a matter of conjecture that this was not a fount cast for Irish type at all, but was simply a fount of Anglo-Saxon type which, being in some letters identical with the Gaelic letters, was used to print the Irish alphabet and other works in Irish. Archbishop Parker was much interested in Anglo-Saxon literature, and for him John Day, the well-known London printer, about 1567 cut the first Saxon types which were used for printing editions of the Saxon

Gospels and other books edited by the Archbishop in 1574, etc. (*Vide* Johnson's Typographia, vol. ii., p. 455.)

Latin.

The earliest "book" printed in the Latin language in Dublin was a medical work, by Dr. Dermod Meara, or O'Meara, entitled "Pathologia Haereditaria Generalis," &c. (a treatise on hereditary disease). It was printed in Dublin in the year 1619, and is a duodecimo of 146 pp. A copy is in the Library of Trinity College, Dublin; and there are three copies in English libraries. It is very rare. The printers were Felix Kingston and Thomas Downes, the London stationers who acquired John Franckton's Patent and position as "State Printer" in Ireland in 1618.

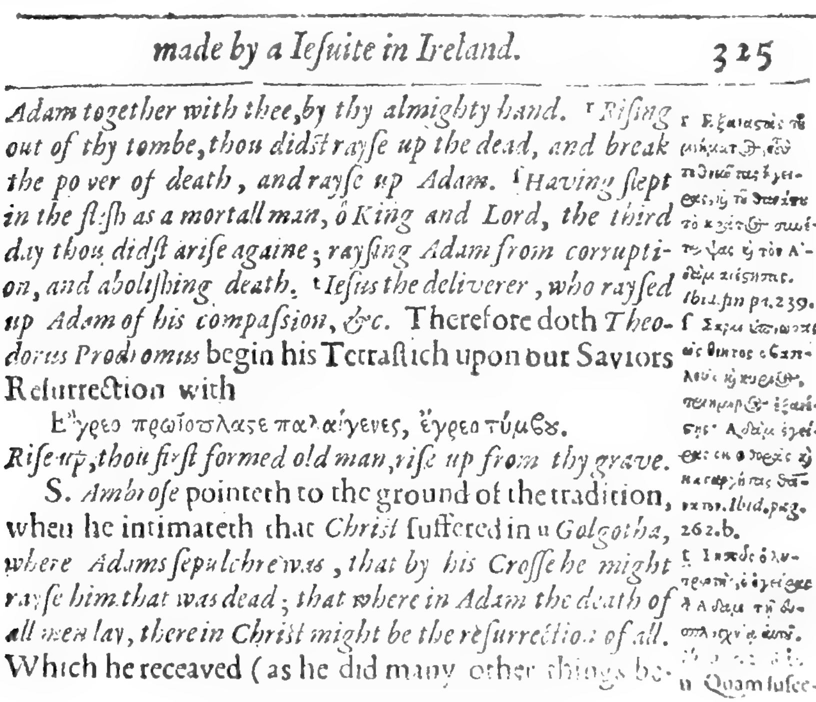
For printing Latin no special fount of type was required; and so it is not surprising to find that Latin words, phrases, and sentences are to be found in still earlier Dublin printing. Latin was then the language of the learned of all countries, and was better known than English by some of the Irish chieftains, for which reason, probably, and for use, it may be, abroad, one of the State Proclamations issued in 1605, was printed in Latin. In a pamphlet issued in 1606 and printed here by Franckton, occur several phrases or sentences in Latin. Thus in Merick's "Abstract of the Statutes" (Dublin, 1617) occur two or three Latin sentences and some odd words. Similarly, in Bolton's edition of the Irish Statutes, printed in 1621, several Latin passages will be found, and the same may perhaps be also found in earlier books or proclamations printed in Dublin prior to 1619, to which I have not access at present. After that date many books were printed in Latin in Dublin in the seventeenth century.

Greek.

The Greek language having a character of its own, printing in it involved the use of special type cast for the purpose. All type, so far as I know at present, used in Dublin in the seventeenth century, was procured from England or the Continent. I mean it was not cast or made in Ireland.

The earliest use of Greek type by a Dublin press that I have found so far occurs in Sir C. Sibthorp's "Friendly Advertisement," &c., and in Archbishop Usher's "Epistle concerning the Religion of the Ancient Irish," &c.; both printed in Dublin in 1622, and again issued in 1623, attached together in one volume, but with separate pagination. In the former volume there is Greek type on thirty-three pages chiefly in a very small fount, both in text and margin; but there also occurs a larger fount in the text only, i.e. on the versoes of signatures *b2* and *c2* (Preface), and on signature *c5*—in all eighteen words. In the smaller fount the largest number of words occurring on a single page is sixteen on page 380. The Greek type is to be found in the latter volume almost entirely in some marginal notes on pp. 3, 17, 19, 21, 46, and 83, and is here of a small fount. At page 54, however, occur two lines in the text of a larger and peculiar fount.

Greek type of two founts is also to be found in Usher's "Answer to a Challenge made by a Jesuite in Ireland," &c., printed at Dublin, in 1624, by the Company of Stationers. One is a small type, brevier Greek, and occurs in the margin of very many pages, far too numerous to give in detail, and thrice in the text (see pp. 357 to 359), but consists of sentences or quotations of some length from certain authors. The larger fount, pica Greek, occurs to a lesser extent in the text itself on fifty-one different pages, sometimes in sentences or in several lines, or else in odd words. (*Vide* fig. 1.)



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Adam together with thee, by thy almighty hand. r *Rising out of thy tombe, thou didst rayse up the dead, and break the power of death, and rayse up Adam.* s *Having slept in the flesh as a mortall man, ô King and Lord, the third day thou didst arise againe; raysing Adam from corruption, and abolishing death.* t *Iesus the deliverer, who raysed up Adam of his compassion, &c.* Therefore doth *Theodorus Prodromus* begin his Tetrastich upon our Saviors Resurrection with

Ἔγρεο πρωτόπλαστε παλαίγενες, ἔγρεο τύμβου.

Rise up, thou first formed old man, rise up from thy grave.

S. *Ambrose* pointeth to the ground of the tradition, when he intimateth that *Christ* suffered in u *Golgotha, where Adams sepulchre was, that by his Crosse he might rayse him that was dead; that where in Adam the death of all men lay, there in Christ might be the resurrection of all.* Which he receaved (as he did many other things be-

Ibid. pag. 262.b.

u Quam susce-

FIG. 1.—Two Founts of Greek Type.

In a very rare work, entitled shortly, "Musarum Lachrymae; sive Elegia Collegii Sanctae & Individuae Trinitatis, &c., in obitum . . . Comittessae Corcagiae," &c., printed, in 1630, in Dublin, and consisting of numerous poems, in several languages, there are three in Greek, and printed in that character.

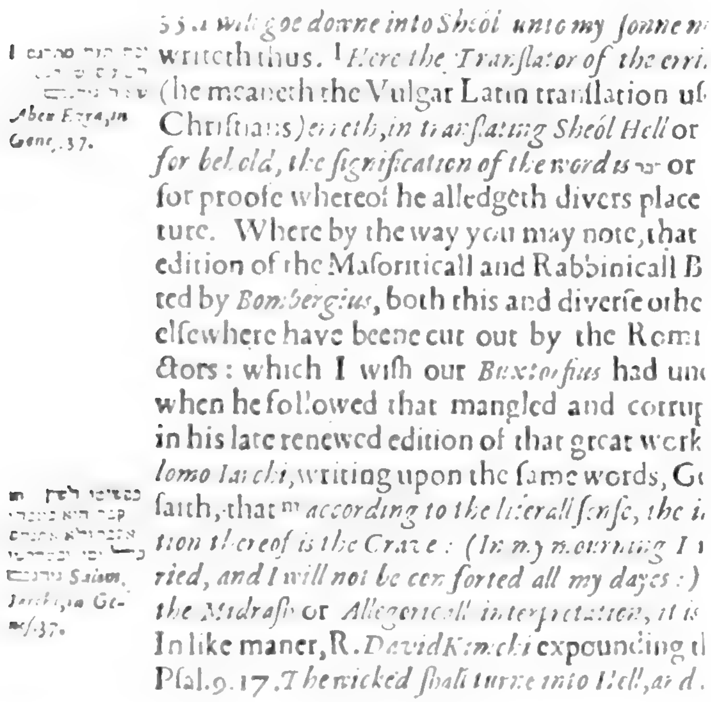
In Usher's "Gotteschalche et Praedestinatione Controversiae," &c., printed in 1631, occur, at page 207, four lines and two words in Greek type, also of pica Greek, with a different face, and mixed with a type of a different fount.

I have not met, so far, any work entirely printed in Greek in the seventeenth century in Dublin.

Greek type was first used at Oxford in 1586.

Hebrew.

As regards printing in Hebrew, involving also a totally different alphabet and special type, the earliest use of Hebrew letter in printing at Dublin occurs in the volume already referred to, i.e., Usher's "Answer to a


35. I will goe downe into Sheól unto my sonne m
writeth thus. *Here the Translator of the erri.*
(he meaneth the Vulgar Latin translation us
Christians) *erreth, in translating Sheól Hell* or
for behold, the signification of the word is or
for proofe whereof he alledgeth divers place
ture. Where by the way you may note, that
edition of the Masoriticall and Rabbinicall B
ted by *Bombergius*, both this and diverse othe
elsewhere have beene cut out by the Rom
ctors: which I wish our *Buxtorfius* had un
when he followed that mangled and corru
in his late renewed edition of that great work
lomo Iarchi, writing upon the same words, G
saith, that *according to the literall sense, the i*
tion thereof is the Grave: (In my mourning I
ried, and I will not be comforted all my days:)
the Midrash or *Allegoricall interpretation, it is*
In like maner, R. *David Kimchi* expounding t
Psal. 9. 17. *The wicked shall turne into Hell, and.*

Aben Ezra, in Gene. 37.

Salom. Iarchi, in Gene. 37.

Fig. 2.—Hebrew Type in margin.

Challenge," etc. (1624), in which on fifteen different pages occur, in Hebrew, words, notes, and phrases, both in the text and margin. The type is of one fount and small. (*Vide* fig. 2.) It also occurs twice in Sibthorp's "Friendly

Advertisement" (1622–1623), i.e., two words on the verso of signature A 5 and one word on p. 349.

The next occurrence of Hebrew type is to be found in another volume already mentioned, viz., "Musarum Lachrymae," etc. (1630), in which are to be found three poems in Hebrew and printed in that character.

In Provost Winter's "Two Sermons on Baptism," printed here in 1650, occurred occasionally Hebrew words in a fount of small type.

I do not know of any work entirely or largely of Hebrew characters printed in Dublin prior to 1700 at all events.

Hebrew type was first used in England in 1592, and at Oxford in 1596, four years later.

WELSH.

In the "Epistle concerning the Religion of the Ancient Irish" (1622), already referred to, at p. 80, occurs a stanza in the Welsh language of nine lines, with a translation. Printing in Welsh involved no special type, and in that respect presented no difficulty to the compositor or printer.

SAXON.

In the same work, just mentioned, at p. 35 (margin), occur four words said to be Saxon; but the letters are, I think, taken from the Elizabethan fount of Irish type, or one of very similar character.

FRENCH.

The earliest work entirely printed in literary French is "La Liturgie," etc., printed in Dublin in 1666, no doubt for some of the French refugees. It is a version of the Book of Common Prayer.

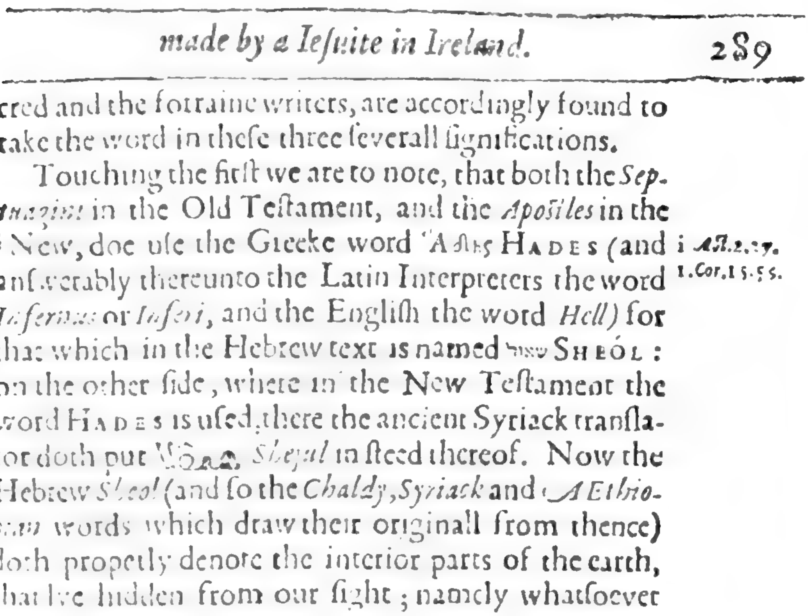
Sir John Davies' "Les Cases en Ley" (Dublin, 1615) is in Norman or law-French.

ITALIAN.

The earliest work printed in Dublin in Italian is entitled "L'Oratione," etc. It is a translation by the learned Dudley Loftus of a speech of the Duke of Ormond, and was printed in 1664 in Dublin. Why this Italian version was printed I do not know.

Syriac (Old).

In Usher's "Answer to a Challenge," etc. (1624), occurs, at p. 289, one word in Syriac character, that for "Sheol." (*Vide* fig. 3.)



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cred and the forraine writers, are accordingly found to take the word in these three severall significations.

Touching the first we are to note, that both the *Septuagint* in the Old Testament, and the *Apostles* in the i New, doe use the Greeke word ᾅδης Hades (and answerably thereunto the Latin Interpreters the word *Infernus* or *Inferi*, and the English the word *Hell*) for that which in the Hebrew text is named שאול Sheól: on the other side, where in the New Testament the word Hades is used, there the ancient Syriack translator doth put ܫܝܘܠ *Shejul* in steed thereof. Now the Hebrew *Sheol* (and so the *Chaldy*, *Syriack* and *Æthiopian* words which draw their originall from thence) doth properly denote the interior parts of the earth, that lye hidden from our sight; namely whatsoever

i Act. 2. 27. 1. Cor. 15. 55.

Fig. 3.

In "Logica, seu Introductio in totem Aristotelis Philosophiam," etc., by Dudley Loftus, there are some words in Syriac type on p. 3 of the "Epistola Dedicatoria." This book was printed in Dublin in 1657 by William Bladen.

In a volume entitled "A Clear and Learned Explication of the History of Our Blessed Saviour," by D. Syrus, translated by Dudley Loftus, are to be found some words in Syriac type, at pp. 7, 9, 15, 16, 21, 32, 45, and 79. This work was printed in Dublin in 1695. (*Vide* fig. 4.)

In 1637 Usher mentions in a letter a project to purchase Syriac type abroad; and negotiations, both in Paris and Geneva, appear to have been conducted with the object of obtaining such. (*Vide* T. B. Reed, pp. 67, 68, quoting from Parr's "Life and Letters of Usher," London, 1681, fol., p. 486.)

The earliest printing in Syriac at Oxford (*vide* Madan's "Chart of Oxford Printing," 1904) was in 1661, and at London in 1652. (*Vide* T. B. Reed, p. 68).

Moreover, The Goſpel, according to Cuſtom, and with regard to the accompliſhment of things, produceth an Allegation; for Iſaiah ſaith, *There ſhall come forth a Rod from the Root of Jeſs, and a Bough ſhall ſprout forth:* And in the Hebrew a *Branch* or *Bough* is expounded a *Branch*, and *Nazaren* one who *ſprouts out*; and when Mathew ſaw that Chriſt came and dwelt in Nazareth, he expounded this of Eſaiah, *A Branch ſhall ſprout out, He ſhall be called a Nazaren*; and he was called a *Nazaren* from Nazareth, that is, [illegible] *one ſprouting out*, from [illegible] *a Sprout*; ſo they are expounded in the Hebrew Tongue: Others ſay that [illegible] which is [illegible] is expounded *New*, and that *Nazareth* ſignifieth *New*, and ſignifies Typically that the Son would newly be made Man for Men: Others ſay, That Nazareth ſignifies *Juſtice*, and Nazaren ſignifies Juſt; and if they ſhall ſay, that becauſe he was born in Bethlehem, and not in Nazareth, Eſaiah calls him [illegible] let them know that the Apoſtles called him as did the Prophets, and that this of Bethlehem was not hid as to the Prophecy, but chiefly intended, according to that of Nathaniel,

FIG. 4.

ARMENIAN (OLD).

In the "Logica," etc., occurs, in the margin on p. 49 of the text, one word in Armenian type. There are also some Armenian words in the margin of p. 91. The earliest acquisition of this type in Oxford was in 1667.

ARABIC.

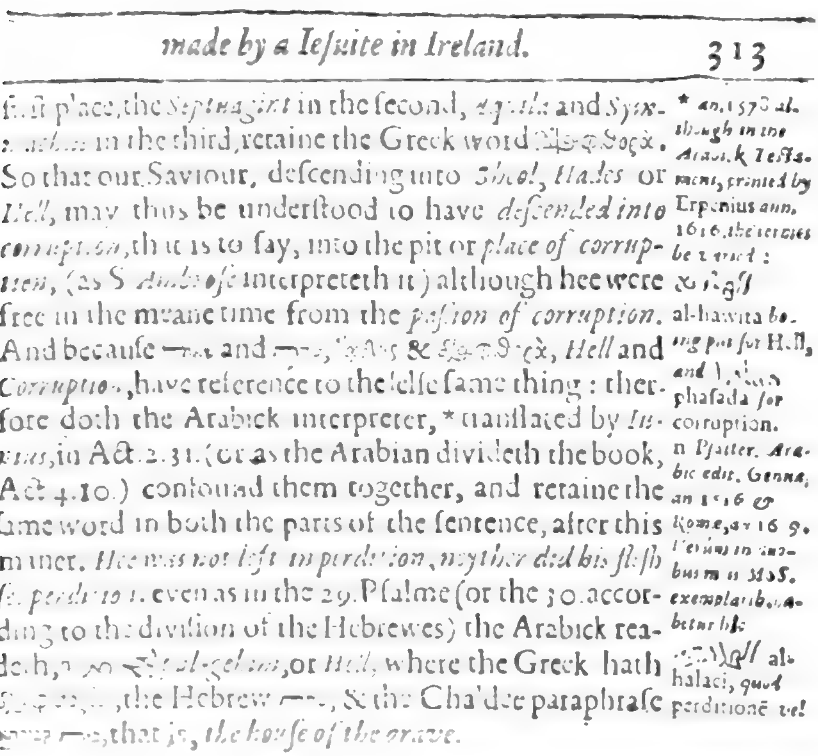
In Usher's "Answer to a Challenge," etc. (1624), occur, on p. 297, two words in Arabic type, in the text; and at p. 313 occur three words in the same type in the marginal note, and one in the text, and at p. 324 one word in the text—seven words in all. Each word seems one type or block. (*Vide* fig. 5.) Where this type was obtained from I do not know. Perhaps the words were specially cut in wood blocks. This was done in similar cases in England. The earliest use of Arabic type in Oxford was not till

1648, that is twenty-four years later. [*Vide* Madan's Chart of Oxford Printing (1904)]. There were Arabic founts on the Continent, i.e., at the Vatican Press in 1591.

The Arabic character or type has been used by the Persians since the conquest of their country by the Moslems, with less exactitude, however, as regards distinguishing dia-critical dots.

[Authority, Mr. E. G. M. Swifte, B.L.]

In the "Logica seu Introductio," etc. (Dublin, 1657), occur on p. 10 in the text (Epis. Dedica. some words in pure Persian, and on p. 16 some words in Arabic as used by a Persian, as I am informed after inquiry at the British Museum.



made by a Iesuite in Ireland. 313

first place, the *Septuagint* in the second, *Aquila* and *Symmachus* in the third, retaine the Greek word [illegible]. So that our Saviour, descending into *Sheol*, *Hades* or *Hell*, may thus be understood to have *descended into corruption*, that is to say, into the pit or *place of corruption*, (as S. *Ambrose* interpreteth it) although hee were free in the meane time from the *passion of corruption*. And because [illegible] and [illegible], [illegible] & [illegible], *Hell* and *Corruption*, have reference to the selfe same thing: therefore doth the Arabick interpreter, * translated by *Iunius*, in Act. 2. 31. (or as the Arabian divideth the book, Act. 4. 10.) confound them together, and retaine the same word in both the parts of the sentence, after this manner. *Hee was not left in perdition, neyther did his flesh see perdition*: even as in the 29. Psalme (or the 30. according to the division of the Hebrewes) the Arabick readeth, [illegible] *al-gehim*, or *Hell*, where the Greek hath [illegible], the Hebrew [illegible], & the Chaldee paraphrase [illegible], that is, *the house of the grave*.

* an. 1578 although in the Arabick Testament, printed by Erpenius ann. 1616. the verses be thus: [illegible] al-hawita being put for Hell, and [illegible] phasada for corruption.

n Psalter. Arabic edit. Genua, an. 1516 & Rome, an. 1619. [illegible] in [illegible] MSS. exemplaribus [illegible] [illegible] al-halaci, quod perditionē vel

Fig. 5.—Showing Arabic, Hebrew, and Greek Type.

VIII.

WILLIAM KEARNEY, THE SECOND EARLIEST KNOWN PRINTER IN DUBLIN.

By E. R. McC. DIX.

Read April 11. Ordered for Publication April 13. Published July 16, 1910.

In a paper read by me in July, 1908, upon Humfrey Powell, Dublin's first printer, there was mention made that the last document printed by Humfrey Powell was in 1566. From that year down to 1571 no specimen whatever of any printing in Dublin is known to exist, or has been recorded so far. In that year, 1571, appeared the two first specimens of printing in the Irish type sent over by Queen Elizabeth to Dublin. One of these consists of a poem; and the only copy of it which is known to exist is the broadside, on each side of which it is printed, and which broadside is to be found in the library of Corpus Christi College, Cambridge, in the "Archbishop Parker" Collection. It would seem to have been set up and printed as the first specimen of the type. It consists of twenty-two and a half stanzas of eight lines each, printed in three parallel columns. The whole broadside measures $15\frac{5}{10}$ by 11 inches. The "Queen Elizabeth" fount of type is an imperfect one; but Mr. Robert Steel, the eminent bibliographer, told me that the various type-characters are identical with the Old-Saxon characters; and it may be stated as confirmatory of this view that there is written at the top of the broadside in contemporary handwriting these words:—"This Irish ballad printed in Ireland who belike use the old Saxon caracte." I venture to submit that this type was simply Anglo-Saxon type cast by John Day in 1567 for Archbishop Parker, and used as if Irish type.[1] The imprint on the title-page of the "Alphabet and Catechism" (shortly to be mentioned) clearly stated that it was printed with Gaelic type at the cost of Mr. John Usher, Alderman. There is no reference in it to the actual printer. John Usher was *not* a printer by trade or business, as far as I am able to learn. In the imprint to the broadside a different Irish phrase is used. It runs thus:—"This is put into print by Mr. John Usher," &c.; but Dr. O. Bergin, whom I have consulted, does not consider that the Irish phrase means that Usher actually printed the broadside

[1] Some contractions may have been specially cast for Irish use.

himself, but rather "caused it to be printed," or provided for its printing, as an editor or publisher might do in these days. Hence the question of the actual printer is still left open; and the conjecture I will put forward now is not wholly untenable or inconsistent with the imprint on the broadside.

At the same time, or immediately afterwards, appeared the "Alphabet and Catechism" in Irish, a 12mo measuring $5\frac{11}{16}$ inches by $3\frac{3}{4}$ inches. It consists of fifty-four pages, numbered, and two pages of Errata, &c. In both the broadside poem and the Catechism are found initial letters that were used by Humfrey Powell at an earlier date, which seems to indicate that his press or some of his type, &c., had continued on here, probably in possession of the Government for whom he worked, and may have been used in the interval. The Catechism was prepared and published by John O'Kearney or Kearney—the name has various spellings. He, too, was not a printer; but he and Nicholas Walsh were the persons to whom were entrusted the printing of the Catechism, and the translation of the New Testament into Irish.[1] So far no direct particulars of who was or were the actual printers who set up this Irish type are on record. Perhaps John O'Kearney himself did so; but we will shortly find mention of a William Kearney, a relative of John O'Kearney, who *was* a printer; and of him I propose now to make mention.

The Government in England represented by the Privy Council there, having decided to have the New Testament translated into Irish and then printed, though there seems to have been much delay over the matter, in the month of August, 1587, wrote a letter to the Lord Deputy and Council of Ireland, and referred in it to both John O'Kearney and Nicholas Walsh, who had then translated the New Testament into Irish, but stated that the reason why it had not been printed was the lack of native Irish printers. The letter further proceeded to state that the manuscript of John O'Kearney was then in the hands of his relative William Kearney—the name is spelt "Carney," though there can be no doubt that it means "Kearney"—and of him it states that during a period of fourteen years, both in England and foreign parts, this *William Kearney* had become a master in the art of printing, knowing the Irish well, and how Irish type should be made and made use of; and they accordingly recommended him to the Irish Council as a proper person to be entrusted with the printing. Kearney is spoken of as the bearer of the letter, though, strange to say, no reference to it is to be found in the Public Calendar of the Irish State Papers. The letter in question is to be found in the Acts of the Privy Council of England), edited by Mr. Dasent. Calculating back fourteen

[1] John O'Kearney and Nicholas Walsh were dignitaries of St. Patrick's Cathedral.

years from 1587 takes us to the year 1573, very near to the year in which the Catechism appeared; and the fact that William Kearney was a relative of John O'Kearney, and knew Irish well, and how Irish type should be made and made use of, suggests that he may have learnt it in Dublin when that type was sent over here, or previously in London. Of course this is only conjecture; but so far as I know there was no other Irish type in existence at the time, not even abroad, nor for many years later, from which he could have learned. The fount of type was probably cast in London, and perhaps Kearney assisted at its making. He was, it would seem, always described as a *printer*; that was his trade or occupation.

Apparently nothing was done in 1587 nor for some years afterwards; but in October, 1591, being then apparently back again in England, he was permitted to pass with his presses over to Ireland for the purpose of printing Irish Bibles. I should add that he was in fact engaged as a printer or bookseller, or both, in London during 1590–91, and even into 1592. Probably, though the warrant was dated October, 1591, he may not have crossed over, or at least left London permanently, until the following year.

In a form of a State letter (existing amongst the muniments of Trinity College), evidently intended to be sent to each Bishop in Ireland by the Irish Privy Council, there is mention of William Kerney (or Kearney) again. He is described as a native of Ireland, and for twenty years brought up in the art of printing; and the Bishops are called upon to assist in collecting money to defray the cost of printing the New Testament. This letter is undated, but would appear to belong to the year 1593. It was certainly after 1587.

Kearney also appears to have been employed by the newly started College (Trinity), as there is extant amongst their manuscripts in their muniment-room, proposed terms, bearing date 18th March, "1596–7," from the College to Kearney, from which it would appear that after having set up his press in the College he had left it, taking away with him his press, type, &c., and also certain shelves, &c., which belonged to the College, as well as the printed sheets which he had bound himself to deliver to them. Kearney must have been already at work printing the Irish Testament, as in the Calendar of State Papers of Ireland for the year 1595 it is stated that the New Testament was then actually being set up and printed in Irish. It was probably at the end of 1596 or beginning of 1597, as I judge, that Kearney left the College.

Further, in the edition of the New Testament in Irish (Dublin, 1602), in the Preface or Address to the Reader (in Gaelic) which follows the title-page the reverend editor refers to the project contemplated for so many years before, and states that five years previously there had actually been set up of the New Testament in type as far as the sixth chapter of St. Luke's Gospel. I think it may fairly be taken that this preface was written in 1602, though the Address to King James (in English) cannot have been written till after his accession in March, 1603; but the date "1602" on the title-page seems to me to indicate that the text, with the title-leaf and Preface, was printed off ready to be issued in that year, but was delayed for some reason, or it is possible that some copies were issued in 1602, and the rest held back.

Calculating back five years from 1602 brings us to 1597, or, excluding 1602, even to 1596.

Again, in the same Preface there is a statement that it was "in the new College, near Dublin," that certain persons named "finished the printing in Irish type (at the expense of the province of Connaught during the Presidency of Sir Richard Bingham) up to the sixth chapter of St. Luke's Gospel," as just mentioned, but that the remainder of that Gospel and St. John's Gospel were not then printed, nor for five years afterwards. Now, Sir Richard Bingham was President of Connaught down to the end of 1596, so that the printing of the first portion of the New Testament must have been completed at the very least before, or early in, that year; and as it was done in the College, it was clearly set up by Kearney. I may seem to have laboured this point too much or unnecessarily; but in the absence of dated or accurately dated documents, it is important to collect every atom of indirect evidence or evidence bearing in any way on the subject, and by the total of such conjoint references deduce a reasonable conclusion, justly acceptable till better evidence is found.

The only extant piece of printing by Kearney bearing his name is a Proclamation which he printed for the Irish Government against the Earl of Tyrone. This Proclamation is dated *12th June* (1595), and in the imprint Kearney is described as "Queen's Printer," and the place of printing was "the Cathedral Church of the Blessed Trinity" (Christ Church). It is a single sheet, or rather two pages attached in one, and it measures 22½ inches in length by 11 inches in width. It is printed in black letter, except the heading and the imprint. There are sixty-seven lines, and each line of print measures 8 inches. This Proclamation was also printed in *Irish*, according to the Calendar of State Papers of Ireland. The initial letter that occurs in this Proclamation is quite different from Powell's.

William Kearney was not a member of the Company of Stationers of London, and what became of him is not known. The last mention of him is in the year 1597, as already shown.

The New Testament in Irish was not published in fact till the year 1603, when Kearney's successor, John Francton, was the printer, and his name occurs in its imprint. Possibly Francton, who printed here in 1600, was an apprentice of Kearney's, or learnt the business from him; but about him I hope to treat on a future occasion.

It is clear that Kearney must have printed a good deal, and there were various Proclamations printed for the Government here, but unfortunately so far extant copies have not been found. It is clear also that Kearney must have set up a good portion, if not all, of the New Testament in Irish several years before it appeared. While, therefore, it is possible that either Usher or John O'Kearney or someone else may have been the actual printer of the Catechism and broadside poem in 1571, yet it seems to me possible, even probable, that William Kearney was the actual printer; and, therefore, in the absence of clearer and more positive evidence to the contrary, I take him to be the second earliest known printer in Dublin.

IX.

CHEMICAL NOTES ON A STONE LAMP FROM BALLYBETAGH, AND OTHER SIMILAR STONE VESSELS IN THE ROYAL IRISH ACADEMY COLLECTION.

By RICHARD J. MOSS, F.I.C., F.C.S.

Read April 25. Ordered for Publication April 27. Published July 16, 1910.

In the year 1875, a farmer residing at Ballybetagh, near the Scalp, on the county Wicklow side, gave me a stone vessel of the so-called chalice-type, and it has been in my possession since that time. The donor was unable to tell me where the vessel was found; all he knew about it was that it had been a recognized object of antiquarian interest in his house as long as he could remember, and that it had been in the same house in his father's time.

In a paper on "Stone Chalices, so called,"[1] Mr. E. C. R. Armstrong discusses the probability of vessels of this type being lamps (a view which it appears was first suggested by Mr. Geo. Coffey, of the National Museum), and not cups or chalices, and comes to the conclusion, on grounds chiefly historical and ethnological, that the vessels are lamps. It occurred to me that a lamp of stone, if at all porous, would be sure to contain some trace of the oil or grease which had been burnt in it. The Ballybetagh vessel is of decidedly porous material, and therefore seemed a very suitable subject for experiment.

The Ballybetagh vessel, as represented in the accompanying photograph (fig. 1, p. 165), weighs 1756 grammes, and its specific gravity is 2·19. This very low specific gravity suggests a much-decomposed rock, and therefore a high degree of porosity.

I placed the vessel in a jar with about 300 c.c. of ether, and after the lapse of twenty-four hours removed the ether and distilled it. This operation left a darkish brown grease-like residue, weighing 0·092 gramme, and with a very distinct odour of tallow. The extraction with ether and the distillation were repeated several times until the residual grease weighed 0·775 gramme. This is only 0·04 per cent. of the weight of the vessel.

[1] Proceedings of the Royal Irish Academy, vol. xxvi., Sect. C, No. 13.

This greasy substance burned with a smoky flame like tallow. Its specific gravity at the temperature of boiling-water was 970·5 compared with water at 15° C. This is much higher than the specific gravity of tallow. The specific gravity of an old specimen of tallow under the same conditions was found to be 904·6; but on heating it for some hours its specific gravity rose to 923·7, and prolonged heating leaves a residue heavier than water.

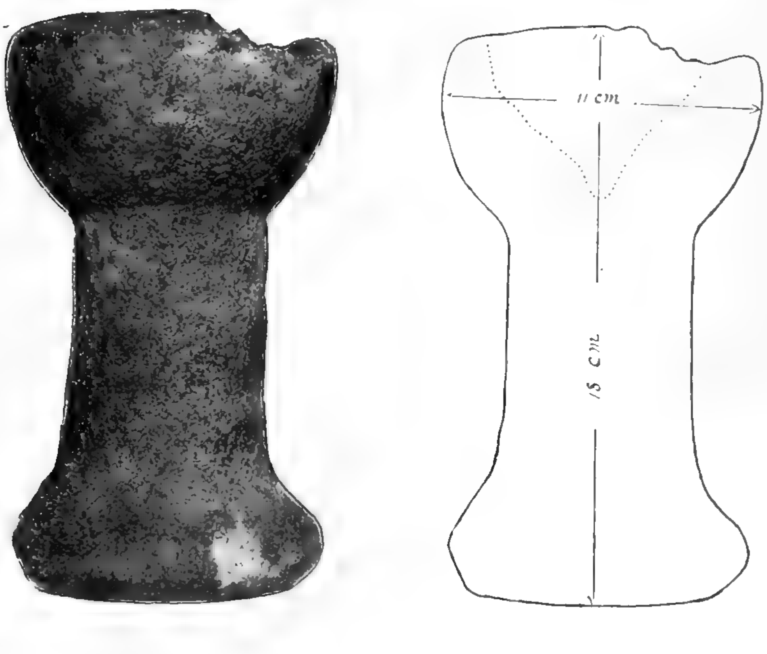


Fig. 1.

The substance dissolved almost completely in alcohol, leaving a small, flocculent, dark-brown residue. The alcoholic solution had an acid reaction and it took 17·8 c.c. of an alcoholic solution of caustic potash, containing 0·101 grm. of potassium hydroxide, to neutralize the acid in 0·727 gramme of the original substance, using phenolphthalein as an indicator. On heating with an excess of alkali no saponification took place; it is evident, therefore, that no unaltered fat is present. When the excess of alkali was neutralized, the solution evaporated to dryness, and, extracted with petroleum-ether, the latter left a slightly yellow wax-like residue, weighing 0·117 gramme. This is probably a hydrocarbon. The portion insoluble in petroleum-ether dissolved in water, and, on adding a slight excess of dilute sulphuric acid, fatty acids weighing 0·355 gramme separated. The melting-point of these acids—for it was obviously a mixture—was 46° to 47° C. The difficulty of isolating fatty acids is well known; it was hopeless to think of separating the constituents of so small a quantity. The aqueous liquid from which these acids had been separated yielded, when shaken with ether, a further quantity, so that the fatty acids present are not wholly insoluble in water.

These observations warrant the conclusion that the substance extracted by ether from the stone vessel consists mainly of a complex mixture of bodies of the nature of fatty acids. The presence of this combustible greasy matter supports the supposition that the vessel was used as a lamp, and is wholly inconsistent with the theory that it was a drinking-cup or chalice.

I thought it desirable to ascertain whether the vessel contained anything soluble in water which would throw further light on its previous history. Accordingly I placed it in a glass vessel with about two litres of water, and left it standing for seventeen days. The water when evaporated left a residue weighing 3·08 grammes. This residue was of a brown colour, had an acid reaction and a taste like common salt. When heated it evolved a little water; then a solid, which I found to be ammonium chloride, sublimed; it then carbonised with an odour like burnt feathers, and fused below redness. Treated with alcohol, 0·24 gramme dissolved. This portion had a strongly acid reaction and was found to be mainly ammonium chloride. There was present also a substance which gave with neutral ferric chloride a precipitate like that produced by a succinate. I tried to further identify this substance by digesting the precipitate with ammonia. On evaporating the ammoniacal liquid a slight gelatinous residue remained. This, when treated with diluted hydrochloric acid yielded dark-brown oily globules heavier than water, weighing, I should say, less than a milligramme.

There was a sufficient quantity of the aqueous extract of the vessel insoluble in alcohol to admit of a quantitative analysis; and I found its composition was as follows:—

Na,	25·81
NH_4,	3·56
Ca,	2·43
Mg,	·67
Fe,	1·18
Cl,	38·29
SO_4,	19·42
Water and organic matter by difference,	8·64
	100·00

I suggest the following as the probable composition of this saline matter:—

Sodium chloride, ...	51·55
Sodium sulphate, ...	11·66
Ammonium chloride, . . .	10·57
Calcium sulphate, ...	8·26
Magnesium sulphate, . . .	3·35
Iron sulphate, ...	4·21
Sodium not accounted for in the above salts,	1·77
Water and organic matter, . . .	8·63
	100·00

The presence of this easily soluble saline matter, consisting mainly of common salt, proves conclusively that the vessel could not have been exposed to the weather. It is highly probable that the vessel had in fact remained, as my informant supposed, in possession of his family for a long time; and I suggest that it had been used as a lamp by some of his predecessors.

Professor Henry J. Seymour has been good enough to make a petrological examination of some fragments of the rock of which the cup is made. He identified a white and a green chloritic mica, plagioclase, granules of quartz, and flakes of kaolin, and from these results and the general appearance of the rock, he concludes that it is a decomposed schistose epidiorite or diabase. It is probable that the vessel was made from a boulder; the nearest locality from which the boulder might have been derived is Bohernabreena, which is about eight miles north-west of Ballybetagh.

An analysis of a small portion detached from a cavity in the base of the vessel gave the following results:—

Silica, ...	51·86
Alumina, ...	18·92
Ferrous oxide, ...	1·31
Ferric oxide, ...	9·22
Lime, ...	trace
Magnesia, ...	9·83
Potash, ...	·31
Soda, ...	2·51
Water, ...	6·19
	100·15

The alumina includes a trace of phosphate and some titanium dioxide.

This result fully confirms Mr. Seymour's opinion, if we assume that most of the iron originally present as ferrous oxide has been oxidized, and that the lime has been almost completely removed, and in part replaced by magnesia —changes which would naturally result in the process of weathering. The weathering must have taken place when the rock was exposed to atmospheric influences, and mainly through the action of water. It cannot be supposed that the rock from which the vessel was fashioned contained the readily soluble salts which I detected in it; the presence of these salts also precludes the idea that any appreciable weathering has taken place since the vessel was used as a lamp. It is highly probable that the weathered rock was selected on account of the ease with which it could be cut into the required form. How is the saline matter to be accounted for? There cannot, I think, be any reasonable doubt that the sodium chloride has its origin in the use of ordinary domestic grease, obtained in the process of cooking, as a material for burning. Such grease, unless it were carefully purified, would be certain to contain nitrogenous matter; and this, if burnt, would account for the ammonium compounds also present.

The saline matter was almost completely free from potash. The quantity of potash was so small that it was only detected with difficulty by means of the spectroscope. This almost complete absence of potash is difficult to explain. Some kind of wick must have been used, probably a vegetable substance, and its ash would certainly contain potash. Moreover, potash is usually found in animal tissue, such as would have given rise to the ammonium compounds found. The only explanation I can offer is that any potash derived from the substances burnt in the lamp formed insoluble compounds with constituents of the rock. That potash may replace lime in certain silicates is well known, and perhaps this is the reason why lime, which enters so little into the composition of the rock, is present in notable quantity in the saline matter.

What is the explanation of the large proportion of sulphates in the saline matter? For the reason already referred to, soluble sulphates could scarcely have been present in the original weathered rock. The small quantity of sulphur in the organic substances, likely to have been associated with the grease burnt, would not account for the sulphates found. In hair, which is rich in sulphur in comparison with animal tissues, the ratio of sulphur to nitrogen is 1 to 3·4; whereas, in the saline matter removed from the lamp, the corresponding ratio is 1 to 0·04. A certain amount of sulphates must have been contained in the common salt associated with the grease burnt; but only a small part of the sulphur can be accounted for in this way. It is obvious that some other explanation of this relatively large quantity of sulphur must be sought: I suggest it is to be found in the use of sulphur matches. It may be assumed that when the lamp was in use the mode of procuring a light was by means of flint and steel. This method was in common use among the peasantry as late as fifty years ago. The spark of incandescent iron kindled tinder, or in later times paper prepared with nitre; and the smouldering tinder or paper was used to ignite slips of wood tipped with sulphur, or "spunks," as they were called. The frequent use of sulphur matches of this type to light the lamp would inevitably introduce sulphur into the grease used in the lamp, and lead to the production of sulphides and sulphites, which would eventually oxidize to sulphates.

The foregoing observations do not throw any light upon the probable age of the lamp, except that the very distinct tallowy odour of the grease suggests that it cannot be very ancient. Colonel W. G. Wood-Martin ("The Lake Dwellings of Ireland," page 142) refers to the use of a very primitive kind of lamp near Carrickfergus, and in the islands off the Ulster coast, so late as the year 1840. The lamp, of which he gives a figure, is a saucepan-shaped iron vessel, with a long pointed lip for the wick. The stone lamp is scarcely more primitive; and it may have been in use in this country in out-of-the-way places within the past century; though it seems strange that so little should have been recorded about this, or indeed any kind of lamp in Ireland.

Through the kindness of Mr. George Coffey I have been able to examine some similar stone vessels in the Royal Irish Academy collection in the National Museum.

The vessel from the Blasket Islands, formerly supposed to be a chalice, figs. 4 and 4A in the paper I have already quoted by Mr. Armstrong, weighs 2130 grammes, and its specific gravity is 2·42. When treated with ether, it yields a greasy substance of a brown colour, weighing 1·34 gramme. This corresponds to 0·06 per cent. of the weight of the vessel. The greasy substance burns with a smoky flame; it has a strong smell like the smoke of peat, but more aromatic, suggesting incense. I could not, however, detect anything that would point to the use of incense-resins such as benzoïn or olibanam. About 70 per cent. of the greasy substance dissolves easily in alcohol; the solution is acid, and with caustic alkali it yields a soap-like body which is decomposed by a mineral acid with the separation of a substance which behaves as a mixture of fatty acids. It was hopeless to identify the constituents of so small a quantity. The portion not readily soluble in alcohol behaved like a gum-resin. It afforded some evidence of the presence of succinic acid; but I could not positively identify that acid in the few milligrammes available.

The saucer-shaped vessel, also from the Blasket Islands, formerly described as a paten, fig. 4 B, in Mr. Armstrong's paper, weighs 205 grammes, and its specific gravity is 2·73. Extracted with ether it yielded 0·39 gramme of a brown grease. This corresponds to 0·19 per cent. of the weight of the vessel—a much larger proportion than the other vessels yielded. The grease has no definite melting-point; it more nearly approaches an oily consistence at ordinary temperatures than the grease from the other vessel from the same place. The grease is completely soluble in alcohol; it is easily saponified; and it yields a mixture of fatty acids semifluid at ordinary temperatures. This grease is sufficiently different from that obtained from the so-called chalice to suggest that the two vessels were not associated in use.

The Dowth vessel (fig. No. 9, Plate XXI., of Mr. Armstrong's paper) weighs 1456 grammes, and its specific gravity is 2·33. Ether extracted from it a brown, greasy substance, weighing 0·07 gramme, or rather less than 0·005 per cent. of the weight of the vessel. The grease is of about the same colour and consistence as that obtained from the Ballybetagh lamp. It has no definite melting-point, burns with a smoky flame, dissolves in alcohol; and the solution behaves like a mixture of fatty acids.

There is one feature common to all these stone vessels—they all contain a brown, greasy substance, which I believe to be a mixture chiefly of fatty acids. It is manifestly not a constituent of any rock occurring in Ireland. The presence of this grease is at once accounted for if we suppose the vessels to have been used for burning some kind of fatty matter, as we know similar vessels to be used at the present time in various parts of the world. One can scarcely hesitate to adopt the view that the vessels are lamps of a primitive type, though not necessarily of any great antiquity.

X.

PROCEEDINGS IN THE MATTER OF THE CUSTOM CALLED TOLBOLL, 1308 and 1385. ST. THOMAS' ABBEY *v.* SOME EARLY DUBLIN BREWERS, &c

By HENRY F. BERRY, I.S.O., Litt.D.

Read April 25. Ordered for Publication April 27. Published July 16, 1910.

So little is known of the medieval religious foundations of this city, as far as their early history is concerned, and so few and scant are the notices regarding the buildings contained within their precincts, that any additional record which throws light on them is of interest. The great abbey of St. Thomas the Martyr,[1] which to-day is only recalled in Thomas Street and the adjoining Thomas Court, was founded in the western suburbs in 1177, under royal auspices, by William FitzAudeline, "dapifer" of King Henry the Second. It was dedicated to Thomas à Becket, the murdered Archbishop of Canterbury, and was set apart for the use of Canons of the Congregation of St. Victor, a Parisian institution, the members of which were canons regular of St. Augustine. King Henry and his son King John specially favoured the abbey, and made it an object of their bounty.

Students of the civic history of Dublin are familiar with two awards relative to the custom known as tolboll, which was a certain proportion of the ale and mead manufactured and sold by brewers and taverners in Dublin, claimed under royal grants by this abbey. These awards, dated respectively 1524 and 1527, are enrolled in the *Liber Albus* of the Corporation, and will be found in Sir John Gilbert's "Calendar of Ancient Records of Dublin," vol. i., pp. 178–189. They are also printed in the "Miscellany" of the Irish Archæological Society, 1846, vol. i., page 33. They arranged differences between the Abbot and Convent on the one part, and the Mayor and Bailiffs of Dublin on the other. The former had filed a bill of complaint, claiming that King John had granted them, for their own use, such measure of ale and mead as he himself was wont to have of the taverns of Dublin, i.e., the tolboll of a gallon and half of the best, and as much of the second brew, which they duly received, until they were hindered in their right by the city

[1] See Paper on the Abbey, by Canon A. L. Elliott, in *Journal*, R.S.A.I., 1892, vol. xxii., p. 25.

authorities. The arbitrators awarded that none of the brewers in the city at the particular time brewed sufficient to justify the proportion claimed being exacted. Henceforward the abbey was to have the tolboll of every brew of not less than sixteen bushels (each bushel being sixteen gallons), and of none under twelve bushels.

King Henry the Second granted this custom to the abbey for a particular charitable purpose, which purpose is not disclosed in the proceedings already mentioned, and which had, most probably, passed completely out of memory. Certain documents in a register of St. Thomas's Abbey, now in the Bodleian Library, Oxford (Rawlinson MSS., B. 499), to which my attention was recently called, make the King's purpose clear, and afford such an interesting narrative of the circumstances (hitherto unknown) attending his grant of the tolboll, and of subsequent proceedings connected with very early brewers and taverners in Dublin, that, as original material, unnoticed by any of our civic historians, they seem worthy of being brought under the notice of the Academy. One of the extant ancient Registers of St. Thomas's Abbey reposes among the Haliday collection of MSS. within our walls; two others are in the Bodleian, one of which was edited by Sir John Gilbert, the second being that in which the documents under consideration are to be found.

At fol. 22 of this Register is an *Inspeximus*, dated 24th September, 1388, of the record and process of a plea in Chancery, between the King and Brother Thomas, Abbot of the House of St. Thomas the Martyr, Dublin, in the ninth year of King Richard the Second (1385), which supplies the following details:—

King Henry the Second granted to the abbey three gallons of ale from every brew for sale in Dublin, so that the institution might find and keep sixty poor people and scholars, in food, drink and clothing, in a house called the King's Alms House for ever; but Brother Thomas had ceased to supply such alms. Very little is known of the original buildings of this great abbey, and it is important to find that such an alms-house stood within the earliest precincts. From the date of the grant the abbey was pleaded to have continuously found support for poor and scholars, until Easter, 39 Edward the Third (1365), when such was withdrawn. Abbot Thomas admitted that Henry fitz Empress had founded the house, and that his son John was seised of a right to three gallons of ale, &c., which he granted to the abbey for the use of the canons. He brought into Court the King's Charter,[1] and it may be noted that the copy of the Charter in St. Thomas's Register contains the names of two more witnesses than the printed copies. They are Roger

[1] Printed in *Chartae, Privilegia*, &c., p. 4, and in *Miscellany*, I.A.S., 1886. Vol. i., p. 42.

de Maundeville and Adam Herforde. *Gilbard* Pypard of the Register appears as William, and Roger de *Playes* as Ilanes, in the printed copies. The Charter was executed at Orbec, in Normandy.

The abbot, taking his stand on this grant, demurred to the plea that King John had made it for support of poor people and scholars in the King's Alms House, or that he and his predecessors had supplied such support. Thereupon, Richard Glynnan, the King's serjeant, averred that King Henry's grant had done this, and that the abbey had supplied support until Easter, 1365.

The following jury was then empanelled:—

John Passavaunt, Peter Wodere, Nicholas Serjeant, Roger Bekeford,	formerly mayors of Dublin.
Thomas Maureward, Robert[1] Serjeant, William Herdman, John Drake,	lately bailiffs of Dublin.
Richard Crux, Robert Fitzleones,	of the 24 Jurats, Dublin.
Geoffrey Lexestre, Richard Corr,	of the Commons, Dublin.

They found that King John, son of King Henry, gave to St. Thomas's Abbey (as before) in support of the canons, and not for maintenance of scholars or poor people in the King's Alms House; but that King Henry the Second had made a grant to the abbey, for the purpose of certain scholars and poor people being supplied with food, &c., in said House. The jury further found that the then King's Alms House was erected by the abbot, &c., forty years since, but they have no knowledge at what time same was first constructed, because this was done before their memory.

They also found that the abbot and convent, sixty years before, of their mere will, supplied in said House, of their own alms, forty, sixty, sometimes thirty, scholars, &c., more or less; without this that they, by reason of any gift of lands, &c., made to them, found or ought to find such scholars and poor people in food, &c. Being asked for what time before the said sixty years the abbey first supplied scholars and poor people in the King's Alms House, they say they have no knowledge, inasmuch as the abbey, before their memory, supplied such in the Alms House of their own will, without being compelled

[1] No *Robert* Serjeant was bailiff. *William* Serjeant held the office in 1384–5.

of anyone, "as from relation of their parents and other old faithworthy persons of said city of Dublin they often heard." For want of repair the Alms House fell down about twenty years before.

The jurors also found that King John, before his said gift, was seised to take of every brew of ale and mead for sale in Dublin, 3 gallons, and that the taking of same was that custom which he was wont to have in the taverns, &c. In addition, they found that the abbey took this continuously from the time of the gift; and they often heard old men say that the abbey had right and title to what they claimed, by pretext of said gift.

Another document, which appears at fol. 27 of the ancient Register, contains a record of legal proceedings brought by the abbey against certain brewers in Dublin, with the result in each case. These proceedings, as a matter of fact, are earlier in point of time than those already considered, but it seems more convenient to have had the origin of the tolboll first described. The various pleas recited at length in them are of interest as affording an insight into the nature of such as were used in courts of law in Ireland at this early period.

In the octaves and quinzaine of St. Martin, 2 Edward the Second (1308), John le Hore, William de Vylers, John Hayward, John de Castleknock' Hugh de Castleknock, Hugh Silvestre, Richard Ethnarde, Mabila Arnalde, [illegible] de [illegible], Elena de Donne, Joan Tyrell, Thomas Corlice, John Coliz, Robert Milton, William Comewayleis, Robert de Trapston, Blissina Lotrix, Walter de Nangle, Juliana Honicode,[1] John Sampson, William Botiller, William Caliane, Roger Barbeare, Walter Shereman, and William de Topishane (brewers and taverners) were attached at suit of the King and of the Abbot of St. Thomas's, to answer wherefore they hindered the said abbot from taking the custom of ale and mead (in this case a gallon and a half) granted by King John which were made in certain taverns in Dublin, from Tuesday next before the feast of the Nativity of St. John the Baptist, 30 Edward I, to 29 October, 2 Edward II, whereby the abbot avers that he has lost to the value of £100. The defendants declared that they were not bound to answer, as under royal charters citizens of Dublin were not to be impleaded outside the walls of the city on any plea arising within it; and the mayor, John le Decer, sought that the plea should be brought within the walls. The abbot replied that as this matter concerned the alms of the King's progenitors, and his own being drawn away it might be brought anywhere, and that the citizens ought to answer in any place at the King's will for trespasses

[1] Juliana Honicode owned a messuage in St. Werburgh's parish, which before 1317 William de Shereman acquired from her. (Deeds of St. Werburgh's.)

committed against him. The brewers were ordered to answer; and on this they said that the tenements they now hold were waste and uninhabited places in King John's time, so that neither the King and his progenitors nor the abbot and his predecessors could have taken the custom where the present defendants' tenements are now constructed, and they sought judgment. Robert de Trapston and Blissina Lotrix answer that they hold their tenements of a church; Walter de Nangle and Juliana Honicode, of an inn,[1] which are exempt from such custom. The court held that as their tenements did not join with the said church and inn, they were liable.

John Sampson, William Botiller, William Callane, and John de Castleknock answered that the abbot was in seisin of the custom of ale without hindrance on their part; but as they never made mead for sale, he could not have been in seisin of it. In this instance, the abbot was adjudged to have made a false claim, and so he took nothing by his writ. The defendant John Silleby had died.

Finally, the court ordered that the abbot should recover against John le Hore, William Donne (representing Elena de Donne), Joan Tyrell, Thomas Coliz (Corlice), Robert Milton, William Cornewalleis, Roger Barboure, Walter Shermane, William de Topishane, Robert de Trapston, Blissina Lotrix, Walter de Nangle, and Juliana Honicode, the said custom to be taken in their taverns, made after the making of the said charter, with damages against them.

Later on, the jurors came before the Justiciar, and assessed the abbot's damages against John le Hore at half a mark; William de Vylers, two marks; John Hayward, two marks and four pence; Hugh Silvestre, two marks and a half; Mabilla Arnalde, two marks; Elena de Donne, twelve pence; Joan Tyrell, twenty shillings; Thomas Coliz, half a mark; Robert Milton, half a mark; William Cornewalleis, half a mark; Roger Barbour, two marks and a half; Walter Shermane, half a mark; William de Topishane, a mark; and Richard Ethnarde, two marks and a half.

It will have been observed that several of the defendants were females; and in this connexion it is remarkable that an enactment specially dealing with female brewers is found among the "Laws and Usages of the City of Dublin," enrolled in the *Chain Book* of the Corporation.[2]

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[1] Possibly a frank house (*liber hospes*).

[2] Gilbert's *Calendar*, vol. i., p. 224. See also "Notes on an unpublished Inquisition, 1258" (Alewyth, &c.), H. F. Berry, Proc. R.I.A., xxiv., Sect. C, pp. 44, 45.

XI.

A STUDY OF THE EARLY FORTS AND STONE HUTS IN INISHMORE, ARAN ISLES, GALWAY BAY.

By THOMAS JOHNSON WESTROPP, M.A.

PLATES V.–VII.

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"THE Aras of the Sea," as the "Book of Rights" records, were in early times regarded as a part of Munster, an appanage of the kings of Cashel. They lie so far cut off from that province (and even farther from the province of Connaught, to which they have been reassigned since the later sixteenth century) that they rather form a little world of their own. This isolation, though modified in later days by a steamboat service, has maintained so many touches of primitive times and remains of early buildings that they are a veritable treasure-house to students of the language, beliefs, and buildings of early Ireland and its primitive condition. At one time its stone huts were second in interest only to those of Corcaguiny and Iveragh in County Kerry; its forts hold the first rank, and, indeed, have usurped more than their just share of attention as representative structures of their class to the outer world.

Having laid before the Academy a study of the chief fortress, Dun Aengusa, we may be allowed to follow up the subject as exemplified in the other forts of the same island and some typical huts. Here, as before, we will study critically the existing remains, and bring to bear on them all available records in endeavouring to discover what features are early, what justifiably restored, and to eliminate as far as possible the distrust naturally engendered by the wholesale restorations of the year 1884. Unfortunately the many sources which yield so full an account of the unrestored Dun Aengusa fail us for the most part. It is as if writers exhausted by the complexity of that fort passed by the rest with a feeling akin to contempt. By ill chance my own notes of 1878 on these other forts were hurried and mere general statements, without even sketch-plans or detailed camera-sketches, so are almost valueless compared with those on Dun Aengusa and the churches. Even of these, my views of Dubh Cathair and Dun Onaght are lost, and that of Dun Oghil too poor for use. No views even of portions of the masonry or steps are in the Ordnance Survey Letters; there are the noble views of the two lesser duns and a defaced one of Dubh Cathair in Lord Dunraven's Notes[1] and a sketch of a trilithic door of a fort, near Baile na séan, by Mr. Kinahan. More material for the huts is extant; views of the Cloghaunnacarriga by Petrie, some plans of others by Mr. Kinahan and Mr. Kilbride, and a camera-sketch of the first taken in 1878. The plans of the forts are poor, and in some cases incorrect when compared with the old descriptions and present remains. The caher of Killeany we describe, giving a view of its wall for the first time, as also that remarkable cloghaun in the same townland near Pouldick cove.[2]

The forts, like Dun Aengusa, give signs of early rebuilding in some instances. One promontory fort, noted by O'Donovan, we failed to reach on any of our visits. It is, however, probable that O'Donovan missed no feature of interest, and that little now remains to be seen.

As to the huts, the question of their age is complicated; some seem very early, and were so regarded in 1685; others are hardly distinguishable from work little over a century old. As in Kerry, so in Aran, such huts long continued to be made; but as a rule massive work may be assigned to an early period. That any are of pre-Christian times we are unwilling to assert. The cells on Skellig Rock and at Temple Gobnet in Inishere are almost certainly Christian, and those at the former probably date from the seventh and eighth centuries; none on Aranmore seem more primitive than the last, and many have the rectangular interiors which occur also at Skellig. Some of the slab-huts are as primitive as dolmens; but, on a small scale, slab-houses were made down to recent times as pig-sties, dog-kennels, and lamb-shelters. The larger dry-stone house near Temple Benen seems late indeed, and the cloghauns near it, and those that stood in the Dubh Cathair and remain in Dun Onaght, are late and rectangular, one with late-looking ambries. Of cells in the walls of forts (other than at Dun Aengusa) we only found a small one in Dubh Cathair; but it was too much filled with loose stones to examine fully. O'Donovan notes a second in the unnamed promontory fort near the latter place.[3] Dun

[1] Vol. I., Plate VI. [2] Page 198.

[3] Cells in walls are rare in Aran and unknown in County Clare, but occur on the coasts of Mayo and Kerry in many stone forts. As we have occasion to use Mr. G. H. Kinahan's interesting articles on Burren and Aran in Hardwicke's "Science Gossip," vol. for 1875, we may here note some necessary corrigenda:—Page 83, the forts in Burren are rarely (not "often") on "conspicuous heights"; "the number of remains and sites of antiquity" do not "seem small," but are surprisingly numerous; "most of the large ones (forts) seem to have chambers in the wall," page 84; no such feature is known to have existed in any of the forts of Burren; same page, the path to a fort there named is straight, not "serpentine," and the abattis from 50 to 100 feet, not "two to three hundred yards." But the articles have many field-notes and sketches of value apart from the preface. The series begins on the geological features of Burren and round Gort in 1872.

Oghil, like Dun Aengusa, has no old huts. There are no warders' huts or cells or any passages in the wall of any fort in the islands.

As to the features there are two kinds of steps: the ladder kind, occurring also in several forts in the kindred district of the Corcomroes in Clare, and the sidelong flight, rare in that county. Nothing like a plinth, or like the narrow set-back ledge found in Clare and Corcaguiny, is known in Aran. In some cases the sidelong flights are in couples rising from a landing in a recess, as at Staigue and many other forts.

Of Fort Gateways, save the trilithon and those at Dun Aengusa, all are defaced; but it is notable that the ancient faces of the gateway of the inner ring of Dun Oghil unmistakably show a wide passage, too wide to be covered by lintels, unless there were detached piers built of small masonry supporting the latter, as is the case at Dun Aengusa.[1] Killeany caher had its jambs built in layers continuous with the facing of the wall, as is most usual in the forts of Mayo, inland Galway, Clare, and in some degree in Kerry. The entrance at Dun Onaght seems like that of Dun Oghil; but the masonry at the outer ope may have been restored.

The walls of Dun Onaght, Dun Oghil, and Killeany have a well-made batter, unlike Dun Aengusa and Dubh Cathair, the last being the worst-built in Inishmore, as Dun Onaght is the best. Upright joints occur in the three; so far as I know Dun Conor is the only other Aran fort with this feature. The walls of all, save Killeany and perhaps the duns at Bailenashane, are usually of two or more sections, each with an outer face, and in some cases an inner one, but, as a rule, of smaller stones than the outer ones. Dubh Cathair has (as restored) three terraces and a sort of terrace across a hollow; Duns Oghil and Onaght have only two. Of rarer features, Dubh Cathair has an abattis of slabs, unlike the sharp pillars of Dun Aengusa and Ballykinvarga—also a winding way, but probably rather modern, as it leads to a blank wall. None of the forts have springs within their ambit; but good water is found near the great ring at Teampull na naemh at Kilmurvey and near Duns Oghil and Onaght.

Historical Notes.—At a risk of repetition, but as briefly as we are able, let us consider the general history of the islands. Early legend asserted, what is probably a geological fact, that "Lough Lurgan,[2] or Galway Bay, burst out" at a very early if doubtful date in Irish history, the remnants of the outer land being the isles of Aran. About the beginning of our era,

[1] And probably at Dun Conor, where the width of the gateway was ascertained as 2 feet 5 inches outside and 3 feet 6 inches inside, the passage being 6 feet 3 inches.

[2] The name survives only in the North Sound, Bealach locha-lurgain. Perhaps before the "bursting" it was a long, shin-bone-like creek (lurga), running up to the river from Loch Oirbsen (Corrib).

legend (in the tenth century, if not earlier) attributed a settlement in Aran to a fugitive tribe of Firbolgs, "the sons of Umoir," Aenghus at Dun Aengusa in Aran, Conchiurn (or Concraidh) in Inismedhon (Inismaan, the Middle Island). Some fancy that Murbech Mil, a third chief, settled at Kilmurvey, a few hundred yards from Dun Aengusa; but the place intended was probably some other seashore on the coast of Galway or Clare. Conchiurn had become Conchobhair by the seventeenth century; but local legend identified him with (and attributed his great fort to) Conor na Siudaine O'Brien, King of Thomond, who was slain in 1267.

The descendants of the mythic hero Fergus mac Roigh and the great Queen Maeve, the Corca Modruadh, replaced the Clan Umoir in northern Clare, of which Aran was a part. There was an Eoghanacht tribe in Corcomroe, the Eoghanacht Ninuis, and it held the islands at the dawn of history. If the late "Life of St. Endeus" rest on solid records, Corbanus, their chief, deserted the islands on the arrival of St. Enda about 480.[1] Enda's monastic settlement lay in the east of Inishmore; but there was another ecclesiastic who established himself in the west—Brecan, son of Eochu Bailldearg, a Dalcassian prince of Thomond (then mainly Limerick and northern Tipperary, with a precarious suzerainty over Clare): he settled where Temple Brecan and his grave preserve his name. The Dalcassians, after 350, under Lughad Meann and Conall Eachluath, Kings of Thomond, seized Clare from Connaught, probably settling the plain from Inchiquin to Quin, and getting nominal supremacy over the free tribes, the Tradraighe, Corcavaskin, and Corcomroe. One might expect that this attached Aran to Munster, for Enda asked his brother-in-law, Aenghus, King of Cashel, for the Isles, but the King had never heard of them till then. As an appanage of Cashel they remained, though they were released from certain tributes in A.D. 546. The late "Life of Endeus" does not mention the forts, and is quite devoid of local colour. Aran became a centre of learning and religion; it was a resort of students from all parts of Ireland, and from the Continent, as the grave inscribed "septem Romani" (no less than our written records) testifies.[2] Of its Irish *alumni*, to select only a few, Kieran of Clonmacnois, Fursey, Brendan the Voyager, Colman macDuach, perhaps Benen, disciple of Patrick, Caimin, brother of Kevin of Glendalough, and Columba, the apostle of the Hebrides, studied in its cells.

Successors of Enda are recorded at intervals from 654 to 1400; but the

[1] Augustin MacGraidin's "Vita Sancti Endei," written about 1380, a work unusually devoid of topographical and archæological interest.

[2] The Calendar of Oengus, "Thrice fifty curraehs of Roman pilgrims." "150 pilgrims from over the sea." "Seven monks of Egypt." There was also an inscription of "Bran the pilgrim" found at Temple Brecan.

series is very imperfect. The monasteries were burned in 1020, plundered by the Danes in 1081, and by the English, under Sir John Darcy, with a fleet of fifty-six vessels, in 1334. The Clan Teige O'Brien, of Tromra in County Clare, became the ruling lay chiefs in probably the thirteenth century, when their relative Conor na Siudaine, King of Thomond, is alleged to have "built" (i.e., as usual, "rebuilt" or "repaired") Dun Conor. The clan built O'Brien's Castle in the chief ring fort of Inishere, and a Franciscan House at Killeany in 1485. They kept Galway Bay free from pirates, and were in close alliance with "the City of the Tribes" at its head; their power culminated in 1560, when they were strong enough to invade Desmond; for, twenty-five years later, the O'Flahertys had driven out the chief and annexed the island. In vain the Galway merchants prayed the Government to reinstate Clan Teige; the Armada was expected, and the English left the O'Flahertys in possession. The dispossessed O'Briens sustained their claim even after the great civil war of 1641, but never established it. The Elizabethan authorities garrisoned a castle of Arkin at Killeany; it was repaired, and a new garrison placed there in 1618, and again, after its surrender to the Cromwellians, in 1651. It was rebuilt in the following year. As to the Firbolg descent of the inhabitants, the inquisitions only exhibit names from Connemara and Clare, evident immigrants with the O'Briens and O'Flahertys. There is also a strong strain of Cromwellian blood, as the garrison, left to itself, merged into the native population. In 1641 the O'Flahertys raided Clare from Aran, and captured Tromra Castle from the Ward family, to the destruction of their leader twelve years later. Roderick O'Flaherty wrote his well-known account of Aran in 1685, and the ruins were conserved by the Board of Public Works exactly two centuries later. It is very remarkable how absolutely silent all history and records are on the subject of the ring-walls. A legend of about the year 1000, an allusion in 1685, and a wild theory and imaginary sketch in 1790, sum up the annals of Dun Aengusa before the nineteenth century. The other forts of Inishmore are never even mentioned. They were of no interest to monk or politician, and even the intelligence and wide mind of O'Flaherty only thought of them for a moment, and did not preserve us even the name of a single fort with which this paper is concerned.

As to the divisions, Aranmore in the sixteenth century seems to have been divided into Trian Muimhneach, Trian Connachtach, and Trian Eoghanachtach.[1] These doubtless represented the divisions assigned, the first to the representatives of Brecan and the men of Thomond, the second to the

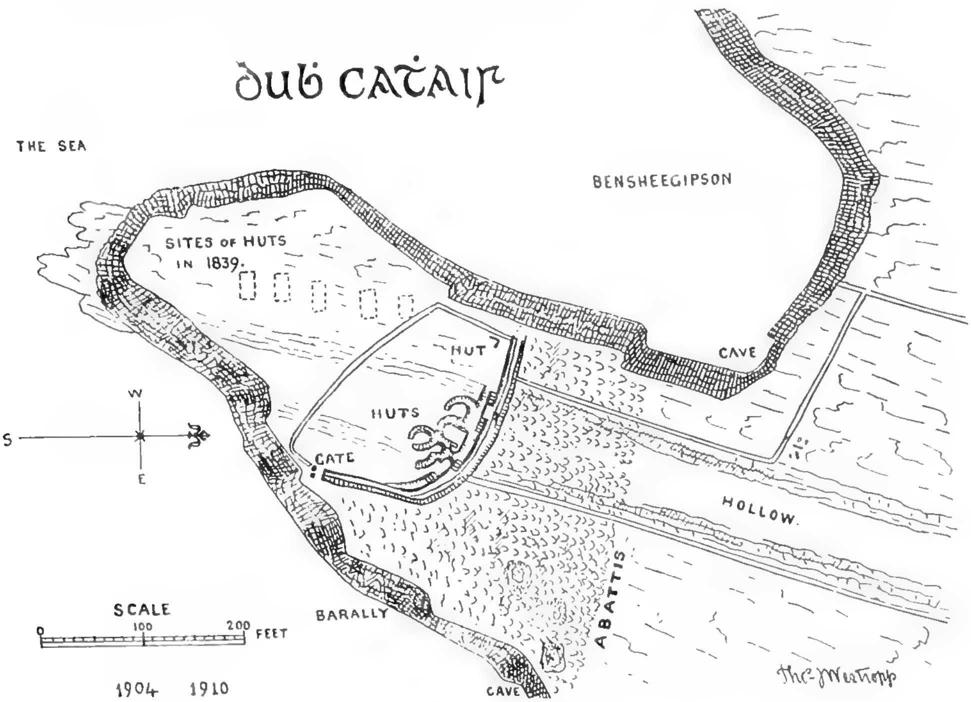
[1] Inquisition P.R.O.I., taken 1594 at Arkyn. Tren-Moynagh, Tren-Connaught, and Tren-Onaght. The second was held by Tuam in right of the old see of Annacoyne (or Annadown), to

see of Tuam, and the third to the representatives of the Eoghanacht Ninuis in Corcomroe, which was a virtually independent state doing nominal homage to the Princes of Thomond and the over-kings of Cashel.[1]

DUBH CATHAIR.

(Ordnance Survey Map, 6 inches to 1 mile, No. 110.)

The most remarkable stone fort on Aranmore after Dun Aengusa, and one of the most remarkable in Ireland, had its restoration been more prudent and better recorded, is the Black Fort, Dubh Cathair, or locally Dun doo 'haar, the fort of the black caher, wrongly called Doonaghard on the map. It is very



Plan of Dubh Cathair, Aranmore.

inaccessible, being fenced off by a long series of tottering, dry-stone walls, and almost impassable laneways, filled with loose stones, the best approach, though circuitous, being along the coast from opposite Killeany. It lies on a high

whose abbot belonged Canonaght or Ferren na prioraght and Balleboght, also the ruined religious house of Monastroconnaught (Manister Kieran), and lands of Ardclone, Turtagh, Farrenconnaght Slevin, Balleconnell, Cloghanеprior, Onaght, Farrane Cannonaght, Ochill, Creaghcarragh, Reynboy, Carrilmore, Killeyne, and its parish church, Ballogalle, Arkin and Sawuskerton (? Carrowkerton). Turtagh is probably Turlaghmore in Onaght.

[1] See the "Book of Rights" (ed. O'Donovan).

headland, about 110 to 120 feet high,[1] to the south of the valley extending from Kilronan to the south-east, and is a conspicuous object from Dun Oghil and the central upland of the island. Its site is remarkable, the strata having formed two arched curves to either side; the sea drilled caves through these till the arches collapsed, originating two long bays, with a slightly hollow headland between; the hollow can be traced inland for a considerable distance between the two curved ridges. The view of the fort from the headlands or bay-heads to either side is very impressive, for (though scarcely a third of the height, "300 feet," stated by O'Donovan in the Ordnance Survey Letters) the cliff on which it stands is perpendicular or overhanging.[2] The rocks, dark grey, black in the shadow, are formed of huge strata of limestone, practically level, their seams often marked and their darkness relieved by close-packed rows of sea-gulls. The boom of the waves into the great caverns can be heard through the rock inland with startling effect.

We first meet with an abattis,[3] formed of low stone slabs, set upright, in crannies of the rock, and far more passable and less ragged and worn than those at Ballykinvarga or Dun Aengusa. There is hardly any earth, save in the bottom of the hollow, and that, usually, 6 or 8 inches deep, and a mass of sea-pink. The band in the hollow varies from 114 to 126 feet, the last being through the middle, beside the winding path.[4] The latter, a zigzag band of green sea-pink, is probably of late origin, as it leads up to the intact wall, and the entrances were far to either side. No tall pillars occur, though several such, as regular as if cut to the square, lie just outside it; one 7 feet long and exactly a foot square, with straight ends, is a surprising piece of nature's work, square and fair as a timber beam. The wall is of rude and altogether poor and small slab masonry, bulging in and out, like the middle rampart of Dun Aengusa, overhanging its base in many places, and sorely needing the modern buttresses of the restorers. It is over 18 feet high at the head of the path, and overhangs 18 inches. There are set slabs and perhaps hut sites among the blocks, but the age of the huts is probably very late. The abattis extends 70 to 80 feet eastward past the end of the bay, as if the fort had once been wider; or at least the wall may have stood on the actual landward end of the headland, and the ground of the approach have been protected along the cliffs.

[1] This approximation is based on photographs; taking the fort wall as 20 feet, it gives 120 feet for the cliff, taking a man as 6 feet, it gives over 110 feet for the height. [2] Plate V., fig. 1.

[3] See Lord Dunraven's "Notes on Irish Architecture" (1875), plate vi. The only detailed view, and it unfortunately partly defaced, of the fort before the restoration. In later times, so far as I know, the only views published are those (by present writer) by Dr. A. Guebhard, "Camps et Enceintes" (Congrès Préhistorique, iii.), pp. 999 and 1017.

[4] This was noted by Petrie as "a serpentine way difficult to trace" ("Military Architecture of Ireland," MSS., R.I.A., p. 65).

When Petrie visited it in 1821, there was a perfect gateway at the end of the rampart to the west. This, with a great square "slice" of the cliff, collapsed before 1839, when O'Donovan visited the spot. This latter writer[1] assigns the date of the Dun to 1000 years before Dun Aengusa,[2] and had little doubt as to its having been built by the Tuatha de Danann, or the remnant of the Firbolgs, immediately after the battle of Moytura. The wall formed a segment of a circle 220 feet long, 20 feet high, and 18 feet thick; it was of rough large stones, far from being perpendicular, and without "any attempt at masonic art." Compared with Dun Conor it must have been raised in the very infancy of society. The "Rinn" was 354 feet long, 220 feet broad at the wall, and 110 feet at the south end, where it forms a terrific cliff 300 feet high. Inside were rows of stone houses "of an oblong conical form," but nearly destroyed; one row extended along the wall and was built against it. The other ran north and south for 170 feet, where it branched into two rows, one to the edge of the cliff at the south-west, the other to that on the south-east, but these rows were nearly washed away by storms. The great storm (the famous "great wind" of January, 1839) had recently done them great damage, hurling the waves "in mountains" over the high cliffs, and casting up rocks of amazing size on to the summits to the east. The shower of spray fell quite across the island. He gives a map which shows no steps, but Dunraven marks two flights. The cloghans, or huts, near the wall included one 12 feet across inside, and perfect (it was probably hut "E" of our plan). The largest, No. 2, was near the wall, and 18 feet long by 13 feet wide.[3] (I cannot suggest its identity, though the sketch plan coincides fairly well with the remains.) The gateway was on the east side, near the margin of the cliff. As may be seen, O'Donovan notes no features in the fort; but, from its condition before the restoration, this is evidently a mere oversight. Ferguson[4] and several writers who describe Dun Aengusa omit all account of the Black Fort.

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[1] Ordnance Survey Letters, County Galway, p. 243.

[2] He repeated this view to the British Association in 1857. "Aran Isles" (Martin Haverty), p. 14. The abattis, no doubt, favours an early date, but the fort in present form is too complex to be dated to very early times, apart from all question of the endurance of the sea-torn headland.

[3] W. F. Wakeman, in "Aran, Pagan and Christian," 1862 (Duffy's Hibernian Magazine, N.S., vol. ii., p. 567), says that O'Donovan counted twenty huts here. "Poulgorrum under the cliff could swallow a ship to the top masts." Rev. W. Kilbride, in "Iararna," 1868 (Royal Hist. and Archæol. Soc., vol. i, ser. 3, p. 112), says all the huts in Dubh Chathair were oblong; but O'Donovan's plan contradicts this. Sir William Wilde mentioned that he had sketched the most remarkable hut on his visit, before 1857, but they had been much dilapidated since then ("The Aran Isles," 1859, p. 14).

[4] University Magazine, 1853, vol. xii, part i., p. 497, he had "come from Dhu Cahir and the Atlantic side," but barely alludes to "the lonely, crumbling pagan fortress, and the utter solitude of the dark, marble-ribbed desert."

About 1870 Lord Dunraven[1] gives us the only other description of value. Repeating O'Donovan's figures for its length, and the length and height of the headland, he notes that the wall had two faces or sections, each 8 feet thick and 16 to 18 feet high, the top being nowhere perfect. The stones were laid as headers, the masonry poor, the eastern gateway utterly ruined. He noted (what O'Donovan overlooked) that there was a chamber in the wall, and adds :—"Scarcely any of the inside face of the walls now remains."

The author in the "Irish Builder"[2] seems to confuse notes on the walls of the Black Fort with those on Dun Onacht, following (even in the error of the cliff's height) the "Letters." He independently, in June, 1877, noted the abattis, inside which were the remains of several buildings, one a beehive cell, part of the roof remaining, but the facing was nearly all gone. In the rampart was a small chamber, 3 feet 8 inches by 3 feet 4 inches by 3 feet 8 inches. One hut (inside the fort) had a midden of bones and periwinkle shells. Mr. Kinahan's notes in 1875 barely name the fort;[3] my own notes and views in 1878 are of little (if any) value—"a big, broken wall across the head, with a lot of low stones set in front over a hollow. It has no doors, and all the inside is upset; but it had huts just inside the wall, and, I think, a terrace, too." The view was only a general one of the headland and distant wall.

The total result, as bearing on the existing features, is that the wall exhibited two sections, a chamber in its thickness, two flights of steps, traces of a terrace, four huts along the wall base, with two outstanding, and the defaced remains of a gateway at the east end, close to the cliff.

As restored, it exhibits an imposing interior, with two lines of terraces, and a lower one in the central hollow.[4] There are three flights of steps from terrace to terrace, the centre being sideways, the others ladder flights. There are two sidelong flights to the west of the huts, and one to the east, from the ground-level to the middle terrace, and a short flight to the lower one. The wall at the east end forms two sections, 8 feet 6 inches inside, and 6 feet outside; between them is a stone set with its edge just outside the wall face, a late feature found in Scottish brochs, the forts at Fahan and near Dingle, and a few others (like Moheraroonan, and the square caher of Cragballyconoal) in Clare; 9 feet from the end of the wall are two large set slabs, evidently the facing of the south pier of the gateway; they stand hardly 9 feet from the cliff edge. Measuring first from the north gate-pier, we find that the wall running northward makes an abrupt turn westward, about 54 feet away, and that the

[1] See his Plate vi.

[2] Volume xxviii for 1886, p. 255.

[3] Hardwicke's "Science Gossip," vol. for 1875, p. 128.

[4] See Plate V. No. 2.

whole of this latter reach is 214 feet long, part near the west cliff having been destroyed and more fallen with the rock. At 31 feet the low terrace begins near the bend. A ladder flight of 8 steps is formed, from 12 to 15 feet from the bend (from which we shall now measure): the lowest terrace ends in steps at 30 feet; the highest rampart disappears at 39 feet; the sidelong steps from the lowest to the middle terrace, and from the latter to the upper, are at 92 feet and 95 feet on the middle terrace; the ladder steps on the upper with 7 steps, from 143 to 146 feet; the sidelong flight below, from 154 feet; the rampart remaining here. Near the foot of the middle lower steps is the chamber in the wall. The thickness at various points is:—Middle terrace, 4 feet to west, 5 feet 6 inches at middle, 3 feet to east; upper terrace, 3 to 4 feet, generally 4 feet 8 inches in middle; rampart, 7 to 8 feet in middle; general thickness, exclusive of lower terrace, 14 feet 6 inches to east; 18 feet 2 inches in middle; height, 15 to 18 feet 6 inches, where measured.

The hut sites along the headland have completely disappeared; of those near the wall there was a dolmen-like house of slabs, 5 feet and 6 feet long and 5 feet high, 15 feet from the wall, near the modern fence. At about 154 feet from the bend and 12 feet from the wall, in the hollow, is a circular hut 18 feet across, then an irregular one 30 feet by 14 feet, with a side cell to the north-east 6 feet by 8 feet 8 inches, and D-shaped in plan. Close to this is the long shapeless hut, a sort of passage, 9 feet wide, ending in a rounded cell. In this are two small low opes, the northern so nearly filled that we could only look into the cell. The lintel is only 7 feet long, the ope 20 inches high and 28 inches wide, at 15 feet from the steps of the lowest terrace. The southern door leads into another rounded hut, 12 feet by 15 feet, with an irregular passage 23 feet long. South of this again is a somewhat circular hut, with (as usual) walls 3 to 4 feet thick and 18 feet by 21 feet outside. I saw no traces of middens in the fort, but the whole interior is strewn with shells, usually (as I have often seen happen) dropped by sea birds. So far as I can judge, most of the ladder steps are old; the sidelong flights are mostly, if not entirely, rebuilt, but probably on the site of similar flights. Much of the small inner facing, especially to the curved eastern end, is new. The lower parts of the huts are ancient, with the two small "creep" doors already named. In the more eastern part of the main wall I think there is a sloping mark, as if a sidelong flight had once run up to the terrace and been closed up and its steps removed, either by early restorers or in the extensive works of 1884. I was sorry to see here, and in other forts on Aranmore, that the curses of Irish archæology, the idler and rabbit-hunter, have again begun to tear into the terraces and to lever stones out of the wall faces.

FORTIFIED HEADLAND.—O'Donovan (followed by later writers) records another fortified headland to the north-west of the last.[1] The cliff had fallen in, and storms had reduced the remaining part of the wall to a shapeless ruin. A small chamber, not unlike that at Dun Aengusa, remained in the thickness of the wall. It was 3 feet 8 inches long and high by 3 feet 4 inches wide. The use of such cells is very problematic, save for storing some very precious small possessions. To the east of the fort are the remains of a cloghaun, 18 feet 6 inches in diameter, the wall 6 feet 7 inches thick. No such fort is marked on the maps to the north-west of Dubh Cathair; but a short headland at Poulbriskenagh has a cloghaun to the east of it, and is probably the place intended. There may be some confusion in O'Donovan's notes.[2] I can only regret that the difficulty of exploring the fine south coast (from useless tottering walls, extended to the cliff edge) did not permit me to verify the "Letters" in this case. I saw no object resembling a fort along the cliffs from Bensheefrontee to Whirpeas; but among the endless walls and rock-ledges this proves nothing.

Bensheefrontee, the headland next to the west of Dubh Cathair, is apparently walled in an unusually massive style. A vast and regular pile of large slabs runs across the neck, the space to either side being clear. There is no evidence of human work, and (though only credible to those who have seen the blocks in Clare and Galway[3] which have been thrown up by the sea, and especially those by the gale of January, 1839, along the coast to the other side of Dubh Cathair) the band is possibly natural.

Still further westward the long, bold headland of Nalhea, Aedh's cliff, seemed so likely a site that I, at some trouble, examined it. However, the wall shown on the maps proved a slight modern one, and there was no trace of older work or anything to reward one for traversing the complicated and rugged bohereens, save the beautiful outlook along many miles of foam-girt precipices extending to the Brannocks past Dun Aengusa, which presides over all at the highest point of the view.

Dun-Killeany. (O. S. 119.)

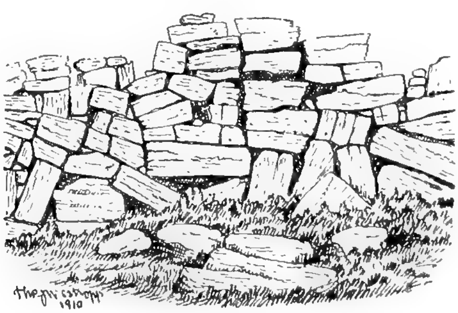
This ring-wall, though it has suffered to a very great extent, was once of better masonry, and in some respects more typical than the great "Duns" of

[1] Ordnance Survey Letters, County Galway, p. 250.

[2] They were taken in April, 1839; the letter was written on August 26th.

[3] As near Ross in south-west Clare, Dunamoe in County Mayo, and elsewhere. As a less incredible fact, Lord Dunraven notices a large mast wedged into the face of the cliff near Dun Aenghus, 70 or 80 feet above the sea. The destruction of the street of huts in Dubh Cathair, and the sweeping away of all their debris, render the flinging of these great stones up on the cliffs at this most exposed spot the less incredible. Also waves gain strength when the wind chases them sideways down a long range of coast, and rush over a projecting headland, even if of considerable height.

the island. It stands on a low, rocky knoll, on the edge of the ridge, in the townland of Killeany, and seems to have been very little altered since 1839, when O'Donovan first recorded it.[1] The caher is much overthrown, but portions of the facing of large blocks, laid very irregularly, but exhibiting one characteristic upright joint, are standing. Many of the slabs are 6 feet thick. There are a large base course, two faces, and large filling; the outer facing remains in reaches to the west, north-west, and south-east. The wall is greatly overthrown by rabbit-hunters inside. The garth measures 81 feet north and south and 51 feet east and west, the wall being in parts 7 feet high and 8 feet thick, but only 4 feet high at the gateway, where the blocks as a rule are 2 feet by 1 foot 6 inches by 9 inches, but some 4 feet to 6 feet long. The gateway faced the south-east; the jambs were built in courses, and the lintel was 4 feet 6 inches by 21 inches by 10 inches, showing that the ope was very narrow; it seems to be but little over 3 feet wide and 4 feet high. No foundations remain in the garth.



CAHER NEAR KILLEANY.

O'Donovan calls it a "cyclopean Bolgic fort of small dimensions," 72 feet in diameter, the wall 7 feet high, but too crumbled to allow its thickness to be ascertained.

Duns near Oghil. (O.S. 110.)

Mr. Kinahan records another "Dun" near Oghil, which had a well-preserved trilithic gateway which he sketched;[2] it is 70 feet in diameter, with a wall 8 feet thick; the doorway is 3 feet high, and 3 feet 5 inches wide, facing the south-east. In the same townland, not far away, is a cashel 60 feet in diameter to the south-west of Cloghaunaphuca. The larger dun seems to measure 110 feet by 220 feet approximately; it is a very dilapidated oval fort, half a mile from Dun Oghil, called "M'Doon," the strongest fort on the islands, with two or three other small cahers. All of these are now extremely dilapidated. The chief "Dun" was described by O'Donovan in 1839; it lay

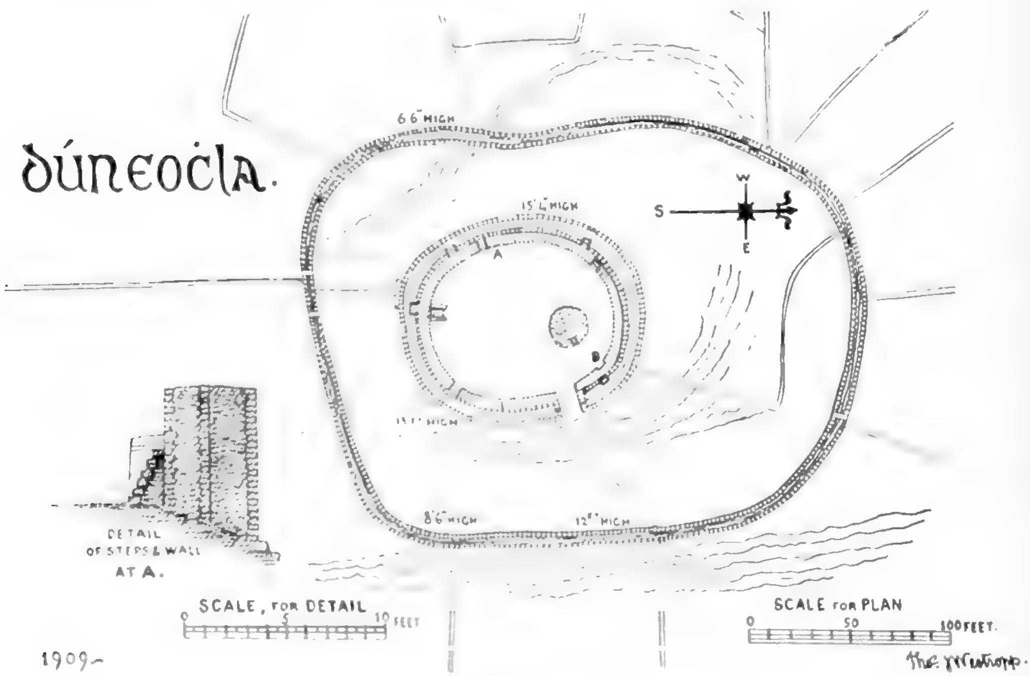
[1] Ordnance Survey Letters, p. 251.

[2] Hardwicke's "Science Gossip" (1875), p. 84. We copy his sketch as little known.

south-west from Dun Oghil fort, and was even then much destroyed for building houses. It was built of very large stones, the wall 7 feet high, but neither its thickness nor the width of the fort could be ascertained; it stood on a rock-ledge 20 feet high.

Dun Eochla. (O. S. 110.)

Dun Eochla, or, as is usual with English speakers, Dun Oghil, is the most prominent fort in the island after Dun Aengusa, indeed more so than the latter, so far as those landing at Kilronan are concerned. It stands on the brow of the central hill, not on the actual summit, but on the edge, perhaps for some shelter from the fierce westerly gales. The name is lost, for O'Donovan's Dun Kimbi or Dun Tamain is a play of imagination, and those chiefs were connected not with Aranmore but with Lough Hackett and Tawin Island. It forms one of a line of four stone ring-walls, which, with many stone huts, formed an extensive early settlement at Baile na Séan.



Plan of Dun Eochla, Aranmore.

Oghil derived its name, Eochoill, from an oak wood; so late as 1821 dwarf-oak scrub grew in the crags not far away.[1] It has been identified with the Lemchoill where St. Enda landed, but this last was evidently on the shore.

The Dun is a fine double enclosure, and is seen at its best from the

[1] John O'Flaherty, Trans. R. I. Acad. xiv. (Antiq.), p. 133, and O. S. Letters, Oghil. There is probably an allusion in Caeilte's song to russet oaks in Aran (Silva Gadelica, ii., p. 109).

eastern slope below, where its full size can be appreciated. The builders took advantage of a natural platform for the centre fort and, in part, of a low rock-ridge for the outer wall to the east, but to the south-west the latter wall disregards defensive lines and drops into a grassy depression in a very irregular manner. O'Donovan[1] describes the site in 1839, giving the dimensions of the inner fort as 91 feet north and south, 75 feet 6 inches east and west, the wall being of three sections, 13 feet to 16 feet high, and 11 feet 6 inches thick, the two outer divisions being of equal height, 8 feet 8 inches thick, the inner much broken, and 2 feet 7 inches thick. To the south the outer section rose 7 feet 9 inches higher than the terrace, which was 7 feet above the garth. A flight ran from the terrace to the south; another ladder 4 feet 1 inch wide, of which some seven steps remained, led up to the terrace. To the west of this spot above the ladder some steps ran to the left: they were 4 feet 1 inch broad, and 2 feet 9 inches deep; he gives their heights, which amount to 4 feet 5 inches. Another flight (now built up) ran from the ground to the terrace at the north-east side: it had three steps, the topmost broken by the falling stones, while some 20 feet from the last was the broken gateway. The north-east section was internally much ruined. In the area to the north was a round heap of stones, evidently a hut, as it had oblong and oval cells, while to the south-east was another building nearly destroyed. The outer ring had two sections, 5 feet 7 inches thick, 7 feet 9 inches to 12 feet high: it lay distant from the inner fort, 50 feet to the east, 90 feet to the north-east, 50 to the south-west, and 39 feet to the south; the outer gateway was defaced. This seems the only good description before the restoration. Lord Dunraven only adds a few details: the triple wall of the inner fort is 15 feet 5 inches high to the west, and 14 feet to the east. He notes the south-west flight as running up to the platform of the terrace, the south flight from the terrace to the top of the wall; its first step was of two stones, the second of one, the third of three. The north-east flight led up to the terrace and was nearly destroyed. The wall was 10 feet high inside at the south-west steps, their height 5 feet, and width 2 feet 4 inches, each being 6 inches hign and wide. He shows ladder-steps near the gateway, combined flights of steps to the south-west, and ladder-steps to the south. He gives R. Burchell's view and plan of the south-west steps; he also names three sections. The author of the notes (1877) in the "Irish Builder" says the masonry is of stones lying on their sides, not with their ends showing, as at Dun Aenghus. This is not absolutely correct, though there *is* "stretcher" masonry at the gateway, and in the lower part of both

[1] Ordnance Survey Letters, p. 230.

walls.[1] The banquette was usually 3 feet high, but 6 or 7 feet lower than the upper wall. The wall was 20 feet thick; the inner division being 2 feet 6 inches, the middle 10 feet, and the outer 7 feet. Three flights of steps south-west, south, and north-east gave access to the banquette: the southern led from it to the top, and the north flight had been nearly destroyed. My own notes on the fort (1878) are valueless.

As it now stands, we may note that the outer ring[2] had two sections visible at least to the north-west, where there is trace of a terrace. It was of large blocks to the south and south-west, some 6 feet long and 18 inches thick, set lengthways at the base, but usually as "headers" above; the square ends being visible, the interstices (as at Dun Aengusa) being packed with spawls of stone. It is 8 or 9 feet high, resting on a low ridge, and much ivy grows out of it, as at Dun Conor. There are gateway gaps with no traces of old work, one to the north-east and two to the south. The interspace between the walls is 59 feet to the east, 89 feet to the north-east, and usually 40 to 50 feet elsewhere, the plan not being an oval, as in the Ordnance Survey Letters and Lord Dunraven's notes, but very irregular. There are only a modern house ruin, and late traverses or rather field walls in the interspace.

The inner wall[3] had two divisions, now indistinguishable, and a terrace; it was from 11 feet to 15 feet high. It has a regular batter, like the Clare, Mayo, and Kerry forts, but this (save to the north and east) is distorted in parts. The jambs of the gateway are ancient below, of great long stones, 9 feet 7 inches by 2 feet 3 inches, where largest. No lintels lie about, but several seem to have lain down the abrupt ridge before the gateway in former years, rendering it probable that there had been an inserted gateway like that at Dun Aengusa.

The passage was 7 feet 9 inches wide in 1870; as restored it is 8 feet 7 inches wide inside. In the interior we note the following features:—A terrace 5 feet to 6 feet 4 inches high, and from 2 feet to 3 feet 6 inches wide (nowhere 7 feet wide, as stated in some books); the wall rises 5 feet or 6 feet above it. Going northward from the gateway, we find traces of two flights of steps, one above the other, to the north-east; the upper only retains three steps now as in 1839: one is of two stones; they are less than 2 feet wide. Of the lower flight the bottom steps remain, but the recess (defaced in 1877) has been built up by the restorers. The upper is 12 feet 9 inches, the lower 13 feet 8 inches from the gateway. The next is to the north-west, about 55 feet (round the wall) from the gateway. Five ladder-steps, 3 feet 2 inches long,

[1] As his fine photograph shows, it also proves that a long reach of the outer wall to (I think) the west, was either entirely levelled to the bare crag, or only three to four courses remained (Plate VIII.). This is now rebuilt. [2] Plate VI., fig. 2. [3] Plate VI., fig. 1.

run up the terrace, with several new steps at right angles, as if the "reach" of the ladder-steps had been miscalculated, or the terrace raised after they were built. These steps are not shown on the plan of 1839, in its description, or in that of 1877. Further to the south, 4 feet 9 inches from the last, a flight 2 feet wide, of which the three lowest steps alone remain, rises from the terrace upward. At twenty feet to the south of the gateway is a flight of eight steps 4 feet 3 inches wide: it leads to the terrace, and is recorded in 1839; so does another flight at 45 feet 10 inches from the gate. This has five steps, and another embedded in the upper wall, where perhaps it once continued to the summit. It has also a flight of five steps at right angles to the north. This arrangement and that in the other flight has a counterpart in the noteworthy ladder-steps in Caherahoagh, in Inchiquin, Co. Clare;[1] but the transverse flight leads from the terrace up the wall in that fort. For comparison we may note that the usual ladder-flights in Clare, like those in Aran, have no spaces under the steps, as in the Caherahoagh stone ladder. The flight in Dun Oghil had three (not five) steps in 1839; two were probably then hidden in the debris, which encumbered the foot of the fort walls at every point at that period. A curious late arrangement of steps between two walls (dating probably from 1884) leads to another ladder-flight of eight steps in the upper section; this latter was also recorded in 1839. It is 36 feet from the south-east flight. About 23 feet west from it to the west-south-west is a ladder-flight of five steps up the terrace; it is 3 feet 5 inches wide, and seems unrecorded, though probably, like other unrecorded steps, the firmly set base stones and traces of the recess with loose step blocks were found in the debris by the restorers.

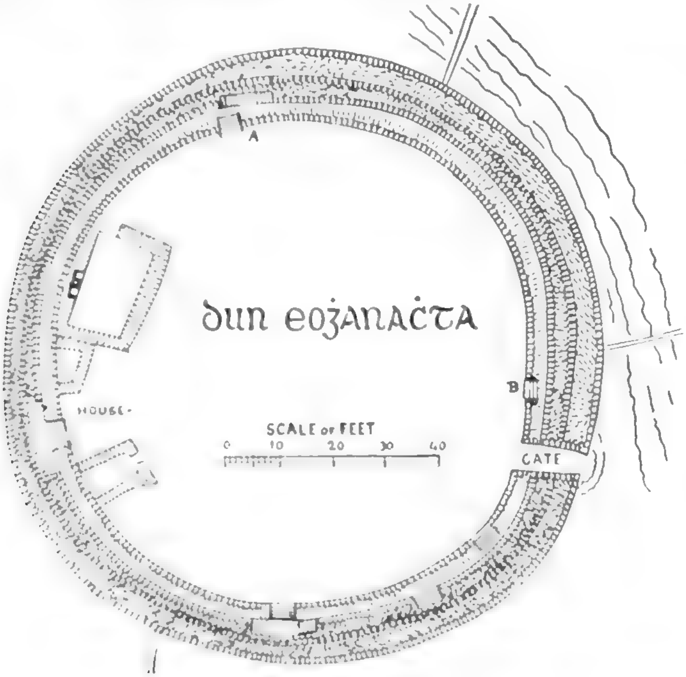
The garth measures 91 feet north and south, and 75 feet 6 inches east and west; there are no hut sites save to the north, where a round pile of stone, with chambers, once remained; we find an anomalous "round thing" with a flight of steps, possibly made with the blocks of the "closed flight," just opposite. From its situation on the central hill, and the large number of huts, with three forts, beside it, Dun Oghil, though less imposing than Dun Aengusa or Dubh Cathair, must have been at one time the chief residence on the island; and it is regrettable that its ancient name and legend are unrecorded and lost.

DUN EOGHANACHTA. (O. S. 110.)

One more perfect ring-wall stands on the edge of a bold rock-ridge, not far from the so-called "seven churches." Among the older settlers of the Corca-modruadh tribe in Clare we find, apparently, a branch of the East

[1] Roy. Soc. Ant. Ir., vol. xxvi., p. 366.

Munster Eoghanachts[1] called "Ninuis." Its chief, Corbanus, was in Aran (if we may trust the 1380 "Life") when St. Enda landed about 480; he then retired to his possessions on the mainland. The story is not unlikely, for the feeling that prompted the natives of a Pacific Island to erect "ghost-scarers" against an expected missionary was strong in early Ireland; a priest of a strange faith claiming to work miracles was a suspect of the darkest dye; and others, beside Mochulla, were described as "nigromancers" by native chiefs in western Ireland.[2] However, the "Eoghanacht" of Aran maintains its name to the present day, as Oonacht, or Onaght. The "Dun" has suffered little by the 1884 restoration; but, in accordance with our plan, we must note the earlier descriptions, and then the remains as they stand at present.



Plan of Dun Eoghanachta.

O'Donovan,[3] the first to note its existence, describes it as nearly circular 90 feet to 91 feet across; the wall was of three divisions with a regular facing

[1] Descendants of Eoghan Mór ("Mogh Nuadat"), who divided Ireland with King Conn, and gave his by-name to Leath Mogha, "the southern half" of Ireland in the second century, and with his son, Oillill Olom, King of Munster, is ancestor of the chief Munster tribes according to the mythical pedigrees.

[2] So also St. Patrick and his companions were supposed to be fairies ("viros sidhe"), and St. Enda, an aerial spirit, or magician: one recalls the supposed theophany at Lystra at an earlier mission.

[3] O. S. Letters, Galway, p. 222. He told the British Association that the fort was "2000 years old," and repeated the theory of the wall being built in sections as a precaution against sapping

of large stones—namely, the inner and central parts 4 feet each, the outer 8 feet and 12 feet to 16 feet high. The doorway was 3 feet 4 inches wide, but was broken down. Four flights of steps lay to the cardinal points, all too defaced for description. The plan shows them as ladder-steps. He then notes Kilchomla, a reputed grave of a saint, below the fort, and an oblong building "near the fort," 20 feet by 13 feet, with three more of similar form and equal dimensions to the north-east. It may be seen that there are also three such houses at that point inside the fort.

Petrie, in 1821, does not name the fort; Ferguson, in 1852, barely mentions its better preservation and more massive masonry. Lord Dunraven gives a fine view (Plate VII of his work) he gives the dimensions as 97 feet north and south, 93 feet east and west; stones 3 feet and 4 feet long, and 1 foot 6 inches deep, well laid. The wall, ruined to the east, 16 feet high, and apparently single, though (as he notes) O'Donovan describes three divisions: the platform is 3 feet deep and 6 feet or 7 feet high, with three-feet "recesses" in it, one opposite the door, the others at right angles, and four flights of steps from the area to the top, "now" quite destroyed.

"The Irish Builder" adds nothing, following Dunraven closely; my notes in 1878 are scanty, "a much smaller fort than Moher (?), or Doon Conor, but high walls and broken door on a crag."

As we find it at present, Dun Eoghanachta[1] is in good repair, the walls being of regular large blocks, many laid as stretchers," one 5 feet 3 inches long, others over 4 feet; there is a batter, of 2 inches to 2½ inches in 36 inches, in places to the west and east. The gateway is rebuilt at the outer ope, being 5 feet 6 inches to 6 feet 3 inches wide, the wall 14 feet 2 inches thick. Going from the doorway south-westward (to the left) the following features occur:—at 11 feet a ladder-flight of six feet steps, 4 feet 2 inches wide, up the terrace, which is 5 feet high; at 50 feet is another ladder 4 feet 2 inches wide, with nine steps in the terrace, and flights to left and right, with late steps up the wall, in a recess; the terrace is 6 feet 10 inches high; at 92 feet 6 inches we reach the huts, hereafter described; at 106 feet 9 inches, the ladder-flight, opposite the gateway, with eight steps up the terrace; a flight of eight steps rising to the left in upper wall, and another rising to the right; at 153 feet another ladder up the terrace, 3 feet 10 inches wide, the terrace being 5 feet 3 inches high and 3 feet 3 inches wide; the steps again are in a recess, five steps to each side; at 273 feet is a peculiar ladder-stair; the whole circuit

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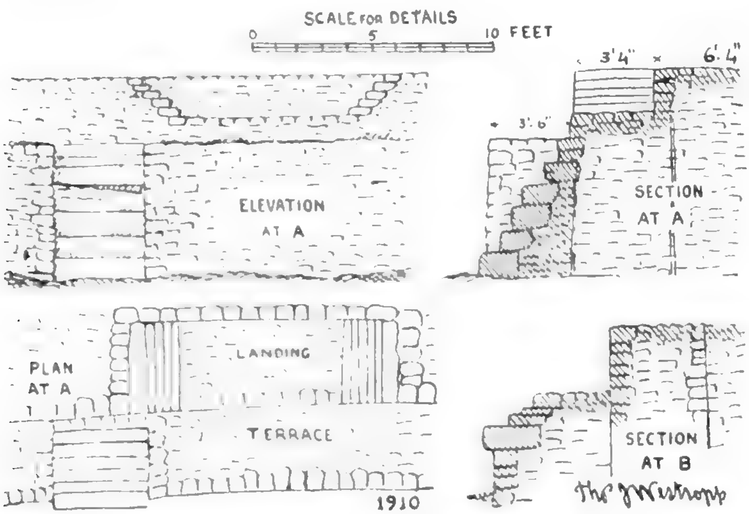
or battering. Petrie gives a plan in "Military Architecture," showing door to north-east, steps to north, west, and east, from the area up; from the south side of the second a stair ascends to the top. The wall is of three sections.

[1] See Plate VII., fig. 1.

[2] The sides remained in 1839; it was 5 feet 9 inches wide.

back to the right pier of the gate is 285 feet, or over 290 feet in all. The last flight is (at least in my experience) unique:[1] it is only 4 feet 9 inches high; the steps project at 21 inches over the garth, and three steps remain. There are no upright joints visible inside, where (as always) the masonry is smaller than outside; but there are some well-marked ones outside. The wall is 16 feet 4 inches high at the east steps, being 9 feet 8 inches thick on top, the terrace 3 feet 6 inches wide, and the whole over 14 feet thick below; the garth is slightly raised over the outer field. The garth is 92 feet north and south, and from the gateway westward is 89 feet 3 inches. Opposite the gateway are three straight-walled but far from rectangular huts,[2] one 10 feet



Dun Eoghanachta. Details of steps and wall.

to 11 feet long, and 6 feet 6 inches wide inside (12 feet to 15 feet outside, and 11 feet 8 inches wide); the next beyond the ladder is from 4 feet to 5 feet 2 inches wide; these two abut against the rampart; the third is 20 feet 8 inches by 12 feet 6 inches, the wall from 1 foot 6 inches to 3 feet 6 inches, and 4 feet 9 inches between it and the next hut; it has a back wall with two plain ambries. A small well springs from under the crag to the south-east.

The only feature in Kilchonla or Kilchorna is a cist, the end stone of which is triangular: this form of cist is evidently of early Christian times, two being found by Lord Dunraven at Termon Cronan Oratory, in Burren, County Clare; another by Sir William Wilde at Slane (the end stones remain); and

[1] Its nearest equivalent is a recess with a single shelf or step half-way up the terrace in Cahernagree, Dangan, in the Burren, County Clare. Journal R. S. A. I., vol. xxxi, pp. 280–1.

[2] See Plate VII., fig. 2.

a third by Mr. P. J. Lynch near St. Finan's Bay, Kerry. The last had a hole through it, and it is not impossible that the holed stone at Kilcannanagh, in the Middle Isle of Aran, was of this character. They are usually distinguished as "cumdachs" (i.e., shrines) or bone boxes.[1]

DUN NEAR KILMURVEY. (O.S. 110.)

There was a large and strong fort, a ring wall, round Temple na naeve oratory, behind Mr. P. Johnson's stables; only the curved line of small filling and large blocks, much overgrown, is found to the north and east of the cell: the name is forgotten. A wall embodying many large upturned blocks runs along the crag behind (i.e. south and west) of Mr. Johnson's gardens. O'Donovan could not learn in 1839 from the owner, Mr. Patrick O'Flaherty, that it had ever been a circle. It is said that stones with arrow-like markings were found in making the garden, but none are known to exist. Petrie[2] says it (Cill múr Mhaighe) was a circular wall, 13 feet wide on top and 20 feet high, in 1821, "the stones being of vast magnitude." At an angle on the west side are the remains of a square tower 41 feet long and 20 feet wide, but the wall was only 3 feet thick. It contained several chambers in the rock, roofed by slabs, and circular or oval houses, of which the largest was 50 feet by 37 feet. It also surrounded two churches and two copious springs. The existing remains do little to support his description, for the remarkable fortress, along with the circular hut, was levelled ere eighteen years had passed. Near the church Lord Dunraven only found four courses of masonry remaining "for 50 to 100 yards."

CLOCHAUNS OR HUTS.

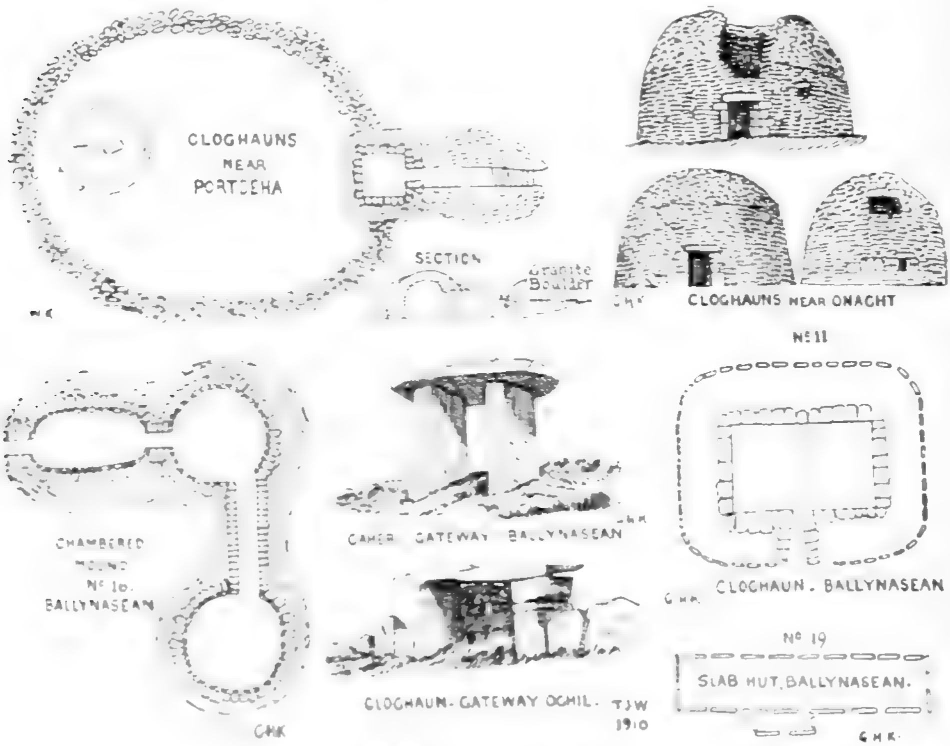
I do not intend to describe *seriatim* all the existing cloghauns in Aranmore; but a few notes on these residences are too closely akin to the subject of the forts to be out of place. They are of very primitive form, but there is every reason, here, as at Corcaguiny, in Kerry (where we have seen "early bee-hive huts" built some five years since), to believe that they were made in Aran down to the last century. Many remember the story of the man who, when the British Association in 1857 were examining some huts,[3] declared he had built them for his donkey the year before; but few remember

[1] This fort is evidently the "Fort Carrick" of Mr. C. H. Hartshorne's somewhat inaccurate paper (Archæologia Cambrensis (N.S.), iv. p. 298). I have found the name in no other place. "Fort Carrick a much smaller work, a single circumvallation, but the masonry, sallyport entrance, and alcove were analogous to the others."

[2] Military Architecture, p. 69.

[3] "The Aran Isles" (the excursion of the British Association, 1857), Martin Haverty, 1859, p. 14.

how after his statement the huts were shown, marked on the Ordnance Survey maps, some twenty years earlier. Such statements, for, or against, the antiquity of primitive structures, should be received with caution. We have retorted crushing facts on facetious dealers in mendacity on more than one similar occasion, through our would-be misleaders being unaware of records of the structures, long before their lifetime, accessible to all students.



Cloghauns, &c., Aranmore.

The oldest seeming type is certainly what Mr. George Kinahan calls a "fosleac," "ligatreabh," or slab-house. We have noted one in the Black Fort: it is closely like a dolmen; indeed, whether the reputed cists in the Aran Isles be really such, and not huts,[1] remains to be seen, but the common legend of Dermot and Grania attaches to one at Killeany, and another at Baile na séan. However, huts and enclosures of slabs set on end are apparently very easily raised in later days; and even a pigsty or dog-kennel of slabs like small cists are not necessarily a century old.

[1] Where exactly similar structures in Co. Clare were found buried in cairns, the argument as to their difference from free standing cromlechs, or that from their being on rock, does little to prove them non-sepulchral.

The round, or oval, domed, roofed hut. The best specimen is Cloghaunnacarriga,[1] between Kilmurvey and the Seven Churches. It has been figured by Petrie, and fully described; similar cells at Skellig Rock, off the coast of Kerry, and in forts in Clare and Kerry, are very common; some may date from the seventh or eighth century. All the late ones we have noticed are of small stones, so the massive character and skilful masonry suggest age. They vary from 12 feet to 18 feet across inside; they are numerous at Baile na séan. Mr. Kinahan records several; the best-known now is Cloghaunaphuca behind (i.e. south) from the Roman Catholic church at Oghil.

A variant of this is square below, and then corbelled at the corners, the roof coming into a dome, and made of slabs projecting one beyond the other, till the space can be closed by a single slab. Others consist of a group of round, oval, or irregular cells; one near Temple Benen, to the south of Killeany and not far from the cliffs, is so massive and so unusual in plan that we are puzzled as to its probable age.[2]

The third type is rectangular like a modern cottage. An early example, probably a monastic cell partly cut in the rock, is found close to the door of Temple Benen oratory. Later still is the curious dry-stone house which we also describe; it lies to the north-west of the same church, and appears to have had four cells. We give a plan so far as the debris allowed us to follow its lines. They seem to be first recorded definitely in the account of Aran in "Ogygia" by Roderick O'Flaherty in 1685. "They have cloghans, a kind of building of stones, laid one upon another, which are brought to a roof without any manner of mortar . . . so ancient that no one knows how long any of them were made," which favours the antiquity of at least the bee-hive form.

The middens near these huts yield shells, the periwinkle predominating, but with mussels and scallops, bonnet-shells, &c.; and bones of cows, sheep, and geese. Some have yielded pins, one a token of 1672; a celt, supposed to be for skinning seals, was found near Dun Conor on the Middle Island. Such implements are not uncommon, and are kept as charms. One midden in the last-named island is 36 feet by 27 feet and 3 feet high. Pillars (other than those bearing Christian emblems, as at Manister Kieran, Templemacduach, and Templebrecan) are few and small. Let us examine a few of the huts in detail.

CLOGHAUNACARRIGA, Clochán na Carraige.[3] (O. S. 110.)—It is an oval, beehive-shaped hut, quite perfect, 19 feet by 7 feet 6 inches wide and about 8 feet

[1] Plate VII., fig. 2. I owe this view to Dr. George Fogerty, R.N. [2] See *infra*, p. 198.

[3] First noted by Petrie, "Ecclesiastical Architecture of Ireland," p. 130, with an excellent illustration, often since reproduced. The photograph reproduced, Plate VII., fig. 2, is by Dr. George Fogerty, R.N.

high; the walls 4 feet thick, but evidently thinner above, as they cove in for the roof. The doorway is of a very usual size, 3 feet high by 2 feet 6 inches; like the 102 feet wide of the garths of forts, I have found the dimensions very frequently on the mainland. There is a door to each side; one was blocked in 1878, and an end window, which, like the eighth-century huts at Skellig, "contrived a double debt to pay" as a window and a chimney.

Cloghaunaphuca, Clochán na púca. (O. S. 110.)—Named after the mischievous demon-horse or goat so familiar in our place-names and folk-lore. It resembles a cairn, and is 30 feet long, 18 feet wide, and 12 feet to 14 feet high, with two rooms inside. There are two low doors, the northern closed by fallen stones; the chamber is oblong, cut in two by a low cross-wall, with a door in the middle and opes to either side. The apartments measure 22 feet by 10 feet and 10 feet by 7 feet. The roof rises in corbelled courses; the hut had once little enclosures to each side.

Onaght. (O.S. 110.)—Two cloghauns stand on the hillside, due west from Dun Onaght. They are of the later type, the northern being rectangular, 18 feet by 14 feet wide, and 10 feet high. It (as is so common) has doors to the north and south; the first is the larger, being 3 feet square; the other is 2 feet 6 inches by 2 feet. There is a window to the south, 1 foot square and 3 feet up. The roof was destroyed just before 1866 by rabbit-hunters, the structure being then perfect. The southern hut is 15 feet long by 12 feet, and 9 to 10 feet high, with north and south doors, and a window at the south-west corner, the west wall resting on a low shelf of rock. They were first noted by O'Donovan in 1839.[1]

Baile na sean.—For illustration, we may select some typical examples from this large settlement on the central hill of the island, for, since Mr. George Kinahan[2] wrote, the remains have so suffered by rabbit-hunters, and been so buried in heaps of stones collected off the fields, that there is little to repay the dangerous and painful climbing of loose walls, endless from the network of little fields, in one's search for huts at any distance from the narrow rough bohereens that give passage across the island. (No. 7.) There is a slab hut of six large stones; it is 8 feet long, 3½ feet wide, and 4 feet high, but may be a dolmen, from its long and narrow proportions. (No. 9.) Two circular huts 24 feet in diameter; their walls are of a single thickness of stones,

[1] Ordnance Survey Letters, p. 225. He gives the dimensions as the southern hut, 14 feet 3 inches east and west by 6 feet 2 inches wide; it is angular at the west "corners" and rounded at the eastern ones. The roof is covered by ten slabs, 8 feet above the floor, with two lintelled doors to the north and south. The second hut is to the north-east. Half its roof is gone; it is 18 feet by 7 feet 5 inches, with north and south doors 1 foot 8 inches to 1 foot 9 inches wide. Mr. Kinahan gives the dimensions as in the text.

[2] Proc. R. I. Acad., vol. x. (1866–70), p. 28.

with slabs set on end round the base, and backed with clay. (No. 10.) Another is smaller, of 15 feet diameter, backed also with a circle of slabs 27 feet in diameter externally. (No. 14.) Part of a circular chamber in a mound; a passage leads eastward, and is 18 feet long, 4 feet wide, and 3 feet high, covered with large slabs. To the south-east is a circle of stones, 21 feet across, with another chambered mound and midden. (No. 16.) A chambered mound; one cell is oval, 15 feet by 8 feet; it has an entrance passage at the south-west side, 3 feet square, leading to a circular cell, 12 feet across; another passage, 15 feet by 4 feet by 3½ feet, runs to a third round cell, also 12 feet across. The surrounding earth mound is fenced by slabs to each side of the entrance. (No. 19.) A large slab hut, 30 feet long, 6 feet wide, and 4 feet high, with a small annexe attached to the north-west side. (No. 20.) A cell (like "creg a blughaun" cloghaun farther south);[1] the chamber is 16 feet long and 8 feet wide; the height cannot be fixed. Part of the roof remains; there are two doors to the north and south 3 feet by 2 feet 6 inches to 1 foot 9 inches wide. At the north-east is a window, 1 foot square and 3 feet up the wall. The chamber of Cloghauncalticaunnien is small, circular, and ruined; it lies south from Cloghaunaphuca to the west of the bohereen from Cowrugh near the field called "the Lag." The only reputed dolmen of the group lies in the fields called "Doonbeg" from the large[2] western fort. A pillar stone on the ridge, south from Farranacurka village, and another near the "Church of the four comely ones," seems to bound the "city." Thirty-one huts were recorded by Mr. Kinahan, and many others must have been cleared when the subdivision took place and the walls were made, probably long before 1839.

KILCHORNA.—Between Kilronan and the prominent headland of Pollnabriskenagh to the west of the Black Fort are two Cloghauns at a burial-ground with a holy well and church name, so they are possibly monastic. One is called Templemore, and measures 48 feet by 22 feet. The dripping well Toberchorna is now usually dry.[3] Two other rectangular huts lie nearer to the sea.

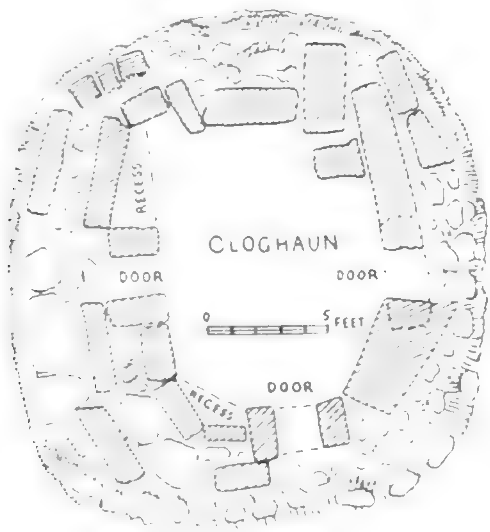
KILLEANY. (O.S. 119.)—This was a place of much importance in the history of Aran as St. Enda's settlement, about 480; a number of churches, a round tower, and a sculptured high cross of some beauty and richness, attested its sanctity. The O'Briens in the fifteenth century added a Franciscan house and (some say) the Castle of Arkin. The last, an Elizabethan manor and garrison, was probably rebuilt in 1618, and was

[1] It lies beside the bohereen, south of the chapel.

[2] Perhaps it was "small" compared to Dun Oghil at the other end of the settlement.

[3] See "Aran of the Saints" (J. Grene Barry), R.S.A.I. xvii. (consec.), p. 499.

probably entirely reconstructed in 1652. We, however, are only at present concerned with the cloghauns near the remarkable church of Temple Benen, locally, and corruptly, Temple Minnaun, the Kid's Church. Close beside the north door of the latter (for it is rebuilt north and south, not east and west) is a cell, built in a hollow, or cutting, in the rock; it is 9 feet 8 inches by 4 feet 2 inches inside, with walls 3 feet 6 inches thick, and quite featureless.[1] It was most probably roofed with stone. Farther to the north-west is a very curious, if late-looking, structure of dry-stone work, called in 1878 the Priest's House and the Monk's House,[2] and quite different in character from any other cloghaun known to me on the island. It measures 25 feet 6 inches to the west, 26 feet 1 inch to the south, and 23 feet 9 inches to the north,



Cloghaun near Pouldick, Killeany.

the south wing, 10 feet 8 inches wide, projecting for 5 feet from the eastern face. In the "set-back," so formed, is a curious semi-circular headed recess beside the door. The latter is 27 inches wide, and over 6 feet high, with lintels; it has a small recess in the north jamb; inside the northern part, about 7 feet to 7 feet 6 inches wide, seems to have had two rooms, while the western had one, but both are filled with fallen stones, and nothing appears to show how the roof was covered. There was a revetment forming a terrace to the north and east on the edge of the crag.

[1] "The Irish Builder," xxix. (1887), p. 103, describes it as 10 feet by 5 feet 4 inches, the door 2 feet wide, the walls 3 feet thick.

[2] I did not hear another name, "The Watch Tower," in my earlier visits.

Farther to the north-west, in the same field, was another straight-walled cloghaun, unmarked on the maps; it has been almost completely overthrown by rabbit-hunters, only a fragment of the facing to the east being visible in the heap of stones. In the next field, about 400 feet from the edge of the cliff at Pouldick, is another cell, one of the most curious of the Aran huts. It may be roughly described as oval, 11 feet 9 inches to 11 feet 1 inch north and south, and 9 feet east and west; but low recesses, where there is a corner, roofed diagonally by an upper slab, render its real shape explicable only by a plan; blocks 4 feet to over 5 feet long are to the north-west and south-west; there is a projecting pillar inside to the north-east. The low lintelled door 2 feet wide, and nearly filled, is to the (compass) east. There is another doorway, 1 foot 8 inches wide, and better preserved, to the south, which leads into an enclosure, 14 feet wide and 17 feet 6 inches long. The hut walls are 5 feet 6 inches to 6 feet thick, with two faces of blocks and an occasional bond-stone through the wall.

About a mile and a half to the east near the bay of Portdeha (Port daibche),[1] celebrated by Magraidin in the "Life of St. Enda" in 1380, the Rev. W. Kilbride[2] found another cloghaun buried in the sand. It is now reburied, and we must follow his description. The cloghauns were near Cala na luinge ship-harbour, and a place called Templenamrawher, Friar's church, where no early building is extant.[3] They resembled piles of stones externally, the second having a rude slab or tombstone on the top. About 1810, said the natives, a French or Spanish ship was wrecked, and all its crew lost in Cala na luinge. The natives buried the recovered bodies in the sand, and so dug down on the hut, its roof falling in. In September, 1867, Mr. Thompson, of Leeson Street, Dublin, and Captain Rowan, of Tralee, excavated the eastern hut, which rests on the rock. The lower part for 4 feet high is rectangular, 8 feet 2 inches by 8 feet 9 inches, and then rises in a dome 8 feet high; the entrance was 1 foot 7 inches wide, and the masonry very regular. From the door is a passage 3 feet 6 inches to 4 feet 7 inches wide and 3 feet 6 inches high. At the east end are six steps, the topmost level with the side walls of the passage. A large ring of stones 72 feet across enclosed the huts.

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[1] Port doibche, see O'Flaherty, 1685, "hIar Connaught," p. 83, "portus dolii," in the "Life," where the barrel of corn came ashore by a miracle.

[2] See "Iararna," Roy. Hist. and Archæol. Assoc., Ir., vol. x., consec. (Ser. 3, vol. i.), 1868-9, p. 109.

[3] The list given by Quelaeus, about 1635, names a Temple Maclonga, near the parish church of Killenda. Unless "near" is used in a narrow sense, one suspects that it is Templenamrawher, for the component "long" ship appears in Cala na luinge. "Mac" is a common mistake for other components, "an," "na," &c.

There is a dolmen (like the last, unmarked on the map), over 150 feet south-east from the church of Teglath Enda, in the sandhills; it seems now to be buried. It was about 9 feet long; three stones remained; the ends faced the north and south: the west consisted of a single thin slab 9 feet long the north of two: the interior was 3 feet 6 inches wide. The natives called it Laba, or bed, i.e., grave, and connected it with the familiar legend of the flight of Dermot and Grania.

Arannmore is indeed a treasury of early remains. To sum up, there exist eight stone-ring forts, one with two and one with four rings; one promontory fort, and perhaps a second. About fifty stone huts exist outside of the forts. It is strange that there are none in the greatest fort, Dun Aengusa. Of the mortar-built structures are a round tower, ten existing churches, sites and graveyards ("aharlas" included),[1] some seven "monastic residences," and two castles,[2] besides five churches, recorded by Quelaeus (i.e., Archbishop Malachy O'Quealy, of Tuam) about 1635. There is also a dry-stone tower called Turmartin, on the shore of Gregory's sound, which boatmen reverentially salute, and fishing vessels lower their topsail before as the reputed tomb of the saint. At least thirteen stones bore Irish inscriptions,[3] six incised crosses, and there were three high crosses elaborately decorated with interlacings and fret-work of later Celtic art.

If we have had to utilize the work of others to an excessive degree, we have at least, in going carefully over most of the remains, used it, not to supersede research, but to show the condition of the buildings before the dilapidator and the restorer worked their will on the early forts of Aran. With this intention, and to record the state of the remains at the beginning of a new century, we lay these notes before the Academy.

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[1] Aharlas are rather unroofed oratories, sometimes near wells. There is a characteristic one in the village of Kilronan.

[2] There is also a place called Castleminna, beside Bungowla, on the north-east of that village.

[3] See "Christian Inscriptions," vol. ii. Miss Margaret M'Nair Stokes), Plates xi.-xvi., pp. 18-33.

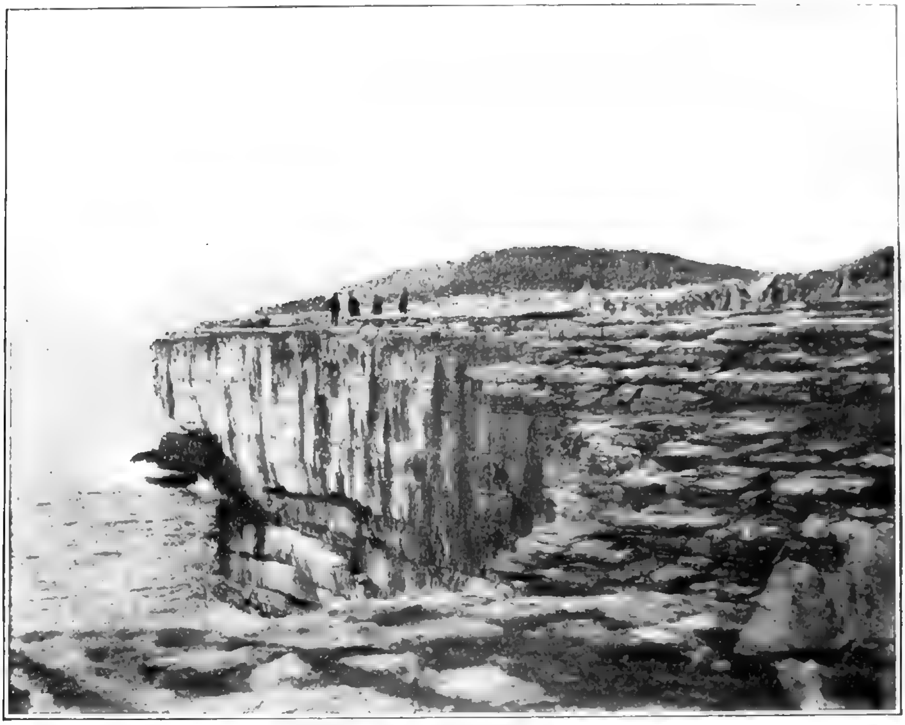

Fig. 1.—Dubh Cathair, Aranmore, from the S.E.

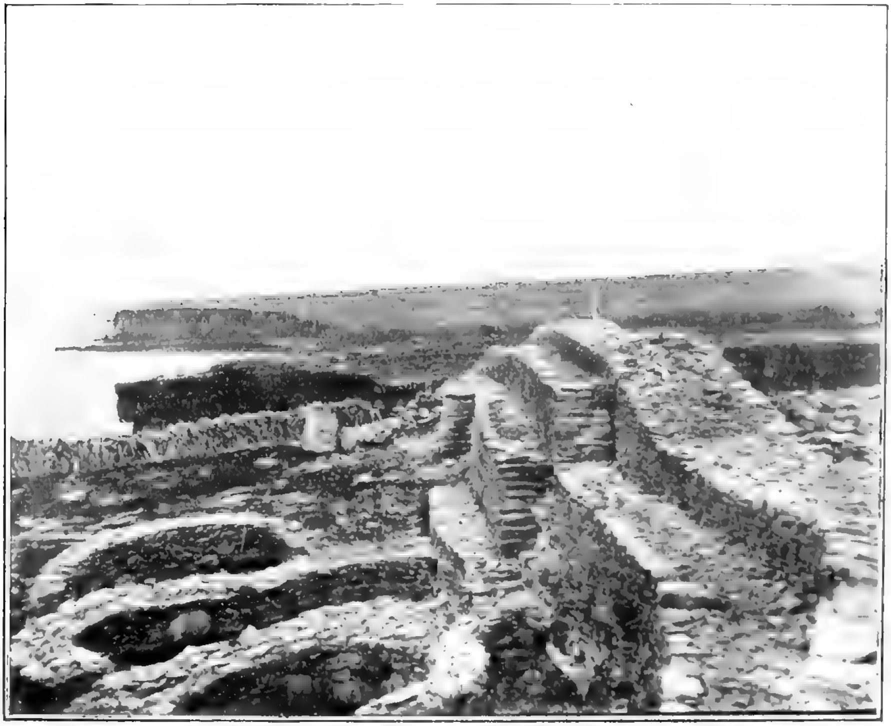

Fig. 2.—Dubh Cathair. Interior from the rampart.

Fig. 1.—Dun Eochla, Aranmore. The central fort from S.E.

Fig. 2.—Dun Eochla, Aranmore. The outer wall at S.E.

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XII.

CONCHUBRANI VITA SANCTAE MONENNAE.

EDITED, WITH AN INTRODUCTION.

BY MARIO ESPOSITO.

(PLATES VIII., IX.)

Read JUNE 27. Ordered for Publication JUNE 29. Published OCTOBER 14, 1910.

OUR principal authority for the life of St. Monenna, or, as she is sometimes called, St. Darerca, is the Vita Sanctae Monennae compiled by an Irishman named Conchubranus. This work is extant in one MS. only, the Codex Cotton. Cleopatra A. ii, preserved in the Library of the British Museum. It was printed from a transcript of this MS. by the Bollandists in 1721, in their great collection of Acta Sanctorum.[1] The edition is, however, very defective. I have counted not less than four hundred places in which the editors have [illegible] deviated from the reading of the MS. They have omitted all the headings of the chapters, the division of which, as marked in the MS., they have disregarded.

In the present edition I have endeavoured to give an accurate reproduction of the original MS., including all the articles omitted by the Bollandists, and introducing into the text no emendations or alterations of my own. In an Appendix I have added six other pieces relating to St. Monenna, which are found in the same MS. Four of these are in verse and two in prose. Of the poems two are alphabetical hymns in her honour, the first in 192 lines, and the second in 92 lines. Neither of them has as yet been printed. The two prose pieces are also, I believe, unedited. One is a catalogue of Monenna's successors, and the other is a legend relating to her bed in one of the monasteries she founded in Ireland. With the exception of some extraneous matter bound in at the beginning of the volume, I have thus reproduced everything contained in the MS.

In preparing this edition I have had the use first of photographs of the MS., which the authorities of the British Museum kindly permitted me to procure,[2] and secondly of an accurate collation of the MS. with the edition of

[1] Acta Sanctorum, Julii tomus ii, folio Antverpiae, 1721, pp. 297–312 ; cf. also pp. 241–246, 290.

[2] Two of these photographs are reproduced in the plates accompanying the present paper. [illegible] for the cheap and rapid reproduction of MSS., which is now in use in the principal libraries of Europe, but which is, I believe, practically unknown [illegible] sensitized paper, there being no intermediate negative. The paper not being so perfect as the usual dry-plate, the result is always less sharp than an ordinary photograph ; but for its great rapidity and economy this process is

the Bollandists, which was made by the late Bishop Reeves. This latter piece of work, bound up in a small quarto volume, is now preserved in the Manuscript Room in the Library of Trinity College, Dublin, where it bears the number 1099.[1] This MS., along with many other of Bishop Reeves' papers,[2] was acquired by the Library in 1893. It has proved of very great assistance to me. Indeed I may say that without it the present work would not have been undertaken. At the same time, it must be clearly understood that Bishop Reeves is in no way responsible for any errors into which I may have fallen.

I.

Of Conchubranus, the author of the Vita, we know absolutely nothing. He gives us his name in the last chapter of his work,[3] and it is clear that he was an Irishman. He cannot have lived earlier than the eleventh century, as he uses the names Scotia, Scotus or Scottus, Scoticus or Scotticus, indifferently of Ireland and Scotland.[4] It is well known that previous to about the middle of the eleventh century, Scottia, Scotticus, &c., applied exclusively to Ireland.[5] On the other hand, he cannot have lived later than the first half of the twelfth century, as the MS. containing his work dates from this period. We may, then, assume that he flourished between the years 1050 and 1150. The name Conchubran or Conchubranus does not occur in the Irish Annals, though of course Conchobhar is very common. A certain learned Irishman named Caunchobrach is mentioned in a tenth-century MS. at Bamberg,[6] but he must have lived in the ninth century, and so could not be identified with our author.

The subject of Conchubran's biography, St. Monenna, is said to have

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invaluable for purposes of collation. For full details I may refer the reader to the following:—P. Gabriel Meier, Die Photographie im Dienste der Paläographie (Compte Rendu du quatrième congrès scientifique international des catholiques tenu à Fribourg (Suisse), Section V, pp. 436–445, Fribourg en Suisse, 1898); Die Fortschritte der Paläographie mit Hilfe der Photographie (Centralblatt für Bibliothekswesen, Leipzig, xvii, 1900, pp. 1–32, 113–130, 191–198, 255–278); Actes du congrès international pour la réproduction des MSS. tenu à Liège les 21, 22, et 23 août 1905, Bruxelles, 1905; and, above all, the masterly summary by the late lamented Byzantine scholar, Karl Krumbacher, Die Photographie im Dienste der Geisteswissenschaften (Neue Jahrbücher für das Klassische Altertum, Geschichte und deutsche Literatur, xvii, 1906, pp. 601–659, 727).

[1] Abbott, Catalogue of MSS. in the Library of Trinity College, Dublin, 1900, p. 193.

[2] Some of these Reeves' MSS. have been utilized by Plummer in his admirable Vitae Sanctorum Hiberniae (cf. tomus i, 1910, pp. xliii n., lxi).

[3] Liber iii, cap. 14 huius editionis, "pro me ualde misero Domini seruo Conchubrano." In ii, 7, pp. 221, 222, infra, he shows minute knowledge of local topography.

[4] Cf. Index Nominum Propriorum s.v. Scotia.

[5] Cf. Zimmer, Nennius Vindicatus, Berlin, 1893, p. 29; Kuno Meyer, Trans. of the Society of Cymmrodorion, 1895–96, p. 60; Holder, Alt-Celtischer Sprachschatz, Bd. ii, 1904, cols. 1406–1418.

[6] MS. H. J. iv, 11, cf. Heiberg, Oversigt over det Kongelige Danske Videnskabernes Selskabs Forhandlinger, Copenhagen, 1889, pp. 199, 202, and Traube, Abhandlungen der K. B. Akademie zu München, Philos.-Philol. Classe, 1891, Bd. 19, Abth. 2, p. 352.

died in 517 or 518, but of her authentic history we know very little. Besides the work of Conchubran, several other lives of her are extant. A list of these is given in the next paragraph. Through all these lives runs an extraordinary confusion of names, dates, and places, and there seems to be no doubt that Conchubran and the other biographers have mixed up two, and perhaps three, different saints of the same name. At present, when only a few of these lives, such as they are, have been even accurately printed, and none has been exhaustively studied from the historical point of view, it would be an unprofitable labour to attempt to unravel this problem.[1]

II.

Besides the Vita by Conchubranus and the hymns and prose tracts printed in the present paper, the following lives of this so-called St. Monenna have been preserved:

(1). Vita Sanctae Darereae, found in the well-known Codex Salmanticensis, a fourteenth-century MS. in the Royal Library at Brussels, No. 3179 (ancien No. 7672–74), fols. 79 r°–82 v°.[2] It has been printed by De Smedt and De Backer.[3] Zimmer[4] would place the compilation of this life later than the tenth century. Conchubran's Vita may be based on it, or both may be derived from the same more ancient source.

(2). Sanctae Modvennae Vita et Tractatus de Miraculis eius, compiled by Geoffrey, abbot of Burton-upon-Trent from 1114 to 1151.[5] Two MSS. of this work, which has not yet been printed,[6] are known to me, MS. Reg. 15, B. IV. fols. 76 r°–88r° in the British Museum, a vellum quarto of the thirteenth century, and MS. No. 260, a vellum quarto in the Library of Lord Mostyn.[7]

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[1] Such an attempt has been made by the late Canon O'Hanlon (Lives of the Irish Saints, vii, [1892], pp. 55–63, and 79–93), but I fear he has only succeeded in increasing the confusion. However, in his own uncritical way he gives the fullest general account of St. Monenna that can at present be obtained short of reading the actual Latin lives. He has also collected all the information available from Irish sources. On the importance of giving accurate texts of the Latin lives of Irish saints, see the interesting review of Plummer's book by Dr. MacCaffrey (Irish Theological Quarterly, July, 1910, p. 338).

[2] Van Den Gheyn (Catalogue des Manuscrits de la Bibliothèque Royale de Belgique, v, 1905, p. 116).

[3] Acta Sanctorum Hiberniae ex Codice Salmanticensi, 1888, cols. 165–188. Zimmer (Göttingische Gelehrte Anzeigen, i, 1891, pp. 153–200) has criticized this publication very severely; but, though by no means perfect, it has rendered great services to students of Irish hagiography (cf. Plummer, Vitae Sanctorum Hiberniae, tomus i, 1910, p. ix n). To all those who wish to understand the nature of Irish hagiography the two volumes of Plummer's book just quoted are absolutely essential (cf. especially tom. i, pp. cxxix sq.).

[4] Loc. cit., p. 186. As these pages were passing through the press, news reached me of the premature death of Professor Zimmer. His loss will be equally great to students of Celtic philology and to those of Hiberno-Latin literature.

[5] Hardy, Descriptive Catalogue of British History, i, pt. 1, 1862, p. 97.

[6] It is to be printed, along with the Anglo-Norman poem mentioned below, from both these MSS., by Professor A. T. Baker, of Sheffield, in one of the forthcoming volumes of the Literary Society of Stuttgart.

[7] Appendix to fourth Report of the Royal Commission on Historical MSS., 1874, p. 361.

This work appears to be based on the Vita of Conchubran, from which, however, it is said to differ in many points.[1]

(3). Vita Sanctae Modwennae, an abridgment of Geoffrey's work made by John of Tynemouth (fl. c. 1320). It is preserved in the Codex Cotton Tiberius, E, i fols. 199 v°–204 v°, saec. xiv, in the British Museum, from which it has been printed by Karl Horstmann.[2]

(4). Vita S. Modwennae, also an abridgment of Geoffrey's work. It is found in a ms. in the British Museum, ms. Lansdowne 436, fols. 126 v°–131 v°, saec. xiv. This abridgment is quite independent of John of Tynemouth, to whom it was unknown.[3] It has not yet been printed. At the end occur the six elegiacs printed as Appendix E in the present paper.

(5). Vita Sanctae Modwennae, found in a ms. in the Library of Lambeth Palace, 99. 5. fol. 187.[4]

(6). La Vie de Sainte Modwenne, a remarkable Anglo-Norman poem in about 10,000 lines, composed in the twelfth century. It is preserved in a ms. in the Bodleian Library, Digby No. 34, fols. 1–80, of the beginning of the thirteenth century.[5] It has not, I believe, been hitherto printed.[6]

III.

As already remarked, Conchubran's Life of St. Monenna is preserved in one ancient ms. only, the Codex Cotton Cleopatra, A. ii, in the British Museum. I give here a full description of this ms.

It is a small quarto parchment volume, consisting of sixty numbered folios measuring 17·5 cms. by 12·5 cms., the actual size of the text being 13·7 cms. by 8·7 cms. It is written in single columns with twenty lines to the page. Capital letters and the titles of chapters are illuminated. The writing is large and beautiful, the words being well separated, and there is some attempt at punctuation. The letter "e" is always written for "ae" and the letter "i," especially when doubled, is generally marked by an inclined stroke above the line. Abbreviations and contractions are not uncommon.[7]

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[1] Cf. Horstmann, Nova Legenda Anglie, ii, 1901, p. 198 n.

[2] Loc. cit., pp. 198–213. Two other mss. of this abridgment are in existence, Oxford, Bodleian, Tanner No. 15, fol. 423, written in 1499, and York, Cathedral Library, xvi, c. 1, cf. Horstmann, loc. cit., p. xv.

[3] Cf. Horstmann, loc. cit., p. ix n.

[4] Hardy, Descriptive Catalogue, etc., i, pt. 1, p. 100. A new and complete catalogue of the valuable collection of mss. at Lambeth Palace (about 1300 volumes) is much to be desired.

[5] Hardy, loc. cit., p. 99; Macray, Catalogi Codicum Manuscriptorum Bibliothecae Bodleianae, Pars Nona, 1883, col. 30.

[6] Cf. H. Suchier, Ueber die Vie de Seint Alban, Halle, 1877, p. 149, and Gaston Paris, La Littérature Française au Moyen Age, 1888, p. 215. An edition from the Oxford ms., and also from one in a private library, is in preparation by Professor A. T. Baker for the Literary Society of Stuttgart.

[7] The principal orthographic peculiarities of the ms. will be found noted in the Index Verborum at the end of this paper.

Hardy[1] has assigned this MS. to the eleventh century; but in my opinion it is not earlier than the first half of the twelfth. Formerly the MS. belonged to Robert Cotton, whose name is inscribed at the foot of fol. 1 r°. At the beginning of the volume are bound in two inverted leaves, apparently part of an old binding. They are written in a late and very small hand, and contain legal matter. At the foot of the second is the following note:—Ex coniunctione dompni Wyllielmy E^d^lys, Monasterii beati Marie sancteque Moduenne Virginum de Burton super Trent monachi, dum esset studens Oxonie Anno Domini 1517. This entry is conjectured to refer to the binding of the MS.[2] On the blank fly-leaf preceding fol. 1 is the false attribution in a late hand: Vita Scē Modwene virginis Hibernie per Galfridum Burtonensem Monachum. Folios 1 r° to 59 r° are written in the same hand of the first half of the twelfth century. Folios 59 v° and 60 r° are in hands of the thirteenth and fourteenth centuries.

The contents of the MS. are:

Fol. 1 r°–3 v°: An alphabetical hymn in 192 lines in honour of St. Monenna, which has not yet been printed. I give it as Appendix A to the present paper. At the top of fol. 1 r° a modern hand has written the incorrect attribution: Vita Scāe Modwennae virginis Hiberniae per Galfridum Burtonensem Monachum An. 1216 (?).

Fol. 3 v°–56 v°: Conchubran's Life of St. Monenna as printed below. I have endeavoured to reproduce the arrangement and orthography of the MS. as closely as possible, and have not recorded the many variations from the text as given by the Bollandists, since their edition represents no separate manuscript authority.

Fol. 56 v°–58 r°: Another alphabetical hymn in honour of St. Monenna, in 92 lines, not hitherto printed. It forms Appendix B to the present paper.

Fol. 58 v°–59 r°: A very brief account of St. Monenna, followed by a list of her successors. I give it as Appendix C.

Fol. 59 v°–60 r°: A short account of the bed of St. Monenna in a monastery which she founded in Ireland. Like the preceding tract, it is in prose, and has not yet been printed. It is written in a court hand of the thirteenth century. It will be found in Appendix D.

Fol. 60 r°: Six elegiac verses in the same thirteenth-century hand. They occur also in MS. Lansdowne, 436, already mentioned.[3] I give them as Appendix E.

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[1] Loc. cit., p. 94.

[2] Cf. Hardy, Descriptive Catalogue, etc., i, pt. 1, 1862, p. 96 n. On William Edys, the last abbot of Burton-on-Trent, see Dugdale, Monasticon Anglicanum, n. ed., vol. iii, 1821, p. 35.

[3] These lines have been already printed, cf. Acta Sanctorum, Julii, tomus ii, p. 312; Hardy, loc. cit. supra, pp. 95, 100; O'Hanlon, Lives of the Irish Saints, vii, p. 63.

Fol. 60 r° : A hymn in honour of the Virgin Mary in six lines, written in a hand of the fourteenth century.[1] It forms Appendix F to the present paper.

Fol. 60 v° : Blank.

There is a seventeenth-century paper transcript of this MS. in the British Museum, MS. Sloane, No. 4788, folios 1–32. Formerly it was No. 39 of the Clarendon collection.[2]

MS. Cotton Cleopatra, A. ii. Fol. 3 v°–56 v° :—

INCIPIT VITA SANCTE MONENNE.

De uita eius atque uirtutibus.
De uirginali pallio dato a Patricio.
De uaccis furatis et iterum aqua redditis.
De profectione eius ad episcopum Ibar.
Habitans in monte Focharde, auditis sceleumatibus, inde recessit.
De Servila quomodo corpore mutata.
De testatione rustica porcarii, et de ieiunio septem dierum.
De porcello necato et cocto, et iterum uite reddito.
De conuersatione Glunelath et Afin ad fidem.
De Chevin a diabolo uexato, et per sanctam uirginem reddito Deo.
De balneo eiusdem Chevin.
De uitulo deuorato, et de lupo uacce amato.
Qua de causa sancta Monenna prius intrauit in Anglicam terram.
Quomodo transiuit mare cum uirginibus suis.

INCIPIT VITA SANCTE MONENNE VIRGINIS.

1. Fuit inter Hibernenses gentes virgo vite venerabilis et morum sancta industria decorata, nomine Monenna, gratia meritorum in omnibus Hibernie, Scotie, et finibus Anglie famosa partibus. Cuius omnem illuminans Aquilonis partem, velud lucerna maxima super candelabrum posita, cunctas ibi tetras ignorantie tenebras illustravit. Habitantibus in regione umbre mortis, lux orta est eis.[3] Habitavit ergo multo tempore boreali sub axe iuxta Colmi Montem, qui est in confinio provinciarum, cognomine Orientalium, quas sibi ab occidente et septentrionali vendicat, et Conalleorum provincie, quam in meridiem et austrum prospicit. Ad cuius radices, a parte aquilonis constructo

[1] It has already been printed by Hardy, loc. cit. supra, p. 95, who remarks, [these lines] "appear to be an abbreviated and corrupted form of the Rhythmical Hymn of the Seven Joys of the Virgin Mary, in the recitation of which Thomas Becket is said to have experienced great pleasure."

[2] Hardy, loc cit., p. 97. [3] Isa. 9, 2. Matth. 4, 16.

glorioso loco competenter, sicut propheticum intonat oraculum, dicens : "Mons Sion, latera aquilonis, civitas Regis magni."[1]

Ergo magno regi edificato cordium sanctorum templo, de quo apostolus ait: "Vos estis templum Dei vivi, et Spiritus Dei habitat in vobis."[2] non ex lignis et lapidibus sed de sanctis hominibus ferventissimo caritatis glutimine, ut sit omnibus cor unum et anima una,[3] quasi fortis heremita, virgo Christi Monenna, sanctam peregit militiam, ut postea cum ad hoc, secundum ordinem perventum fuerit, Deo cooperante, dicemus. Sed nunc de huius vita vel virtutibus, etiam ab infantia sua vel ceteris etatis temporibus, quid nobis apud nos a verissimis testibus traditum est, Deo volente, et suis adiuvantibus meritis, in quantum possumus, sermonibus proferre conamur.

De Vita eius et Virtutibus.

2. De supra dicto itaque Conalleorum populo sancta Monenna patrem habuit nomine Maugtheum, regentem Oneahhulud et totam terram in circuitu Hardmacha, a Lune usque ad Uluester, prosapie cognationis Hilech, obtimum[4] uirum, sicut in hoc probari potest, quod magnam gratiam in conspectu Domini inuenit qui talem filiam habere promeruit, quam sibi a natiuitate sua Dominus elegit. Mater uero eius Coman nomine nobilissima filia regis [illegible] qui regebat omnem terram a Dunelin usque ad Regumlech. Nam et illa in finem obtimam uitam duxit per quindecim annos. In illam denique prouinciam in qua Monenna cum parentibus habitabat, sanctus hospitio deuenit Patricius, missus a Celestino Papa, ut uerbum Dei omnibus Hiberniensibus in captiuitate diabolica positis predicaret, nonnullisque ab ipso in baptismum traditis vel manuum impositione consummatis, venit et ipsa Monenna pulcherrima filia cum aliis fidelibus obviam episcopo et totius Hibernie illius temporis apostolo, que ab eo benedictionem intellexit. Vir Dei plenus religiose virginis et Deum timentis sanctum desiderium fervere comperiit, ei spiritualia monita in quantum potuit vel ipsa capere vel tempus sinere, largitus est.

De virginali pallio dato a Patricio.

3. Post hec etiam virginale pallium sanctam sancto Patricio benedicente, [illegible] iuxta [illegible] Bruges quod in latina sonat largitatis. In [illegible] iuxta quam sancta Monenna recepit pallium virginale, habundantiam in ea gratiarum et virtutum cum benedictione episcopi procedere, de qua et omnes haurirent cotidie sanitatum gratiam et fluenta [illegible] vite. Docuit ergo episcopus sanctus sanctam et sponso Christo vero desponsatam filiam diligenter mandata Dei scire et ex corde intelligere, quia tanta distantia est inter virginitatem et matrimonium et Christum. Virginitas

[1] Psal. 47, 3. [2] ii Cor. 6, 16 ; i Cor. 3, 16. [3] Cf. Act. 4, 32. [4] Obtimum] corr. optimum cod.

enim prima est virtutis indicio, Deo proximior, similis angelis, parens vite, amica sanitatis, domina gaudii, dux virtutis, fundamenta et corona fidei, spei amminiculum et caritatis subsidium. His diligenter preceptis instructa, etiam hoc Patricius addidit, ut alias virgines sibi etiam copularet, quas in timore Domini ab adolescentia secum nutriret, quatenus earum solatio suffulta, facilius posset implere et perficere bonum quod inceperat.

Et tradidit in manu sua uirginem pulcherrimam, nomine Atheam. Commendata est ergo ab episcopo alii religioso presbitero, ut eam in primis salmos doceret et in divinis studiis semper nutriret. Cum benedictione episcopi Patricii revertitur parentum domum cum quibus seorsum aliquanto tempore permanens, presbitero docente, que domus mergit homines in interitum;[1] nam et ille bene lectitabat salmos. Multum in ea memoria et ardens ingenium prevaluerat, cito legens et firmiter lecta mente retinens. Lectio augebatur de die in diem. Refert quidam quod esset nata bonis ac piis parentibus, bene nutrita, virgo pulcherrima, corpore et anima casta, in domo parentum crevit adulta, voveratque se Domino ab infantia sua virginitatis coronam sanam et integram, quamdiu viveret, servaturam. Iuncteque sunt in loco, qui dicitur Fochard, imprimis octo virgines, inter quas erant et Brigida, Athea, et Orbile, et una vidua cum infantulo, quam episcopum esse factum postea sue gentis constat preclarum, id est Conalle dominum nomine Luger. Qui primus ecclesiam Ruscane in Colgi Campiolo fundaverat sine dubio. Hic privilegio dignitatis sanctitatem recipere promeruit per benedictionem sancte Monenne, quem illa sibi imprimis in locum filii ab infantia adoptavit. Ibique in nativitate sancte Brigide illam ecclesiam Monenna edificavit.

De vaccis furatis et iterum aqua redditis.

4. Contigit autem in una nocte, quod fures furarentur duas vaccas, quas habebant. Cumque venissent ad flumen, quod vocatur Fertas, hoc miraculum evenit, ut tam calidum fieret flumen, ut comburerentur pedes illorum, et per totam noctem ambulantes nullo modo transire potuerunt. In summo autem mane inventi sunt iuxta ecclesiam, et penitentiam agentes cum lacrimis receperunt fidem, dicentes se semper amplius non furari.

De profectione eius ad episcopum Ibar.

5. Post hec aliquanto tempore cum parentibus transacto, monasteriisque puellarum adhuc inter illas gentes, utpote nuper iactatis fidei seminibus, subvenit in sancte virginis mente pia cogitatio, ut a seculi hominibus, licet parentibus et cognatis, recederet, que seculo propter Christum renuntiaverat ne eius animi propositum, quod Domino direxerat, vel secularium rerum inepta et vana confabulatio, vel antiqui adversarii semper surripiens nequam

[1] Cf. i Tim. 6, 9.

persuasio ab incepto removeret. In Dei nomine cum suis puellis et una supradicta vidua, infantulo dimisso, et cum aliis comitibus pro Christo iter agentibus, proficiscitur, ut tradunt, ad sanctum episcopum Ibar, in illis temporibus commorantem in insulis ultra Hiberniam in occidentali oceano positis tribus, in uno vocabulo coartatis, id est Triairna. Ubi multum temporis in Dei servitio et disciplinarum sanctarum stricta regula, et dura vite sed recta abstinentia, in vigiliarum et lectionis assiduitate nimia, sub illius episcopi potestate transegit. Congregatis ad illam ibi multis Christi virginibus, fit etiam novus et apostolicus virginum Christi chorus. Marie ad pedes Domini sedentis et bonam partem eligentis exemplum imitatur.

Habitans in monte Focarde, auditis sceleumatibus, inde recessit.

6. Igitur sancta Monenna veniens ad monticulum Focharde, primum ibi habitare coepit. Congregatis simul multis Christi virginibus, habuit, ut refertur, in illo tempore secum centum quinquaginta. Interim fluxerat temporis spatium. Alia nocte audivit de proximis villulis, que supradicto subiacebant monticulo, seculares aliquos cantus, qui lascivientium esse, et vana letitia proclamantium cognosci poterant. Interrogabat sancta Monenna sorores, quidnam esset hoc, quod sic homines vana garrulitate clamarent. Indicatur ei in domo alicuius de vicinis pronubentium esse cantus, ubi humana copula sponsa carnali sponso desponsata erat. Dixitque Sancta Monenna suis sororibus: "Nos que spiritali sponso sumus coniuncte, et Christo Dei filio disponsate, spiritales cantus die ac nocte convenit audire. Ad remotiora ab omnibus loca debemus recedere, ubi orationi tantum et lectioni possimus vacare, et angelis Dei pro notis et cognatis visitari sit possibile." Mane autem facto, misit fratrem suum, Ronan nomine, in deserta proxima, explorandorum locorum gratia, et invento ibi iuxta Colmi montem aptissimo et a Domino revelato loco.

De Servila quomodo corpore mutata.

7. Tunc dixit sancta Monenna suis sororibus: "Necesse est ut una puella custodiat locum istum." Et responderunt ei: "Que potest hic manere nisi Orbile? Prudentissima filia regis est et nobilissima." Et ait Sancta Monenna ad illam virginem: "Cum Dei gratia oportet te hunc locum custodire." Cui respondit Orbile: "Non possum sine te esse propter nobilitatem corporis mei, et capillos capitis, et pulchritudinem, quia valde timeo presentiam iuvenum. Hac de causa non licitum est mihi hunc locum custodire." Tunc surrexit Sancta Monenna et oravit, et post orationem insufflavit super capillos capitis, et statim facti sunt candidi sicut nix, quasi in senectute. Cui respondit Orbile, gratias agens Deo: "Timeo domina quod species corporis adhuc me decipiet." Audiens hec Sancta Monenna corpus illius timentis

precinxit sua zona benedicens. Perfectis talibus, puella transfigurata est in speciem anus, et inde mutato nomine vocata est Servile. Videns hoc Servile, quod factum est de corpore, sua bona voluntate gratias agens abbatisse, respondit: "Intento corde volo locum custodire." Tunc Sancta Monenna tradidit ei locum ad custodiendum, et perrexit ad predictum locum, qui vocatur Chellecleue, id est Cellula Montis, cum virginibus suis. Quo cum pervenirent, et illic habitare incipientes, invenit illas silvestris homo, porcarius alicuius regis de Orientalibus, nomine Macloithe, porcos pascens per silvas.

De contestatione rustica porcarii et de ieiunio septem dierum.

8. Primo admirari coepit, vel tales personas in deserto consistere, vel multitudinem ancillarum Dei, nichil secum de alimoniis habentes, unde viverent, preter herbas. Sed forte ibi erant hominibus pascuales arbores et arborum cortices, unde possent vivere. Primo, ut rusticus homo, coepit illas contestari per Deum, ne de silva quicquam sumerent, donec suo domino illarum adventum enuntiaret, putans ille miser, vel iram domini sui sustinere, si tacuisset, vel silvas quibus porci saciabantur deficere, si tantam multitudinem vesci de lignorum radicibus vel corticibus sineret. Post hec ille malefactor pergit ad dominum suum, procul positum, narrans de ancillarum Dei adventu in fines suos. Cui respondit rex se esse letum debere in illarum adventu, et donare eis licentiam de omnibus quecumque voluissent, et illis opus essent. Inter hec, ut tradunt, transierant septem dies, quibus sorores Christi, rustici contestatione constringebantur, ne de silvis, ut dixi, quicquam gustarent donec reversus esset ille homo frigidus, et inedia deficientibus, vel etiam extremum spiritum exhalantibus, donatur eis licentia vescendi de arboribus secundum regis mandatum. Coepit subulcus, postquam pervenit, querere perditos, et diu quesitos invenire non potuit. Venit ad sanctam Monennam homunculus, complangensque se dixit: "Vestri causa porcos perdidi et diligenter quesitos non inveni. Mala hora venistis in istam terram, pro quibus perdidi meam pecuniam." Cui Sancta Monenna, tristem consulans leni alloquio, per nuntium dixit: "Mente benedicte, securus esto, porci servati sunt a Domino, et a nobis exiens, nunc invenies porcos integro numero incolumes et salvos. Crede in Deum ubique posse quodcunque sanum et integrum voluerit servare." At ille digressus ab eis in verbo hoc, porcos in illa hora omnes invenit, ut Sancta Monenna certo eventurum predixit.

De porcello necato et cocto et iterum vite reddito.

9. Et assumens unum ex iis porcellum, post non moram temporis, ad sorores detulit dicens: "Oblatiunculam meam vobis detuli, quia recta Christi

commeruisti. Pecuniam enim mihi creditam, tota integra septimana, nullo alio conservante, orationibus vestris servastis in desertis, non solum ab hominibus, sed etiam a bestiis minime intactum. Bona hora vos vidi, quia nunc cognovi quod estis perfecte ancille Christi." Dixeruntque ad eum ex verbo sancte Monenne sorores: "Tuam oblationem non refutamus, sed his nobis vesci non est consuetudo carnibus. Nos in deserto propter Christum venimus. De feris deserti, quibus servis Dei consuetudo vivere est, si Dominus tibi in promptu dederat, aliquid sumemus." Postquam vidit rusticus oblationem suam, quam diu vivam dilexerat, et interfectam coxerat, a sororibus non esse receptam, corde suspirans, tristitias magnas agebat. Nam inopia cibi non erat ei, nec cui venderet, aut inde quid faceret, omnino insciens erat.

Audiens virgo Monenna, Spiritu Sancto repleta, dolores rustici non taliter consolari, iussit ad pedes suos coctum porcellum aferri, frusta cuius composuit, gratia Dei secata membra collocavit, atque sua benedixione videnti rustico porcellum vivum reddidit. Eadem hora ab eis digressus, post modicum, captum cervum adportavit sororibus, dicens: "Ecce sine labore et aliqua iniuria invenire mihi citius contigit quod vestro proposito in Deo magis placuit." Deinde assumentes cervum cum gratiarum actione, quasi a Domino transmissum, accipiunt, credentes semper in eius nomine, cuius est omnis terra cum sua plenitudine. Et in hoc semper habebant totum desiderium, ut etiam si supra vires propter Christum sustinerent laborem durum. Non putabant autem etiam carnes reliquas ad vescendum esse illicitas, quia sapienter audierant, omnia mundis esse munda,[1] et nihil reiiciendum, quod cum gratiarum actione percipitur.[2] Sed solent nonnulli sancti, et maxime monasteriales inter illas gentes homines, cum quibus magna pecorum habundantia viget, omnium animalium non vesci carnibus, ne secularibus videantur adsimilati, quibus semper in hoc pendet omnis cura, ne aliquid desit in mensa. Cervis vero et apris sive capreis vescuntur, eo quod rarescentius adprehenduntur, et ne putentur licita damnare, illorum carnes, quando Dominus transmittit, cum gratiarum actione percipiunt. Sed et illorum consimiles personas, si omnibus carnibus, quibus utuntur Christiani, uiuant, non refutare, recte intelligentes, quod scriptum est: "Qui manducat et gratias agit Deo, et qui non manducat, manducantem non spernet"[3] et reliqua, scientes per omnia locum et tempus et personam esse servanda.

De conversatione Glunelath et Afin ad fidem.

10. In tempore illo erat quidam tirannus nomine Glunelaht, in illa terra desolata ac deserta, cum perversis sociis suis nulli parcens, quorum numerus erat quinquaginta, iuxta ecclesiam Monenne. Quadam die contigit, quod octo presbiteri, missi a sancto Patricio episcopo, venissent, ut visitarent sorores in

[1] Tit. 1. 15. [2] i Tim. 4, 4. [3] Rom. 14, 3.

deserto positas, et maxime Monennam abbatissam. Cumque invenisset eos Glunelath iuxta viam, ubi ipse manebat, interfecit illos. Cumque audisset Monenna malum, quod factum fuerat, surrexit et dixit virginibus suis: "Eamus et queramus pacem in terram istam." Responderunt virgines dicentes: "Non debemus ire ad latrones, quia volunt nos damnare." Et dixit sancta Monenna: "Dominus defendet nos. Eamus et postulemus corpora sanctorum ad sepeliendum." Et exiens comitata quinquaginta virginibus, pervenit ad locum, ubi erat Glunelaht, in campum, qui vocatur Macdathevene. Videns has tirannus adpropinquantes, gavisus est valde, et demonio impletus, dixit suis comitibus: "Ecce quinquaginta virgines veniunt ad nos, ut unusquisque nostrum habeat uxorem." Tunc tirannus obviam venit abbatisse, ut apprehenderet eam et uxorem haberet, et dixit: "Ecce quod desideravi multis diebus." Et respondit sancta Monenna: "Propter nobilitatem tuam da nobis pacem interim, ut loquar tecum parum, et dic sociis tuis, ne noceant sororibus meis." Et dixit tirannus militibus suis: "Expectate parumper, ut loquar cum Monenna." Et fecerunt sic. Et dixit abbatissa ad Glunelaht: "Domine mi inclina caput tuum in sinum meum." Et cum inclinasset capud in sinum illius, dormivit statim, et omnes socii eius similiter. Et tunc oravit sancta Monenna ad Deum et dixit: "Domine Iesu Christe, fili Dei vivi, fiat voluntas tua in celo et in terra[1] et adiuva nos." Post hec descendit angelus Domini de celo et dixit: "Ne timeas filia, quia tecum sum, et modo accipiam spiritum istius tiranni, et tu veni mecum." Et assumpsit eos spiritualiter, et ostensus est eis infernus et regnum celorum, et viderunt locum pulcherrimum cuiusdam pontificis, qui vocabatur Chevin, et interrogavit Glunelaht, cuius erit hic locus. Et dictum est ei: "Paratus est in honore Chevin." Et post hec ostensa sunt eis et alia multa, reversi sunt ad corpora. Tunc surrexit sancta Monenna et dixit eis: "Surgite, surgite, surgite, quia tribus diebus et noctibus non vigilastis." Et sic factum fuit, ut a prima hora diei Iovis, usque ad horam nonam diei Saturni non surrexerant. Tunc incepit sancta Monenna ymnum cum virginibus suis: "Hibernia ostensus est hominibus maximum mirabilibus,"[2] et cetera. Cumque surrexisset Glunelaht a somno, dixit ad sanctam Monennam: "Vis dare mihi locum Chevin, et non nocebo te neque virginibus, qui tecum sunt." Et respondit abbatissa: "Quomodo possum tibi dare locum alterius militis Christi, et nescio ego, utrum erit mihi proprius locus in celo." Et ait tirannus: "Vere et si non dederis mihi locum illum, statim eris uxor mea sine mora." Et respondit abbatissa: "Si credideris in Dominum Iesum Christum et baptizatus fueris, et mecum consilium feceris, non peiorem locum habebis."

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[1] Cf. Matth. 6, 10.

[2] This is a reference to the Hymn of St. Ultan in praise of St. Brigid:

"Xp̄s in nostra insola quae uocatur Hibernia
ostensus est hominibus maximis mirabilibus," etc.

(Bernard and Atkinson, Irish Liber Hymnorum, 1898, i, p. 14.)

Et dixit ille: "Faciam quodcumque preceperis, si illum locum mihi dederis, sed non accipiam alium locum." Et ait illi sancta Monenna: "Habebis, sed surge et veni mecum, et esto fidelis ad mortem,[1] et habebis locum illum." Tunc surrexit Glunelach cum Afin, filius sororis sue, et separati sunt ab aliis sociis suis, et venerunt cum sancta Monenna et sororibus ad ecclesiam, que vocatur Chillesleve, et illic baptizati fuerunt, et illa doctissima abbatissa docuit eos psalterium, et postea sanctissimi episcopi effecti sunt.

De Chevin a diabolo vexato et per sanctam virginem reddito Deo.

11. Post hec autem venit diabolus in similitudine clerici ad Chevin, et dixit ei: "Ecce Glunelaht, latro pessimus, precessit te in regno celorum, et abstulit locum tuum a te." Et respondit Chevin et dixit: "Vere non potest illud fieri, sicut videtur, ullo modo." Et dixit inimicus: "Si non credis, mitte duos clericos mecum ad cenobium Monenne, ut probent quod predixi." Respondit Chevin: "Fiat sic." Et exierunt simul ad monasterium et invenerunt Glunelath et Afin cum sororibus legentes salmos. Et videntes reversi sunt, et nuntiaverunt domino suo quia verum esset. Et tunc dixit diabolus ad Chevin: "Que sunt premia tui maximi laboris et diurnarum orationum? Et que septem annorum, quibus usque modo pastus es radicibus urticarum? Ecce Monenna abstulit locum tuum a te et dedit pessimo latroni Glunelath." Tunc valde iratus fuit Chevin, et dixit clericis suis: "Preparate mihi arma et eamus in locum Glunelaht, et destruamus cenobium Monenne." Et exierunt ut facerent mala, ut annuntiaverat angelus Dei sancte Monenne, et dixit illi: "Vade cito in occursum Chevin, quia diabolus temptat illum." Et ait abbatissa sororibus: "Orate pro nobis et pro his fratribus." Et exivit sanctissima in occursum illius, et invenit eum in loco, qui dicitur Surde, et alios multos cum eo. Et vidit sancta Monenna quasi parvum nigrum puerum stantem iuxta pedem sinistrum Chevin. Et dixit sancta Monenna ad Chevin: "Nonne vides diabolum ad sinistrum pedem tuum, monitu cuius huc venisti de loco sancto tuo? Signa cor tuum, frater, et oculos tuos diligenter." Et fecit sic. Cui respondit Chevin: "Vere soror mea, modo video." Et expellit sancta Monenna diabolum ab eo, et signavit eum manu sua et adduxit secum ad monasterium, et preparavit ei balneum bonum in petra durissima supra parvi montis cacumina.

De balneo eiusdem Chevin.

12. Et accessit sancta Monenna ad frigidum fontem suum, quo solitis noctibus sedens usque ad mamillas in aqua totum decantare solebat psalterium, et imposita benedictione cum baculo suo, iussit aquam in nomine Dei Patris omnipotentis sequi illam. Et secessit inde, ad culmen proximi montis, quo preparaverat balneum, post se trahens suum baculum. Et aqua secuta est eam usque ad summum, et virtute sancte virginis aqua attracta de imis in

[1] Cf. Apoc. 2, 10.

balneo recepta, gratia Dei fit semper calida. Deinde usque ad hunc diem multi habentes infirmitatem, in nomine sancte virginis, per balneum recipiunt sanitatem. Et dixit sancta virgo ad Chevin: "Ecce balneum tibi offero in honore tuo, et non deficiet aqua in eo." Et vocatum est balneum Chevin, quia sancta Monenna, dedit illud tiranno, ut reciperet eum a diabolo.

De vitulo devorato et de lupo vacce amato.

13. Contigit quadam die, ut unus lupus venerit iuxta ecclesiam, ubi manebat sancta Monenna, et interfecit unum vitulum, quam custodiebat supradictus puer, nomine Luger. Venit autem puer ante pedes abbatisse flens et ululans atque dicens: "Quare perdidi vitulum meum, O domina?" At illa sanctissima respondit: "Nescio, fili mi, ubi est vitulus tuus." Et respondit puer: "Canis devoravit vitulum meum, et adhuc iacet super illum." Et dixit sancta Monenna ad eum: "Accipe baculum meum in manu tua, et dic ei ut veniad ad me." Exivit autem puer, et invenit lupum adhuc rodentem ossa, et dedit ei ictum super dorsum et dixit ei: "Precepit tibi Monenna, ut cito venias ad eam." Et surrexit lupus et precessit puerum ad modum domestici canis. Cumque stetisset coram abbatissa dixit ei: "Quare, O miser, interfecisti vitulum nostrum? Ecce precipio tibi nomine Domini nostri Iesu Christi et Sancte Marie virginis, ut sis in loco vituli cotidie, et fiat vacca lactifera, quasi habuisset vitulum." Et sic factum est, ut vacca diligebat lupum et lingebat eum, quasi esset vitulus proprius, et lupus custodiebat illam vaccam quasi pastor. Sed et usque hodiernum diem de genere istius sunt lupi iuxta ecclesiam, et per tria millia custodientes pecora ecclesie, et omnes diligunt et agnoscunt genus illorum, quia minores sunt quam alii lupi, et albi sunt in frontibus illorum, et vivunt semper de venatione tantum.

Qua de causa sancta Monenna prius intravit in Anglicam terram.

14. In tempore illo Alfredus, filius regis Anglicorum, habens infirmitatem maximam, perrexit ad serviendum Conaldo regi in Hiberniam. Cui Hibernienses dixerunt: "Vade ad abbatissam Monennam, et pete, ut pro infirmitate tua Dominum Deum suum deprecetur. Cuius intercessione statim tibi sanitas reddetur." Credidit, et morbo expulso, virginis interventu sanus efficitur. Recepta sanitate, rediid ad regem, querens licentiam redeundi in patriam. Cum autem rex audisset et sciret, quod filius regis Anglicorum vellet redire in patriam, adquisita licentia, coepit cogitare, unde haberet pecuniam, quam sibi dare deberet, quia noluit, ut exspers munerum ab eo recederet. Tunc iussit ministris suis, ut provocarent consiliarios ad se, a quibus consilium quesivit, quam regionem predari deberet, ex qua tanta pecunia recedenti daretur, pro retributione servitii sui, ut accepta pecunia honorabiliter redire in patriam suam posset. Quorum unus repondens, cui nomen

erat Chanoncun, dicens: "O rex honorabilis, erige aures meis consiliis, nam in ecclesia Monenne multe sunt divitie, quas si vi raperes, milites tuos bene restaurares." Audiens hec princeps, sciens gratiam Dei esse cum ea, timens illuc ire dixit: "Notum est nobis pluribus, quod cunctis malefactoribus pro amore illius gravem vindictam reddit Deus." Et dictis illius deprecans, respondit consiliarius: "Si nobis videtur licitum, mitte mecum exercitum tuum, ut destruam cenobium, et tibi reddam totam virginis Monenne pecuniam." Et dixit rex: "Si ausus es, vade." Et huic annuit, et affectum itineris implevit, et cum exercitu magno exivit. Et hoc miraculum media nocte contigit, ut hostes venientes ex improviso totam terram illius Chanoncun vastarent, et omnia bona sua arriperent, nesciente illo, cuius terra iuxta cenobium sancte Monenne fuit, et ipse cognatus illius.

Et iuxto Dei iudicio contigit, ut malum, quod sanctis monialibus inferre voluit, sibi ipsi eveniret, sicut scriptum est: "Convertetur dolor eius in capud eius, et in verticem ipsius iniquitas eius descendet."[1] Tamen omnia bona monasterii illius violenter rapuerunt, nullo timore Dei et sanctorum eius perterriti. Et quicquid raptum est inde, datum est filio regis Anglorum, et reversus est in patriam suam cum plurimis donis. Cum autem audisset sacra sancta virgo Monenna, quod locus Deo consecratus vastaretur a tiranno, cognato eius, irata est ei valde et dixit: "Hoc det Deus, ut sit semper in vastitudine terra illius, et ecclesia, Deo adiuvante, iterum renovabitur." Et factum est sic.

Quo modo transivit mare cum virginibus suis in Britannia.

15. Et tunc sancta Monenna, commota de eo, quod factum fuerat, exivit ad litus, quod est iuxta Fochart cum Brigida et Athea et Luge. Et clamaverunt ad Dominum fortiter et rogaverunt eum, ut daret eis auxilium trans mare eundi. Cum vero orassent, ecce angelus Domini descendit de celo coram eis et circumcinxit parvam partem de terra in circuitu illarum sanctarum virginum, et mare circuivit illam signatam terram, et abstulit eam de loco suo, et erat eis pro navi usque in Britanniam, et ibi posita est iuxta castellum, Dagunno nomine, sicut venit de Hibernia sub pedibus sanctarum virginum, sic permanet usque hodiernum diem; non crescit neque minuitur sed semper aqua marina circuit illam. Dixit autem sancta Monenna ad Brigidam et ad Luge: "Expectate hic et edificate ecclesiam in loco sancto isto donec revertamur ad vos. Et nos ibimus ad curiam regis, ut res nostras inquiramus, que ablata sunt violenter a nobis." Post hec vero invenerunt regem in villa, que vocatur Streneshalen, iuxta silvam que dicitur Arderne.

Cumque vidisset rex virgines ad se venientes, valde letus effectus est in adventu illarum. Et cum audisset, quod de ecclesia illius essent homines et

[1] Psal. 7, 17.

peccora, reddidit omnia, et dixit ad eam rex: "Dabo tibi istam villam cum sorore mea virgine, ut doceas eam disciplinam divinam." Et respondit sancta Monenna: "Libenter fiat." Et mansit illic tribus mensibus, et iussit sancta virgo Atheam, ut doceret virginem, regis sororem, spalterium. Sancta Monenna vero reversa est ad Brigidam cum donis pluribus, et servi regis cum illa, donec essent naves parate. Et tunc exivit abbatissa et Brigida cum familia sua in Hiberniam, et restituit ecclesiam suam.

INCIPIT LIBELLUS SECUNDUS.

De aqua in vinum conversa.

1. Nunc ad narrationem ordinem, iam secundo incipiente libello, revertamur.

Igitur sancta Monenna pervenit tandem itinere finito in Hibernia, in campum Murthemene, in quo Conalleorum gens maxime viget, de qua et ipsa sanctissima Monenna, ut dixi, procreata est, antiquitus pre ceteris gentibus, que in confinio sunt, magicarum artium libris imbuta, sed nunc, subacta gentilitate, Christi fide tota effecta est Christiana per sanctam Monennam. Divertens itaque ad alias Christi famulas, quas Campani filias nuncupant, fecisse narratur grande miraculum. Quarum unam semper in comitatu habuerat, et nunc earum monasterium, postea ab alio, ibi principatum tenente, vocabulum sortitum, cuius nomen erat Luge. A quibus cum omni gaudio suscepta, que caritatis erant, in quantum potuerant in eam fecerunt et quod ille non habuerunt, id est potum, quo letificarentur tanti hospites Christi, Deus operatus est per adventum hospitum, de aqua iocundissimum vinum. Nam benedicens sancta Monenna aque vasculum in domum adportatum, Deus mutavit laticis undam, virtute summa conversam in vini naturam, ut caritati ancillarum Dei, quod deerat, suppleretur, et nomen Domini semper ubique magnificum et enarrabile ab omnibus crederetur. Multis his servis Dei certissimum est, inter illas terras hoc contigisse miraculum, que vineas non generant, ut vinum de his sumerent, ut haberent sufficienter, ut puto, serve Dei haustum vini ad peragenda mysteria corporis Christi.

Ab episcopo veniens ad sanctam Brigidam.

2. Sanctus vero Ibar, episcopus supradictus de predictis insulis, Domino itineris duce, in meridianam Hibernie partem pergit, audiens ibi parvam insulam, quam Modicam Hiberniam vocant, in qua et postea post gloriosam vitam reconditus est. Oves Christi pastorem sequuntur. Sancta Monenna cum virginibus episcopum et salutans doctrine magistrum consequuntur.

Devenientesque in Lagenorum terram, cui et supradicta iacet insula, parte meridiane, audita sancte Brigide sancta Monenna cum puellis ad se pertinentibus, episcopo permittente, ad illam divertit visitandam. Apud quam habitavit non parvo tempore, humiliter se deiiciens, in quantum semetipsam pre ceteris humiliabat, tantum illam Dominus super omnes virtutum meritis exaltabat. Erat enim affabilis, lenis, hospitalis, omnibus ornata bonis moribus, cunctis in Christo placuit, omnesque inimici versutias non ignorans, erat enim a dextris et sinistris armis spiritalibus valde munita. Donavit autem illi Dominus etiam sanitatum gratiam, ut diversorum malorum languore depulso, infirmitates varias sanare, et verbo et oratione de obsessis despellere corporibus. Credidit illi omnis populus in tantum, ut magnis etiam donis et muneribus cotidie ditaretur. Sed ex his nihil sibi reservans, que in Christum suam iactaverat curam, cuncta pauperibus miseris et peregrinis, qui ad se cotidie veniebant propter Christum, pauperum pro omnibus et peregrinum factum erogabat.

De duodecim vestibus sancta Monenna a Domino donatis.

3. Deinde compertis his, que sancta Monenna cotidie largiebatur, dixit ad illam familia sancte Brigide: "Quid ita facis? Cur munuscula, que tibi a Domino et a populo donantur, in alios expendas, et nos non requirens, etiam tuorum, qui ad te pertinent, curam negligis?" Et spiritu invidie aliqui instigati, sub ostenta figura religionis, etiam hec dicebant: "Non audistis in apostolo esse scriptum, 'Qui negligit curam suorum, et maxime domesticorum, fidem negavit, et est deterior infideli.'[1] Ne sorores, que tecum venerant, pene consumptis his que apportaverant secum, non habent sufficientiam, et tu dividis que illarum sunt forte habentibus superflua." Quibus sancta Monenna leniter respondit: "Si in Christum habent fidem non fictam, cibum et corporis indumentum habentes, contente erunt. Nam qui volunt divites fieri incedunt in temptationem et laqueum diaboli et desideria multa et inutilia.[2] Si propter Christum feci, quod in me culpatis, qui dixit in se fieri quicquid in suis membris impletur, et vobis potest dampna, que putatis, reddere et illis mercedem laboris et meditatis, quando vult, tribuere." Quid plura? Surrexit illa continuo, corde confidens in Christum omnia posse, quando vult necessitatem habentibus subvenire, levansque oculos subito ad lectulum, in quo pausare aliquid putabatur, vidit, ut refertur, duodecim vestes optimas ibi ante eam positas visas, credens a Domino sibi esse allatas, statim detulit sancte Brigide, dicens: "Ecce Dominus quod vobis reddidit habetote et sit sororibus in supplementum cure." Cui dixit sancta Brigida: "Vestes, que tibi a Domino transmisse sunt tuis ut tibi placeat divide, nobis plus habentibus non licet habere."

[1] i Tim. 5, 8. [2] i Tim. 6, 9.

A sancta Brigida vadens habitavit in Airdsconis apud episcopum Ibor, et de cisterna aqua repleta.

4. Reversa ergo a sancta Brigida ad episcopum Ibor, habitavit in Airtchonis. Congregatis ibi simul multis Christi virginibus, sub potestate episcopi vivebant, quarum cotidie augebatur numerus, et non solum virginum et viduarum multitudo, sed et regine et quamplurime matrone ad illas cotidie confluebant. Cunctis saluberrime vite preceptis tocius bonitatis magistra tam verbis quam exemplis sancta Monenna omnes hortabatur. Contigit deinde alio anno, inter illas terras, nimio estatis calore cogente, humidas deesse populis aquarum copias, ita ut non solum laculi vel cisterne siccarentur, sed et fontanei et rivuli minus fluerent. Sorores ergo cum sancta Monenna, quibus discurrendi non erat licentia, aquarum penuria sentiebant dampnum, non tantum pro domesticis necessitatibus, sed et sitientibus imo spiritum refocillare cupientibus aquarum satiamenta defuerant. Videns hoc sancta Monenna, aliorum iniuria commata et sancti Helie exemplum secuta, fontem aquarum vite pro transitoriis deprecatur aquis, et in illa nocte, qua orationem pro adipiscendis aquis ad Dominum fudit, cisterna nocte aquis impleta, aquarum copia mane. Devulgatum est autem tale miraculum sancte Monenne in multos populos, ita ut cotidie incessabiliter venirent ad illam, non solum feminii sexus homines, sed et maxime principes, quibus honor et dignitas maxima erat, si sancte virginis benedictionem accipere mererentur.

De prophetia sancte Monenne et de puella sibi ab episcopo commendata.

5. Porro propheticus in ea spiritus inter ceteras eius virtutes primatum tenebat, ut eventura frequenter predicaret et pronuntiata semper eventa probaret, sicut et in hoc intelligi potest, quod sequitur. In alio die de vicinis filia alicuius ab episcopo commendata ad sanctam Monennam adducitur, ut illam cum ceteris virginibus in Dei timore et monasterialibus nutriret disciplinis. Qua recepta et cum sororibus dimissa, sancta Monenna dixit virginibus: "Istam parvam filiolam hac hora ad nos ductam debemus etiam pre ceteris diligentius nutrire, huius enim causa tempore coget nos necessitas de isto migrare loco." Quod ita certissime evenit, ut sancta Monenna per spiritum predixit. Nam predicta puella paulatim crescens et ad iuuentutis etiam etatem perveniens, coepit antiquus bonorum adversarius diabolus eam spiritu agitare invidie. Cuius invidia, ut legitur, mors intravit in orbem terrarum, malum discordie, quod anima Domini pre odibilibus sex detestatur, incessanter semper seminabat. Dicebat enim ad episcopum: "Nullus te in populo nunc requirit, omnium dona et munera qui in tuis commorantur finibus, ad istas deferuntur peregrinas, nullius momenti nunc reputati, quid

istas, utpute imprimis peregrinas propter Dominum benefaciens adduxisti; se enim[1] magnificari et elevari desiderant, quanto magis nos nullius esse bonitatis arbitrantur." Hac et his similia cum suis parentibus et vicinis, diabolo suadente, susurrans, scolam episcopi etiam et eos quos sibi sciebat in populo privatos, his venenosis commovebat verbis. Sed episcopus, ut erat homo mitissimus, his non accommodabat auditum sermonibus.

De egressione sancte Monenne de Airdsconis et de fluvio se elevato.

6. Hec audiens sancta Monenna dixit sororibis: "Ecce quod Dominus de filiola vobis ostendit, imprimis nunc apparet. Si nobis simul hec incipiunt facere, scio quod post mortem meam non poteritis hic habitare. Melius est ergo aliorum invidie locum dare et ire, quam in tali animarum rancore cum ceteris simul perire. Omnia quecumque nobis Dominus hic dedit cum illis relinquenda sunt; preter vestes nostras communes nihil portabimus de omni crappa: que illi diligunt cum illis maneant. Nos quem diligimus et in quem nostram iactavimus curam, precedit nos, et subsequemur, ut nobis commodum et sibi placitum perducat ad locum." Proficiscuntur inde, Domino comitante, et itineris duce, sancta Monenna cum sororibus non minus, ut refertur, quinquaginta; pergentesque viam veniunt ad quemdam fluvium, per quem sibi transitus esse debuerat, non tam magnum, ut etiam parvulos vel mulieres transitu impediret. Subsistentes paululum, vident fluvii verticem contra se statim intumescere, et eperbolice ripas exundans transfluere. Intuens hoc sancta Monenna subsistit dicens: "Quid est quod nobis fecit Dominus? Sine dubio nostra culpa hoc prebuit nobis facere, quod videmus rivulum insolito sibi more, Deo volente, contra nos elevare. Scrutemur diligentissime nostras conscientias, si forte in aliquo nostrum trangressionis culpa ut illam pia confessione emundans immonis esse possit a poena." Respondens una de sororibus, semetipsam accusans, dixit: "Confiteor culpam meam, quam stulte commisi, pro qua istud impedimentum, ut puto, videmur pati. De monasterio nostro egrediens vidi diversas in solito siccare cepas, et unum de alleo, quod nostrum esse putabam, capitulum adportatur, quo sciebam pro dolore, in modum colerii tuos oculos perungi. Ago inde penitentiam, qualemcumque iubeas, tantum ut mea culpa, quam sola commisi, multis non faciam iniuriam." Cui dixit sancta Monenna: "Refer ergo ad domum de qua venimus, que attulisti. Si maiora, que nostra erant, ibi Dominum propter dimisimus, minora sine eorum licentia, cum quibus dimissa sunt, et portare non debueramus." Sicque factum est, ut reportata ad terram, sibi a Domino destinatam, in parte aquilonis Hibernie sitam, ibi sancta Monenna cognationem propriam quasi ad oves domus Israel, que perierant.[2]

[1] Se enim], sic Boll.; siñe cod. [2] Matth. 10, 6.

De vasculo argenteo in flumen transmisso a Brigida ad sanctam Monennam.

7. Coepto itaque itinere, Christo comite, recte vie proficiscuntur aquilonis sub axem, pervenientesque, ut referunt, in Limphi Campaniam, in cuius optima et planissima septentrionali parte monasterium sancte Brigide modo constructum est, veniunt ad sanctam Brigidam, manentesque apud illam aliquantis diebus, semper desiderabat sancta Monenna audire, que sibi et suis in Domino potuissent proficere, ut exirent in peregrinationem Rome. "Oves mee vocem meam audiunt, et ego vitam eternam do eis."[1] Quando tempus postea eundi ad optata loca advenerat, quasi apis prudentisima mellifluis honusta sancta Monenne colloquiis, dixit ad sanctam Brigidam: "Da benedictionem tuam super nos, et pro nobis Dominum diligenter roga ut viam nostram in se recte dirigat, et ad loca destinata sua misericordia incolumes perducat." Cui sancta respondit Brigida: "Deus omnipotens custodiat vos in via qua pergitis, ut ad desiderata habitacula prospere perveniatis"; protulitque vasculum argenteum, quod potum Hibernenses principibus haurire solent, quod vocant escre dicens: "Accipe munusculum de manu mea[2] quod tibi do, ut fiat de illo aliquis profectus tibi et que tecum sunt Christi sororibus." Accepit ergo vasculum sancta Monenna, in ullo contradicere non audens, nec volebat. Accepta benedictione a sancta Brigida, quidquam de rebus portare presentibus noluit, sed salutatis cunctis sororibus, iterum quasi aliquid obliviscens, intro domum ingreditur, reponitque vasculum supradictum illic in tutiori loco, ubi servari possit, et non videri continuo. Deinde resalutatis omnibus, desideratam pergunt viam, tandemque perveniunt. A Domino descripti sunt, credo, ab eterno remuneratore, ipsa sorore mea sancta Monenna, fraterna caritate intercedente, premium qualecumque accipere. Inter hec, transactis aliquantis diebus, vasculum argenteum supradictum invenitur, et quomodo contingit sancte Brigide enuntiatur. Que nuntiantibus respondisse fertur: "Vas, quod tribuimus in Dei donarium, non licet nobis habere ad usum nostrum, et ne de hoc imbecillioribus aliqua suplicatio vel dubietas in mentem veniat, Dominus ad quem vult locum vasculum perducat. In flumen, quod nobis est contiguum, mittendum est, et Dominus, ut voluerit, et sancte Monenne meritum, faciat, quod sibi placet." Itaque ut certissime adfirmarent, qui sic antiquitus habent sibi traditum, ita factum est. Vasculum in flumen missum est, nomine Life, quod in mare Hibernicum fluit orientale, et Domino conservante et portante, quocumque modo inventum est a Ronan episcopo, fratre Monenne, ut habet opinio, in Capite Litoris, sicut Scoti locum nominant Stanniribae, quod de mari erumpens orientali Scotico et in circum tendens inter Bairce et Coilgi Campiolum primo porrigitur, deinde usque ad fines populorum, cognomine Orientalium, multum silvis et montibus coarctatum in longum

[1] Evang. Joannis, 10, 27, 28. [2] Gen. 33, 10.

extenditur. In quorum confinio, ut supra dixi, iuxta Colmi Montem, sancte Monenne collocatum est monasterium. Episcopus hoc inventum secum admirans, detulit sancte Monenne vasculum. Quo agnito, omnes glorificaverunt Deum, in tali facto agnoscentes donum sibi transmissum a Domino. Inter monasterium sancte Monenne et sancte Brigide est iter quinque vel sex dierum, etiam his qui per terram recto itinere pergunt sine mari, sicut nos frequenter probamus. Tale autem, ut mihi videtur, miraculum utrisque reputandum est. Quod enim fides sancte Brigide indubitata credidit, id est, Christo conservante, vasculum non perire, hoc humilitatis sancte Monenne et meritum et in ea rerum omnium verus contemptus promeruit perficere, ut illa haberet, tamquam a Domino sibi proprie missum vasculum, quod propter Dominum dimisit in camera repositum. Et quod illa ab humana laude celare voluit, Deus claro miraculo postea manifestavit.

De peregrinatione eiusdem Rome.

8. Post hec vero in peregrinationem exierunt sancta Monenna et Brigida, et Romam petierunt. Que cum venissent in Britanniam ad Ardert, perrexerunt simul Athea et Ite cum abbatissa. Et postquam Roma reverse sunt, exiit Brigida ad patriam suam in Hiberniam. Alie vero virginis manserunt simul in supradicta silva in priorem locum tribus annis. Tunc dixit eis sancta Monenna: "In istam silvam ibo iuxta vos et edificabo alium locum." Et fecit sic, et habitaverunt simul sancta Monenna et Athea tribus annis. Ite vero et Osid in primo loco manserunt.

De puella tribus diebus aqua submersa et postea per sanctam Monennam vite reddita.

9. Quadam vero die dixit Ite ad puellam suam Osid: "Duc volumen istud ad sanctam Monennam." Exivit puella cum volumine. Cumque venisset ad quandam aquam ut transiret pontem, erat enim unum lignum, cecidit in medio fluminis et mersa est in profundum. Die vero tertia perrexit Ite ad Monennam et invenit eam iuxta flumen. Nam et illa exierat, ut quereret puellam. Interrogavit autem Ite, ubi esset puella. At illa respondit: "Nescio vere." Et ait Ite: "Nudius tertius misi eam cum volumine, et miror valde quare non est reversa." Et respondit: "Non vidi illam. Eamus et inquiramus eam." Pastores autem erant iuxta illas, qui dixerunt: "Vidimus eam nudius tertius euntem ad pontem, et ultra non vidimus eam." Tunc dixit sancta Monenna: "Vere mersa est in aqua. Eamus et queramus eam in flumine." Cumque pervenirent ad flumen, clamaverunt ad Deum, fusis lacrymis et dixerunt: "Domine Iesu Christe, filii Dei vivi, per intercessionem sancte matris tue et sancti Petri et Pauli atque Andree et omnium sanctorum,

redde nobis puellam nostram." Et completa oratione, dixit sancta Monenna: "In nomine Domini nostri Iesu Christi, precipio tibi puella, ut respondeas nobis, si es in ista aqua." Et exclamans voce magna, mixtis lacrymis, ter vocavit Osid. Vix finita oratione, respondit puella in profunda aqua, et dixit: "Ecce ego, ecce ego, domina." Et dixit ei sancta Monenna: "Surge in nomine Domini, et veni foras." Et surrexit statim, et venit ad illam, et signavit eam sancta virgo, et tradidit in manu Ite, et dixit: "Ecce puella, manete in pace, quia non est mihi licitum manendi vobiscum, nam ibo ad Hiberniam visitare ecclesiam." Responderunt virgines dicentes: "Vere et nos tecum ibimus et te nullo modo dimittemus." Et post hec exierunt omnes simul trans mare in Hiberniam et manserunt illic pene septem annis.

Vitulum a lupis rapto et iterum reddito.

10. Alio die sororum vitulis in aliquo agello pascentibus iuxta montem, luporum de silvis irruit impetus, vitulisque in fugam dispersis, unum ex his lupi rapacissimi rapiunt, et diu persecutus, utpute per silvas raptus, tenebris supervenientibus non conparuit. Narrant hec sorores in auribus sancte Monenne, que contigerant, conquerentes. Quibus illa dixit: "Fidem in Christum habete et mentem estote secure. Sub cuius etiam potestate vivunt et bestie, potest inter luporum dentes sanum custodire vitulum, qui quondam Danielem prophetam eripuit de ore leonum. Propter hoc enim lupi vitulum rapuerunt, ut mirabilius intactum reddant, et crastino ad vos, Deo volente sanum reducant." Ita facto mane, videntibus omnibus lupi reduxerunt eumdem vitulum, a se pridie raptum, sanum et invulneratum, quasi de pascuis alibi non exivisset. Quis nesciat, quod per orationes sancte Monenne, inter rapaces bestias incolumis servatus est vitulus, non quia cura Domino maxime est de pecoribus, sed quia sanctos suos vult in magnis ita et in minimis magnificare, ut numquam cessant illum diligere, quem credunt omnia, quecumque vult, posse facere.

De petra in sale conversa.

11. Quodam casu temporis, pessimi homines latrocinando nonnunquam penetrantes, invenerunt non longe a monasterio venientem quamdam. Quibus interrogantibus unde venisset, vel quo exire vellet, tremebunda respondit: "Non de longe venio, et ad sanctam Monennam properare debeo." Cui iterum irridentes dicunt: "Nos non sumus locupletes in ista terra, dic ad Monennam nobis ne sit irata, cui undique transmittitur adeo multa pecunia, nostram tamen oblatiunculam, quam nunc habemus, ad illam porta, quam credimus multo tempore posse perseverare, si secum potuerit fructum facere." Apprehensoque uno lapillo de his, qui coram erant lapidibus, et qui ab illa posset portari, miseram abire permittunt, positoque in eius scapulis onere, contes-

tantur illam, alibi non de collo honus deponere, nisi presente sancte Monenne. Quo perveniens, et honere deposito coram sancta virgine, inveniunt inpositam ante durissimam petram, in naturam salis statim transmutatam. Quod enim increduli, subsannando virtutem Dei fecerant, virtus superna mirabiliter commutavit. Petra enim scandali erat et lapis offensionis,[1] virtutem Dei non credentibus, sed eorum duritia in naturam salis transmutatur, fidelibus quando virtus patefacta monstratur, que eorum animas in interitum et alias in vitam eternam ducit.

De pauperis cibario rapto et iterum reddito.

12. Fuit alia Christi famula, nomine Suil, non tam longe habitans a monasterio sancte Monenne. Cuius monasteriolum semper ibi consistit, ad quam alimonia cotidie imprimis a sancta portabantur Monenna. Accidit autem alio die, unam de sancte Monenne sororibus vetulam cibaria ad supradictam portantem, in via latrunculos incurrisse pessimos, raptisque ab ea per vim cibariis, dimiserunt illam exire vacuam. Revertens ad sanctam Monennam, narrant que acciderant. Cui respondisse fertur sancta Monenna: "Tui laboris et devotionis premium integrum tibi manet in celo, et a latronibus intactum. Sed et hoc, quod illi rapuerunt pessimi, potest Dominus servare, et ab eis intactum, quando vult, reddere." Post hec illi raptores per desertum cum prediola, avia petentes, viam ignorare coeperunt, in illam terram, in qua peritissimi erant, nullamque viam invenire vel cognoscere poterant. Excecavit autem illos virtus divina, ideo non poterant agnoscere terrena. Tribus ergo, ut referunt, continuis diebus in silvis errantes, hostium, quos in illo confinio esse sciebant, sed putabant intra se fines intelligunt. Ergo licet sero, miseri divino nutu, pro culpa, quam commiserant se esse constrictos, confitentur invicem suum delictum, et promittunt ad sancte Monenne iudicium facere penitentiam, si Dominus eorum oculos aperuisset rectam cognoscere viam. Et in illa hora apertis eorum oculis, intelligunt se esse in loco proximo sororum Christi monasterio. Deinde venientes ad monasterium, primo reddunt que portaverunt ab eis intacta iuxta prophetiam sancte Monenne. Subitaneus enim stupor incognite vie eorum mentes perculsit, et adversariorum in unaquaque hora semper suspicatio, illos non permisit, Domino volente, etiam vel cupida manducare. Ergo agnoscentes culpam suam, eorum confitentur errorem, prostratisque in terram vultibus, promittunt se inplere indicatam sibi penitentiam, acceptoque remedio vulnerum, in viam suam reversi sunt, promittentes latrocinia post hec numquam facturos, etiamsi Dominus eisdem concederet longo tempore vivere.

De filia resuscitata.

13. Multa mirabilia preter hec, que per sanctam Monennam Dominus

[1] *Cf.* Isai. 8, 14.

operatus est, certissime etiam adfirmant, quod nuper pervenientem ad Christi fidem filiam, et subita infirmitate morte oppressam, facta longissima oratione sancte Monenne, Dominus vite reddidit. Et que erat mortua ad sepulturam ducta, per orationes sancte Moduenne suscitata, multis temporibus, ut referunt, postea permansit in vita. Ex ore Domini cotidie audivimus etiam que videntur hominibus incredibilia per sanctos suos esse facienda miracula. Quibus imprimis, euntibus ad predicationem iubet leprosos mundare, mortuos suscitare, demones eicere,[1] et cetera, que consequens lectio divini demonstrat verbi. Et iterum: "Qui credit in me, opera que ego facio faciet, et maiora horum faciet."[2] Licet in hoc testimonio intelligere quidam volunt, hoc spiritualiter per sanctos magis impleri posse, in his qui semel mundati vel resuscitati sic permanent, ut iterum numquam moriantur, sed sic vivant in vitam eternam.

De puero alio resuscitato.

14. Narrant etiam similiter hic mirabile per sancte Monenne Domini factum. Alium puerum, non credentem, sed denegantem, quod superius diximus, domum esse divinum, subita morte statim percussum, et per sancte Monenne preces vite iterum redditum restitutum.

De vitulo in domo Donech occiso et iterum vivo.

15. Narrant item et alius sancte Monenne miraculum factum in domo alicuius viri de vicinis, nomine Donech, contigisse miraculum, qui in eius adventu et aliorum bonorum secum comitantium, occidisse narrantur suum quem habebat vitulum. Non enim magnam habebat facultatem, sed in corde suo collocaverat abundantem caritatem. Et hoc comperto, quod fecit ille homo, sancta Monenna pollicita est illi, bene facienti Dominum in futuro retributurum, preparanti refectionem in adventu Christi hospitum. Hoc ergo confirmant ibi etiam presens factum inauditum signum, quia crastino die, eiusdem etatis et coloris cum sua matre inventus est vitulus, qualis et ille qui hospitibus fuerat pridie occisus, ut usque hodie affirmant et unum et eumdem esse vitulum, quem et pridie occisum et crastino cum matre vivum inventum. Talis etiam virtus devulgatur per sanctam Monennam. Quod autem incredibile est, Deo volente, vel consumpta redintegrante, volens in omnibus suam virtutem ostendere, aut animal similium qualicumque materia facere, aut aliunde, qui omnia ex nichilo fecit esse, et cunctorum hominum corpora, qualicumque morte consumpta, reparabit in resurrexione.

De vasculo parvo benedicto cum cerevisia in domo eiusdem Donche.

16. Alia vice supradictus homo, apud quem factum est, quod de vitulo enarravimus, invenit in alio agello suo sanctam Monennam cum puellis suis

[1] Matth. 10, 8. [2] Evang. Joannis, 14, 12.

Athea et Ede et Osid, in die requies. Narrant ergo certissime de sancta Monenna, postquam de peregrinatione Roma revertens, in terram venerat sue cognationis sancte, sexum virilem numquam intueri. Sed quando necessitas proficiscendi alibi cogebat infirmos visitare, aut vinctos precibus sive muneribus solvere, vel captivos redimere, illam affirmant in nocte procedere, si autem necessitas cogeret, facie operata pallio, homines contra ire vel appellare, semper volens iunioribus exemplum relinquere, ne per fenestras ullatenus sinerent mortem ad animam intrare.[1] Solebat enim, ut predixi, plus in nocte in illa terra ambulare, ne humanis se in die comisceret aspectibus, et super veniente sole, si non esset domus apta in propinquo ad manendum, etiam sub quodam umbraculo in alio secreto loco, vel in papilione, ab estu vel pluvia defendente, manebat. Rogavit ergo illam benedictus homo, diligentissime per Deum contestans, ut ad domunculam suam, quam habebat remotam, secum venirent, affirmans in possessione sua nihil esse, quod servos Christi impediret ad se venire. Post nonnulla, impetrata petitione, illo precedente, sequuntur eum ad domum suam, lavatisque pedibus Christi virginum pio obsequio, et mensa apposita coenula ministratur. Potus autem de cervisia miscitur. Finitis[2] iis in domum et omnem supellectilem hospitis benedixit, hoc etiam, ut fertur, dicens: "Monstrate mihi, inquit, etiam, vasculum cervisarium, de quo attulistis nobis potum, ut et ipsum diligentius benedicamus." Quo coram apposito, modicum, quod intus remansit, diligenter benedixit. Et in huius virtute benedictionis, parum, quod, in vasculo erat, usque ad summum vasculi labrum creverat. Dixit iterum ad hospitem: "Si aliquos bonos homines, quoscumque volueris, invitaveris, potum eis sufficienter de isto vasculo, si credideris, habebis. Modicam substantiam adhuc habuisti, sed nunc multiplicare Dominus vult tibi bona, et tuis post te heredibus, eo quod semper etiam supra facultatem fuisti letus in recipiendis Christi hospitibus. Multi enim, ut Apostolus ait, per hec placuerunt Deo, angelis receptis hospitio."[3] Post sancte Monenne inde degressus, ille supradictus homo Bar regem, cui pertinebat, secus se pretereuntem accersivit dicens: "Veni domine mi ad domunculam servi tui, iam enim prandium, ut habui, qualecumque paravi." Cui rex respondisse fertur: "Multi sumus, ut vides, et habemus alicubi paratam cenam." Dixit iterum homo: "Nolo vos impedire ad preparata exire, sed prius mecum exibitis etiam paululum gustare." Quid plura? Rex cum omni multitudine veniens ad domum eius, apposito prius prandio, biberunt omni illo die et nocte, de illo tantum supradicto vasculo, potum a sancta Monenna benedictum. Sequenti etiam die et nocte similiter biberunt. Et quantum de cervisia, ut referunt, pincerna hauriebat, tantum interius benedictio redundabat. Hoc omnes cognito, valde mirati sunt, magnificantes sancte Monenne virtutem in tali facto, scientes quod multa mirabilia

[1] Cf. Jerem. 9, 21. [2] Finitis] sic Boll., finiteriis cod. [3] Hebr. 13, 2.

preter hec perfecit, largiente Domino. Cotidie videtur impleri quod Scriptura ait: "Benedictione iustorum exaltabitur civitas."[1] Et iterum: "Benedictio Domini divites facit."[2] Ille supradictus homo post sancte Monenne benedictionem, semper melius et melius habuit, et sua generatio in populo postea multo tempore primatum obtinuit, eo quod sancte Monenne benedictionem recipere promeruit.

INCIPIT LIBELLUS SECUNDUS.[3]

De aqua in vinum conversa.

Ab episcopo veniens ad sanctam Brigidam.

De duodecim vestibus sancta Monenna a Domino donatis.

A sancta Brigida vadens habitavit in Airhsconis apud episcopum Ibor, et de cisterna aqua repleta.

De prophetia sancte Monenne, et de puella sibi ab episcopo commendata.

De egressione sancte Monenne de Airdsconis, et de fluvio se elevato.

De vasculo argenteo in fluvium transmisso a Brigida ad sanctam Monennam.

De peregrinacione eiusdem Rome.

De puella tribus diebus aqua submersa et postea per sanctam Monennam vite redita.

Vitulum a lupis rapto et iterum reddito.

De petra in sale conversa.

De pauperis cibario rapto et iterum redito.

De filia resuscitata.

De puero alio resuscitato.

De vitulo in domo Donehc occiso et iterum vivo.

De vasculo parvo benedicto cum cerevisia in domo eiusdem Donehc.

INCIPIT IN CHRISTO LIBELLUS TERCIUS DE SANCTE MONENNE VIRTUTIBUS.

De rigore vite eius et dura abstinentia.

De vasis preparatis inedia cogeretur et a Deo repletis.

De peregrinatione sancte Monenne Rome iterum.

De ampula vitrea reperta.

Quod sancta Monenna angelos non venisse conquirens oraciones suas impediri sensit fichonum causa neophite.

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[1] Prov. 11, 11. [2] Prov. 10, 22.

[3] This heading, with the list of chapters which follows here, ought to have been inserted by the scribe at fol. 20r°, before the beginning of Book ii (p. 217, supra). I have, however, thought it well to follow the order of the MS.

Quod vidit Brig supradicta duos, ut sibi videbatur, cienos, id est angelos, de domuncula sancte Monenne egredi.

De profectione Lazar in Anglia.

De novissima peregrinacione sancte Monenne Rome euntis per Scottiam.

Quod Conagal rex, filius Conail, et qui convenerant barones misit ad illam de die mortis debito in futurum differendo.

De ostensione sancte Monenne post obitus sui diem tercium ad Taunatim.

De translatione sancte Monenne.

De columpna ab angelis elevata in tempore Derlaisre.

De aqua in cerevisiam motata.

De muti lingua per sancta Monenna soluta.[1]

INCIPIT IN CHRISTO LIBELLUS TERCIUS DE SANCTE MONENNE VIRTUTIBUS.

De rigore vite eius et dura abstinentia.

1. Multis itaque annis sancta Monenna iuxta predictum montem cum suis virginibus, constructo monasterio, sanctam peregit militiam. Quantum vero se in vigiliis et orationibus incessabiliter cum multis etiam laboribus corpusculum afflixerat, quantum ieiuniis creberrimis et lectionis in terrea adsiduitate omnia carnem attenuans maceravit, qualibus spirit[al]ibus preliis contra demones desudaverat, vel quod et quales creberrimas ab inimico pertulerit insidias, quantis miraculorum coruscationibus effulserat, nullus hominum ad integrum numerare potuit. Omnia enim ab hominum notitia, in quantum potuit, celaverat, preterquam manifestari hominibus necessitas certa cogebat. Ita namque priorum heremitarum et anachoritarum vestigia secuta est, ut etiam propriis pedibus in sarculo terram hararet, et seminata postea semetipsa, in quantum sustinere poterat, exercebat. Viriliter enim animum et sanctum flagrans desiderium et in desertis erat consuetudo habitare locis, maxime iuxta montes, et supra nudam petram nudis membris in vigiliis et orationibus pernoctare, vel salterium in aqua usque ad scapulas decantare, et virilem animum gestabat in femineo sexu, et pro laneis vel lineis vestibus, quasi quedam filia Helie et Ioannis Baptiste discipula, utebatur. Sarculus itaque eius et fossorius, in quibus operabatur in suo monasterio, pro hiburneis ossibus carius usque hodie custodiuntur. Pelliciam autem illius et melotem, ibi conservata, et olosiricis merito multo pretiosiora, illic similiter reposita vidimus, pectinamque eius ligneam, qua capud pectinabat semel, ut refertur, in anno, id est in coena Domini, vel quando summa necessitas infirmitatis cogebat, honorifice conservantes secum habent, merito magis pretiosam quam si de auro fuisse facta. Quantum autem semetipsam humilians propter Christum deformaverat, tantum illam Dominus gratia virtutum exaltavit. Progressu namque temporis

[1] This chapter does not occur in the MS. The incident is not related in any of the hitherto printed lives of St. Monenna.

coeperunt ab omnibus in circuitu visitari nationibus, et honoribus etiam multis virgines Christi nobilissime. Etiam regine audita sancte Monenne, deposito regali fastigio, ad illam cotidie veniebant, suppliciter in terram prostrate, et deprecabantur ut eius iussu, si esset possibile, vel etiam colloquio ditarentur. Cotidie crescebat numerus virginum Christi, et non solum de propinquis, sed et de longinquis regionibus, elemosine multe cotidie mittebantur, sive in iumentis et pecoribus, sive in ciborum et vestimentorum habundantia, iuxta illarum terrarum consuetudinem, que omnia expendebat sancta virgo in pauperum et peregrinorum, viduarum et pupillorum necessitates, vix relinquens que infirmis prime et extreme etatis solatio forent.

De vasis preparatis inedia cogente et a Domino repletis.

2. Alio tempore, inedia perstante, sorores sancte prope ad mortem ducte sunt. Sed de sua commoditate quicquam dicere non audebant nec volebant. Sancta autem Monenna in tali etiam virtute pre omni primatum tenuit. Nisi enim, quod natura humana non sustinet, pene desiderio carebat, ciboque semper fruebatur, dulci colloquio Christi. Audet ergo, ut refertur, homo Dei perveniens ad sanctam Monennam dicere: "Cur sorores Christi, moriuntur te presente, inedia confecte? Quia si volueris, potes, Deo adiuvante illas citius sublevare. Multum enim melius est, ut per te possint vivere, que Christo omni vite tempore deserviunt cotidie." Quid plura? Quasi rubore superfulsa, iussit a sororibus vascula parari plurima et omnia in apto reponi loco, benedicens singulas, Christum oravit. Sequentique post hec nocte, oratorium ingressa, vigiliis preces Domino fudit, confidens in eum, qui dixit: "Petite et dabitur vobis,"[1] et reliqua. Ut qui toto mundo sua dona sine cessatione preparat, etiam suis privatis ancillis, que inde tantam iactaverant curam, alimenta tribueret. Mirum dictu, crastino subsequenti omnia vascula ut refertur, inventa sunt plena, que in vespere precedente dimissa sunt vacua. Videmus nunc Spiritus Sancti dona sine personarum acceptione tribui, sed non sine meritorum gratia commerui. Qui enim in Heliseo, quondam propheta maximo, operatus est, per Benedictum quemdam monachum similia fecit, cuius vita et virtutes a sancto Gregorio papa describuntur.[2] Nunc etiam per suam famulam Monennam, licet in extremis terrarum finibus sitam, facere non dedignatur, ut a solis ortu usque ad occasum suum laudabile nomen magnificetur.[3] In Christo enim neque masculus neque femina, sed omnia in omnibus Christus.[4]

De peregrinatione sancte Monenne Rome iterum.

3. Post hec vero coepto itinere, Christo comite, sancte virgines trans mare in Scotiam, ad sanctum Andream, et iterum transfretaverunt in Britanniam

[1] Matth. 7, 7.
[2] The life of St. Benedict occupies the entire second book of the Dialogues of St. Gregory the Great (ap. Migne, Patrologia Latina, 66, cols. 125-204). [3] Psal. 112, 3. [4] Galat. 3, 28.

et edificaverunt ecclesiam in honore sancti Michaelis Archangeli in cacumine montis, qui modo vocatur Edeneburd. Enim erant quinque virgines, quarum ista sunt nomina, sanctissima abbatissa Monenna, Athea et Ede, Osid et Lazar; et habitaverunt ibi quinque annis. Et inde profecte sunt petentes limina sanctorum Apostolorum Petri scilicet et Pauli atque Andree, ut horum precibus adiute, regnum celorum valerent ascendere. Cum autem venissent ad fluvium qui dicitur Trente, qui decurrit iuxta Montem Calvum, qui Anglico sermone dicitur Calvechif, et edificaverunt ibi ecclesiam, qui locus Deo consecratus et sancte Andree, vocatur Andreseie, quia est parva insula et tunc erat deserta. Et habitaverunt in ea sancta Monenna, Lazar, et Athea septem annis; Ede vero et Osid in priore loco in Arderne supradicta silva. Et postquam Rome reversa sunt, ex altera parte aque edificaverunt ecclesiam in honore sancti Petri et Pauli ad radicem Montis Calvi. Et fecit Deus per illas multa miracula iuxta predictum fluvium. Sed quia tantum favorem populi sancta Monenna adepta est, noluit tunc ibi manere, et dixit sororibus suis: "Visitare volo, Deo permittente, sorores meas in Hibernia." Responderunt virgines cum fletu dicentes: "Ibimus et nos tecum." Que ait: "Non fiat sic, sed cum gratia Dei manete hic et ossa mea cum ossibus vestris Deo volente, cum gaudio expectate." Et dixerunt: "Si ita erit, magnum donum dedisti nobis." Et ait sancta Monenna: "Quadraginta diebus et noctibus manete mecum hic, ut faciamus orationem, et Dominus Iesus Christus perficiat, quod prediximus, et fiat eius voluntas." Cumque completa esset oratio virginum, apparuit eis angelus Domini et dixit: "Fiat vobis sicut petistis." Et postquam benedixit eis abbatissa perrexit ad Hiberniam. Athea vero mansit in Andreseia, sicut preceperat ei sancta Mo[nenna]. Erat enim cognata abbatissa. Propterea postulaverunt ut remaneret cum illis. Adhuc autem gentilitas et maximus tenebatur error per totam Anglicam terram. Sanctissima omnipotentis Dei virgo Monenna multas in Dei nomine edificavit ecclesias, quasdas in Hibernia, quaram ista sunt nomina; id est Focharde, deinde Cehllescleve, et post Cheneglas, et edificavit ecclesiam unam in Surde, et alteram in Ahrmacha, nec non et Mitha, et multas alias, quarum nomina hic non sunt scripta. Hec autem sancta virgo viguit ac floruit virtutibus divinis ac miraculis, et fuit in tempore Celestini pape, qui sanctum Patricium ad Hibernenses gentes, sub caligine peccatorum et ignorantie positas, misit. Sed hec interim. In Anglica vero terra quasdam constituit ecclesias, quia in tempore illo, sicut dixi, maximis gentilitatis tenebris tenebantur. In Arderne vero, maxima et longissima silva, tres construxit ecclesias. Quarta autem in quadam insula, posita in fluvio supradicto Trenti, qui iuxta Montem decurrit Calvi.

De ampula vitrea reperta.

4. Unus de poetis Scotorum preclarissimus, nomine Brenden, vir ab infantia oculis orbus, sed in arthe poetica inter omnes erat precipuus, venit ad quemdam fluvium nomine Berbam. Et ille in navicula transiens, cecidit de suo sinu ampulla vitrea, que erat de vino plena, in profundum aque. Quam diu querentes numquam invenire potuerunt, et omni spe inveniendi ablata, dixit postea in suo, quod per verbum canebat, carminiculo: "Si ista ampulla nunc fuerit inventa, sancte Monenne sine dubio erit donanda, ut habeat illa secum in altaris ministerio, quod suum meritum monstrabit de profundo." Hec canens in sua lingua, unus prospiciens videt vasculum sanum et integrum iuxta se in aqua positum, quod asumens, foris produxit de aqua et ad sanctam Monennam postea transmisit, quod invocatum nomen eius Deus monstravit.

Quod sancta Monenna angelos non venisse conquirens orationes suas impediri sensit fichonum causa neophite.

5. Angelos Domini cum sancta Monenna collocutiones habere frequenter adsiduas non dubium est, et die nocteque ab illa numquam defuisse, ex quo monasterio collocaverat usque ad mortis sue diem, exceptis tribus, ut alii affirmant, noctibus, alii una nocte, qui ab initio semper sibi traditum adfirmant, et quid traditum causae prestitit sequens contextus verbi monstrabit. Alia nocte sorores oratorium ingresse ad matutinas ibi peragendas vigilias, finitisque aliquando orationibus, signo pulsato, silentio dixit sancta Monenna sororibus: "Puelle benedicte Domini, non debemus festinando negligere, quod in ista nocte video vobis evenire. Debemus enim nostras, in quantum possumus, orationes ad Christum sursum erigere. Et nunc ultra oratorii culmen non possunt ascendendo transire. Debemus hac hora, in quantum possumus, omnes nostras conscientias mundando investigare. Sanctos enim hospites, qui nos visitare soliti erant, multo miramur solito tempore non venire. Si namque nostra delicta qualiacumque non fuissent, sine dubio more solito semper advenirent." His auditis, omnes ancelle Domini ceciderunt in facies suas, timore in eius verbo perterrite, plus credebant verbo abbatisse, quamvis sciebant in suis conscientiis nichil peccare, sicut et Apostolis quondam Domino Christo dicente: "Quia unus vestrum me tradet,"[1] respondisse leguntur singuli dicentes: "Numquid ego sum, Domine?"[2] Quod enim in corde suo unusquisque non habuit, supra se scire Dominum vere putavit. Responditque una de penitentibus, que nuper de seculo venerat, dicens: "Mea culpa sine dubio hec vobis feci. Nunc enim recordor, quod penitentiam meam promittens, oblita sum duos sotulares

[1] Matth. 26, 21. [2] Matth. 26, 22.

confiteri, quos ab alio seculari viro, mihi illicite ante copulato, adportavi, et illos in ista nocte sub pedibus propter frigus habui." Dixit sancta Monenna: "Melius ut illi subtulares imponantur in profundissimum bramum, pro quibus nunc absentiam sentimus angelorum." Vocata itaque una ex sororibus Brignam et aliis cum ea ex sororibus, dixit eis: "Ite et illos subtulares in aliquo profundo abscondite, ubi nemo illos possit invenire." Illis exeuntibus iussa complere, quod restabat vigiliarum rite peragunt. Dixitque sancta Monenna: "Deo omnipotenti gratias debemus ex toto corde agere, quod orationes nostre ut ante ad superna nunc aliquid possint ascendere, et nostri obtati hospites non timeant ad nos venire, reiecta materia Dei offense." Nunc aperte potest intelligi quantum se mundaverat ab omni macula principalis peccati, que orationem suam senserat his minimis impediri. Non sineret maiora delicta succrescere, que sic voluit sine ulla mora in tantum etiam minima purgare.

Quod vidit Brig duos cervos, id est angelos, de domuncula sancte Monenne egredi.

6. Reverse sorores, impleto precepto, pulsato oratorii hostio, vident omnia esse in silentio. Dixitque Brignam ad sorores, que secum ierant: "Ite dormitorium ingredientes aliquantulum pausate antequam lucescat mane." Illis intrantibus, revertitur ad tegorium sancte Monenne, in quo, cubiculo diligenter clauso, solebat diutius in oratione persistere super nudam petram cum angelis Dei mutuis conlocutionibus familiter sermocinari, sicut amicus cum amico loquitur. Adpropinquansque eminus intuetur duos, ut sibi videbatur, cienos, de domuncula, in qua sancta Monenna requiescebat, in celum volare. Quos diligentius primo intuens, mirari coepit, et alius esse sciens quam forma monstrabat, non audebat, diutius aspicere, sed cito in terram corruens coepit Dominum instantius orare, timens ne periret perculsa stupore visionis angelice. Tandem ergo tremebunda levat se de terra et appropinquans hostiolo coepit leniter pulsare. Audito in domuncula pulsantis motu dixit: "Ego sum ancilla tua, quam misisti, et fecimus que nobis, ut putamus, iussa sunt. Sed nunc timore concussa et omnibus tremulatis membris, vix spiritum cohibeo meum." Cui sancta Monenna clementer respondit: "Signa diligenter tuum cor, forsitan bestiarum vel demonum horrorem invenistis, que omnia in desertis solent accidere, et sexum femineum potest modicum commovere." At illa dixit, aliam esse causam concusse mentis et non de horrore procedere rei corporalis, "sed hec et hec a me visa sunt, et non potui nec volui te celare." Cui dixit sancta Monenna: "Nunc credo quod te Dominus bonis omnibus non privabit, quando secreta sua, que ab aliis celantur tibi revelavit, non privabit enim bonis qui ambulant in innocentia cordis sui.[1] Et nunc tempus est, ut in

[1] Psal. 83, 13.

tua terra propria habites aliis proficias. Ad hoc enim te Dominus servavit, ut per te edificentur deserta et inveniantur perdita massa, qua inventa, Christo et angelis fiat magna letitia. Nunc autem scias, quod visu oculorum, quibus nunc vides, post talem visionem carebis, meliores oculos habens, quibus paradisum videas, et similis angelis, quos vidisti in splendore fulgebis firmamenti. Sed ante mortem meam de tali visione nulli dicas. Nunc autem festinabis, ut potueris, ad terram tuam, sciens quod pergentibus semper de nostris, inter me et te, sive in vita sive post mortem nostram numquam accedet malum vel aliquid contrarium." Quod verissimum esse usque hodie probatur, periculosa semper et ardua ambulantibus inter illa duo monasteria, numquam audivimus accidisse quicquid mali. Post hec illa festinans ad terram nativitatis sue, que a monasterio sancte Monenne unius diei itinere disiungitur, invento ibi apto loco, usque ad diem mortis sue orbata oculis corporis, sic permansit, ut futurum sancta Monenna predixit.

De profectione Lazar in Anglia.

7. Habuit sancta Monenna secum unam de puellis nomine Lassar, quam supra memoravimus virginem Christi perfectam, sicut postea probavit eventus, quam sancta abbatissa pre maiora volens videns in ea sanctissime vite industriam, dixit ad illam: "Vade propter Christum in peregrinationem in alienam terram, quam diligo, trans mare in Britanniam, et ego veniam illuc, Deo volente, propter Dominum. Perge ad locum qui vocatur Andresie, in quo cupimus suscipere maxime precepta discipline." Surrexit illa complere, nihil contra dicens indubitata fide. In illo itaque itinere hoc mirabile contigit, quod obedientie sancte Monenne meritum promeruit, quia sic omnia, que sibi erant necessaria, in itinere semper preparata invenit, ut de sui itineris commoditate, quam propter Christum et obedientiam suscepit, nihil defuit, quod raro contingit his, qui non solum per peruersa terrarum pericula, sed etiam per fluctivaga maria transeunt. Ad mare autem pervenientes, ubi transitus de Scotia in Britannia est, navem paratam invenerunt in portu, que illas trans mare perduxit ad monasterium destinatum. Iuxta quod in hospitio permanens multo tempore illa predicta puella postea iterum exivit Romam.

De novissima peregrinacione sancte Monenne Rome euntis per Soctiam.

8. Cum vero esset sancta Monenna centorum et decem annorum coepit ire Romam novissima vice. Duabus enim vicibus ante ad predictam perrexit urbem. Pervenerat etiam in Albania, id est in Scotiam, in qua edificaverat ecclesias in Christi nomine, quarum hec sunt nomina. Una est Chilnecase in

Galuueie, altera vero in cacumine montis, qui appellatur Dundeuenel, quia sic semper solebat, sicut prediximus, ut supra nudam petram nudis membris in noctibus oraret Deum, qui semper orandus est, sicut Scriptura ait: "Orate sine intermissione,"[1] et reliqua. Tertia autem in alio montis Dunbreten. Quarta in castello quod dicitur Strivelin. Quinta vero Dunedene, qui Anglica lingua dicta Edeneburg. Sexta enim mons Dunpeleder, et illic transfretavit mare in Albaniam ad sanctum Andream. Post hec vero exiit ad Aleethe, ubi modo est obtima ecclesia, quam Lonfortin edificavit cum quodam fonte sanctissimo, et mansit illuc aliquanto tempore, et multum dilexit illum locum, in quo in finem vite sue, ut affirmant, Domino volente, emisit spiritum.

Quod Conagal rex, filius Conail, et qui convenerant barones misit ad illam de die mortis debito in futurum differendo.

9. Cum autem agnovisset sancta Monenna, Spiritu Sancto revelante, quod exitus vite appropinquasset, tunc misit nuntium in Arderne ad sorores Athea Osid et Ela, ut venirent ad eam in locum, qui vocatur Lonfortin in Scotia. Et venerunt et manserunt cum illa aliquantis diebus. Et appropinquante novissimo die et audita infirmitate eius in populo, maximum contulit omnibus luctum. Veneruntque ad illam visitandam Conagal, qui erat rex Scotie in illo tempore, et Rotheri et Cobo et Bollan et Choilli et omnes maiores natu populi cum cetera multitudine usque ad propinquantes monasterii loca. Miserunt itaque episcopum Ronam, fratrem Monenne, ad illam ponentes verba hec in ore eius: "Obsecramus te propter consanguinitatem nostram," nam et ipse rex matrem habuit Conalneam, "et germanitatem, quam habemus, et in carne et in Deo, ut etiam uno anno nobiscum maneas, et quasi orphanos nos in isto anno non derelinquas. Credimus enim et scimus quia quecumque Dominum rogaveris sine dubio ab illo impetrabis. Nos autem omnes, quanticumque hic sumus, et omnis populus similiter nobiscum demandat istam petitionem prestes, et quicumque de nobis principes, vel qualemcumque principatum tenentes, donabimus singuli ancillam Domino pro tua vita, et omnis vir de toto populo, qui potest armatus incedere, voluntario animo donabit vaccam etatis integre, et de ista pecunia simul in unum congregata, facies quodcumque tibi placeat." Quibus illa per episcopum remandat hec dicens: "Benedicti vos a Domino sitis qui dignitate deposita ad me infirmam visitandam venistis. Si pridie vel nudius tertius venissetis, forsitan Dominus sua pietate concedisset ut vestra petitio prevaleret. Hodie non possum vestre petitioni adquiescere, quia venerunt ad me hospites venerabiles valde, qui nostros sermones audiunt, qui missi sunt a Domino animam meam recipere secum, Petrum et Paulum dico, quos video habere secum lintheamen

[1] i Thess. 5, 17.

album de auro, ut mihi videtur, mirabiliter ornatum, et cum illis me oportet exire ad Dominum meum, qui misit illos, Iesum Christum. Donet autem Dominus vestro adventui mercedem, et quod voluistis donare voluntarie pro mea vita, unusquisque donet hoc ad Dominum pro sua anima propria. Benedictionem meam, quam postulastis, sine dubio recipietis. Benedicti enim vos a Domino, qui fecit celum et terram, cum uxoribus et liberis, filiabus et filiis, et omnibus que ad vos pertinent, sitis in omnibus benedixione Dei ditati. Pelliceam meam et melotem et cetera mea utensilia pro thessauris vobiscum tantum dimitto. Reliquie mee cum baculo meo in aliam terram apportentur. Que si vobiscum habueritis, contra inimicos pergentes, qui veniunt vestros depopulare fines, victoriam per hec habere Dominus vobis promittit. Extra vero terminos terre vestre alias gentes adire bellando non debetis, sed si ille gentes voluerint vestros devastare terminos et ibi pugnare contra illos necessitas coget, semper vobis victoria prospere subveniet. Alias autem gentes adire extra fines terre vestre, nisi maiore potestate cogente, vos non oportet, ne forte ira Domini super vos veniat. De mea autem absentia nolite esse tristes. Credo enim sine dubio non minus posse impetrare a Domino de his que vobis proficiant, si ad illum exiero, quam quando fui vobiscum in seculo." Hec et his similia diligenter eis demandans per episcopum, vale dixit singulis, nominibus suis, qui hec audientes per renuntiantem episcopum, proiectis armis, omnes fletu maximo planxerunt pro eius absentia, quam sciebant orationibus suis adiuvari posse per omnia. Post hec, consolatione suscepta, et ab episcopo confortati, accepta benedictione sancte Monenne, reverse sunt ad edes suas. Ergo eadem die, ante dispositis omnibus, in futurum suo monasterio pertinentibus, et predictis per spiritum que temporibus futuris per ordinem postea evenerunt, cum his vero hospitibus, qui ei in obviam processerant, die tertio Nonas Iulii perrexit ad Christum, septimo die a natali Petri et Pauli Apostolorum, cum quibis exiit ad regnum celorum, regnatura cum Christo in secula seculorum. Amen.

De ostensione sancte Monenne post obitus sui diem tertium ad Thanatim.

10. Post tertium obitus sui diem sancta Monenna ostendit se corporali visu alii de sororibus nomine Taunat, venienti de sororum dormitorio post completorium, nescio qua causa cogente, viditque sanctam Monennam iuxta crucem foris in proximo sitam in oratione stare. Qua agnita, ad pedes eius corruens, dixit: "Domina, quid me iubes facere?" Cui illa respondit: "Introiens domum, ad cunctas dices sorores, ut magis in tali tempore habeant sanctum silentium et ne earum sermones sonare audiantur foras extra domum.

Quid tam cito obliviscuntur statute regule, cuius terminos non licet ullatenus transgredi? Non debetis, filie mee, negligere etiam modica, ne similiter neglegantur et maiora. Tu ergo vadens, iter tuum prepara, quia mecum exibis transacta septimana." At illa gaudens in tali sponsione deduxit eam aliquatenus usque ad modicum, ut dicunt, fontanum in septemtrionali castelli parte positum. Reversa ergo Tannat domum nuntiavit hec sororibus, que sancta demandaverat Monenna. His auditis, timore perterrite, cuncte in terram prostrate sunt, gaudentes simul et trementes de manifestatione tante visionis. Completis autem septem diebus, ut predictum est, Taunat omnibus valedixit sororibus, lacrymantibusque singulis de eius absentia, simul gaudentes de itineris duce, intravit, ut adfirmant, suum cubiculum. Et ibi pedes recolligens, eius anima cum sancta Monenna migravit ad Dominum.

De translatione sancte Monenne in Anglicam terram.

11. Post dormitionem vero sancte Monenne, turba multa que convenerat de Hibernia, Scotia, et de Anglia ad locum ubi fuit defuncta, et propter corpus eius prelium voluerunt facere, quis tolleret. Venit etiam archiepiscopus Columpcille pacem facere inter illos. Dixerunt Hibernenses: "Cognata nostra est et de terra nostra nata, et ideo volumus adducere corpus ad propriam patriam." Scottici dixerunt: "Et de genere nostro est et ad nos venit, et finem vite sue nobiscum fecit, et debet nobiscum manere." Dixit vero Athea et qui cum ea erant: "Pro caritate Dei, Columchille audi nos. Preterierunt iam[1] . . . . . . annis, quod dixit nobis sanctissima virgo, "Ossa mea cum ossibus vestris[2] . . . . . . erunt, Deo volente.[3]" Et nos credimus et speramus, quod non potest aliud fieri cum voluntate Dei. Quia illa causa huc venimus." Et respondit sanctus Columchille et dixit omnibus: "Dabo vobis rectum consilium. Ieiunamus hodie et faciamus orationem ad Deum, ut nobis det consilium bonum et faciat pacem inter vos." Et fecerunt sic. Mane autem facto, dixit sanctus Columcille episcopus: "Eligite ex vobis octo homines, quatuor de Scotia, et de Hibernia duos, et alios duos de Anglia. Et illi de Scotia accipiant feretrum in occidentali parte, et alii quatuor in orientali parte, et Dominus dividat inter vos, quorum sit." Et sic factum est ut Scotigene exirent cum integro feretro, et corpus illius super illud, sicut eis videbatur, ad ecclesiam, que vocatur Aleecht, cum festinatione. Hibernenses vero et Anglici, exierunt cum Athea et venerunt illa die cum integro feretro et corpus super illud integrum iuxta castellum quid dicitur Strivelin, ad ecclesiam que vocatur Ecléés. Et postea adduxerunt corpus eius de loco ad locum, usque dum venientes ad predictum locum, quam sibi elegit in vita.

[1] There is a blank space in the MS. here. [2] Another blank space in the MS.
[3] Cf. Liber iii, cap. 3, p. 230, supra.

Nam et baculus suus cum ea illic posita est. Pellicia vero eius et melotes et cetera utensilia pro thesauris in Hiberniam ducte sunt ad ecclesiam que dicitur Chellescleve.

De columpna ab angelis elevata in tempore Derlaisre.

12. Post sancte Monenne dormitionem, sicut illa constituerat, Bia, filia Ailella fuit secunda abbatissa. Tertia Dognidui, filia Mothai, filii Lilac. Quarta Derlaisre, filia Daisremi, filii Buissidi, que monasterio puellarum prefuit quinquaginta annis. In cuius tempore contigit in omni Scotia famosum et tam grande miraculum. Ecclesie in monasterio sancte Monenne cum supradicta abbatissa construitur tabulis dedolatis iuxta morem Scotticarum gentium, eo quod macerias Scotti non solent facere, nec factas habere. Tota ergo ecclesia pene ad integram constructa, iterum artifices et lignorum cesores vadunt ad silvas propinquas arbores secare, ad ea que deerant domui perficienda. Inventisque sufficienter apparatui aptaverunt longiorem arborem et grossiorem querunt, qui in summo culmine ambarum sub se et in se summitatem contineret parietum, quam latine spinatam vocamus. Itaque diu quesita illa spinata columna et non inventa, tandem in arduo et satis maximis petris circumvallato loco inveniunt arborem ad opus aptam, securibusque secata dimissis omnibus ramis et radicibus talliatam. Putabant enim in primis aliquo modo petrocleas[1] inde attrahere posse. Sed movere vel modicum spatium nulla machina hominum vel fortitudo boum propter loci difficillimum situm. Domum artifices cum operariis redeunt, et hec que contigerant sancte Derlaisre dicunt. Quibus illa dixit: "Sancta Monenna vivit in celo, in cuius honore domus edificatur in terra, illa potest vos adiuvare." Itaque sic factum est, deficiente inde machina humana subsequenti nocte aderat virtus divina. Nam supradictam spinatam angeli sine dubio a Domino missi transportaverunt ad locum planum, ubi adiri potuit sine ulla iniuria hominum et iumentorum. Venientes die crastino artifices super via non longe a monasterio posita invenerunt columnam, quam crediderunt numquam adiri posse per magnam et difficillimam silvam. Et hoc miraculo diffamato, omnes qui audierant glorificaverunt Deum, dicentes se alibi non audisse plus factum mirabile, quam quod fecit Dominus per meritum sancte Monenne. Explorantes autem otiose artifices si deprehenderent maxime columne aliquod vestigium, videbantur ab eis in summitate arborum fracti ramusculi, ut sibi videbantur, quasi a columna tacti. Inde suspicabantur per aerem columpnam esse ab angelis subvectam. Et nunc illa domo renovata, illa supra dicta spinata in reliquiis reputatur.

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[1] petrocleas] sic cod. pro per trocleas.

De aqua in cerevisiam motata.

13. Alia vice in tempore sancte Derlaisre, sanctus episcopus nomine Finbar, cognomento Vinnianus, ad monasterium sancte Monenne direxit iter, et nullo nuntio ante se misso, descendere videtur de aliquo non tam longe monticulo. Quo viso et agnito, dixit sancta Derlaisre puelle que sibi ministrabat: "Haurite nunc festinanter aquam de sancte Monenne fontano, et implete cupas, que in domo sunt aqua, in quibus videtur aliquid fermenti remansisse." Completisque vasis usque ad summum, et aliis egredientibus domum, singula benedixit vasa, quibus in virtute benedictionis ferventibus, dixit ad puellam sibi pre ceteris fidam: "Proba qualiter est quod in vasis fervet." Que iussa conplens dixit: "Perfectissima cervisia est in vasis et similem illi numquam gustavi." Cui dixit sancta Derlaisre: "Ante mortem meam nulli dicas de hoc, quod contigit, quia meritum sancte Monenne et episcopi hec fecerunt sancti. Sed ne ulla humana adulatio hoc mihi inputat, nolo ante mortem meam, ut alius preter te sciat." Veniente ergo episcopo et suis, initoque conuiuio, biberunt omnes talem ceruisiam tam perfectam, ut omnes contestarentur nullam alibi unquam inuenire similem. Tam leti effecti ut nisi episcopo prohibente pene omnes hebrii deuenirent.

14. Harum uirtutum lectorem simul et auditorem per Deum testor, ut pro me ualde misero Domini serno Conchubrano, peccati sarcina oppresso, piis orationibus intercedant ad Dominum, ut quod impediente aduersario, uiribus meis inplere de Dei preceptis non ualeo, ut debet, sororum mearum meritis pro me intercedentibus, ante mortem meam perficere possim, ut mortis uinculis absolutus per earum suffragia, Christo prestante, transire merear in sanctorum consortium celicolarum, in mansionibus simul perfectorum cum Christo, qui regnat in secula seculorum. Amen.

APPENDIX.

A.

MS. Cotton Cleopatra, A. ii. fol. 1r°–3v°.[1]

Ymnus Sancte Monenne Virginis.

I.

Deum deorum dominum,
Autorem vite omnium,
Regem et sponsum uirginum
Sempiternum infinitum,
Invocemus perualidum
Sancte Monenne meritum,
Ut nos ducat post obitum
In regni refrigerium.

II.

Audite sancta studia
Virginum Christi milia,
Sancte Monenne plurima
Sana summa salubria,
Quam perrescit industria,
Donante Christi gratia,
Quam tu Christe perpetua
Collocasti in gloria.

III.

Benedicta Patricio,
Sub uirginali pallio
Consecra[ue]rat[2] Domino
Templum cordis hospitio,
Christo digna possessio
Salva viro perpetuo,
Quam [tu Christe perpetua
Collocasti in gloria].

IV.

Corde perfecta sobria,
Sponsa Deo dignissima,
Vestimenta pulcherrima
Habuit nuptialia,
Quibus induta regina
Regis stetit in dextera,
Quam [tu Christe perpetua
Collocasti in gloria].

V.

Donavit illi maximam
Deus virtutum gratiam,
Certam veram prophetiam,
Futurorum scientiam,
In omni cetu gloriam,
De adversis victoriam,
Quam tu Christe perpetua
[Collocasti in gloria].

VI.

Erat illi mirabile
De aqua vinum facere,
Petram in salem efficere,
Temptata filiis Sathane,
Semper ditata munere
Visionis angelice,
Quam tu Christe [perpetua
Collocasti in gloria].

---

[1] In the same hand as the Vita. The hymn is not written according to the metre, but in full lines as the page admits. The metre is marked by dots.

[2] Letters or words printed in square brackets are omitted in the MS.

VII.

Fertur Monenne vitulus
Raptus a lupis protinus
Egit nocte miserrimus,
Inter lupos fit pavidus,
Illa orante scicius
Sanus a bestiis redditur,
Quam [tu Christe perpetua
Collocasti in gloria].

VIII.

Gloriosum miraculum
Devulgatum per populum,
Unum occidit vitulum
Servis Dei convivium,
Quem fecit Monenne meritum
Vivum haberi iterum,
Quam [tu Christe perpetua
Collocasti in gloria].

IX.

Humilis erat animo,
Excelsa tamen merito,
Terram harabat sarculo,
Heremitarum studio
Virum gerens proposito
In corpore femineo,
Quam [tu Christe perpetua
Collocasti in gloria].

X.

Ieiunii in rigore,
In caritatis ardore,
In omni bono labore,
Propter Dominum proprie
Sic vixit omni tempore
Crucifixo iam corpore,
Quam tu Christe perpetua
[Collocasti in gloria].

XI.

Kasta electa columba,
Perfecta matri unita,
Turtur et castissima,
Voce sonante cognita,
Vitis vera florigera,
Christo Domino condigna,
Quam tu [Christe perpetua
Collocasti in gloria].

XII.

Lucerna erat lucida
In templo Dei posita,
Virgo Iesse florida
Pulcra fortis et unica,
Margarita pulcherrima
Ornata regis placita,
Quam [tu Christe perpetua
Collocasti in gloria].

XIII.

Magnam construxit ecclesiam
In desertis egregiam,
In qua virtutem maximam
Fecit laude dignissimam,
Defunctam unam filiam
Suscitavit emortuam,
Quam [tu Christe perpetua
Collocasti in gloria].

XIV.

Narrant idem de vasculo
Mirum dictu argenteo
Magno immisso fluvio
Longo terrarum spatio,
Quod Monenne nutu superno
Transmissum est a Domino,
Quam [tu Christe perpetua
Collocasti in gloria].

XV.

O Christi sanctam virginem,
Sancte Marie [i]mitatricem,[1]
O uere vitis palmitem
De omne fructu laborem,
O regis sponso sublimem
Deo semper amabilem,
Quam tu Christe [perpetua
Collocasti in gloria].

XVI.

Patriarchas sinibus (?)
Cum electis virginibus,
Apostolorum cetibus,
Solis luce fulgentibus,
Sublimatis honoribus
Sanctorum his similibus,
Quam tu Christe perpetua
[Collocasti in gloria].

XVII.

Quantum crucem sustinuit,
Tantum corde congaudebit,
Quantum Domino placuit,
Tantum signa promeruit,
Quantum Deo obedivit,
Tantum premium accepit,
Quam [tu Christe perpetua
Collocasti in gloria].

XVIII.

Regno celorum fruitur,
Viro Dei reficitur,
Celesti manna alitur,
In paradiso pascitur,
In quo a sanctis canitur
Carmen quod nunquam finitur,
Quam [tu Christe perpetua
Collocasti in gloria].

XIX.

Stola induta glorie,
Spe secura victorie,
Sponsum sequitur ubique
In celi latitudine,
Electorum in ordine
Refulget solis splendide,
Quam tu Christe [perpetua
Collocasti in gloria].

XX.

Transacta nocte media
Voce clamantes superna
Cum lampade perlucida
Sponsa occurrit obvia,
Prudens edocta filia
Sponsi transit ad gaudia,
Quam tu Christe [perpetua
Collocasti in gloria].

XXI.

Urbem intrauit supernam,
Celestem Ierosolimam,
Sortita vestem candidam
In modum solis splendidam,
Post perfectam uictoriam
Habet laudem et gloriam,
Quam [tu Christe perpetua
Collocasti in gloria].

XXII.

Xpi sedit in dextera
Una cum sancta Maria,
Summa habentes gaudia,
Trinitatis in gloria,
Milium inter milia
Angelorum sublimia,
Quam tu Christe [perpetua
Collocasti in gloria].

[1] There is a little blank space before the first 'm.'

XXIII.

Ymnum Deo infinitum
Canentes regi omnium,
Laudantes in perpetuum
Summum eius imperium
Consona voce carminum
Electorum sublimium,
Quam tu [Christe perpetua
Collocasti in gloria].

XXIV.

Zona Christi durissima
Percinxit sancta viscera,
Qua perfecta deposita
Vestita stola bissina
Inter sanctorum agmina
Seculis in secula,
Quam tu Christe perpetua
Collocasti in gloria.

Amen.

Ora pro nobis, beata Monenna, ut regnemus cum Christo per sancta tua merita.

Per merita et orationes sancte virginis Monenne Dominum invocemus, ut peccata atque delicta nostra per penitentiam deleamus.

B.

MS. Cotton Cleopatra, A. ii. fol. 56 v°–58 r°.[1]

YMMUS SANCTE MONENNE VIRGINIS.

I.

Audite fratres facta
Sine ullo crimine
Sancte Monenne
Salutaris femine.

II.

Beata mansit
Sine ulla macula,
Terris apparuit
Post vite miracula.

III.

Celestis uirgo
Intrans cum melodia
Obviam sponso
Cum electo oleo.

IV.

Digna precamur
Per eius auxilia,
Ut mereamur
Magna mirabilia.

V.

Electa fuit
Deo et hominibus,
Christo adhesit
Annis iubilibus.

VI.

Femina fida
Miro fulget favore,
Celum concendit
Sed cum magno labore.

[1] In same hand as preceding. On fol. 56 v° half-way down begins, without any title, "Audite fratres facta" down to "Celestis uirgo." The hymn starts again at the top of fol. 57 r° with the title above, all the nine lines being repeated. Each stanza fills two lines of the MS.

VII.

Gratia Christi
Requievit gratissima
Mixta casta
Facta fidelissima.

VIII.

Humilitatis
Exemplar exsteterat,
Hinc exaltata
Celi prata peterat.

IX.

Iuvenculorum
Erat norma numeris,
A Deo[1] docta
Casta atque humilis.

X.

Kastam custodiuit
Carnem coram angelis,
Fulget in albis
Stolis claris candidis.

XI.

Lucerna clara
Nec sita sub modio,
Erat ostensa
Cum accenso oleo.

XII.

Marie matris
Imago mirabilis,
Hec virgo facta
Alta ineffabilis.

XIII.

Neminem lesit,
Pressit cuncta caduca,
Fulsit virtute,
Iuventute adulta.

XIV.

O sancta sponsa
Summi legis latoris
Complens perfecta
Precepta Saluatoris.

XV.

Patria de sua
Peregrina pergens
Habens in cruce
Lux de luce ardens.

XVI.

Quasi advena
Mundi cura caruit,
Domini digna
Fide firma floruit.

XVII.

Regina sancta
Sine labe manens,
Pura puella
Tanquam stella cadens.

XVIII.

Sancte Monnene
Laudibus resonantibus
Tanquam organa
Choris exaltantibus.

XIX.

Templum perfectum
Construxit in pectore,
Casta in sede
Cum rege rectore.

XX.

Vere permanet
Sine ulla macula
Inter sancta sanctorum
Angelorum miracula.

[1] adeo cod.

XXI.

Xpum secuta
Tuta ab infantia,
Mundum reliquid
Cum sua substantia.

XXII.

Ymnus exoriens
Christi cunctis auribus,
Cuius memoria
Permanet cum laudibus.

XXIII.

Zona precincta
Castitatis candida
Fulget in gaudia
Tanquam aurea lampada.

Gloria Patri
Atque Unigenito
Cuncti tonantis
Exaltantis merita
Sancte Monenne
Postulemus egregia
Ut per eius auxilia
Possideamus premia. per.

Sancta Monenna [illegible] ascendit in candilabro nitidum sponsum sicut sol in meridie. Qui regnas in secula seculorum. Amen.

C.

MS. Cotton Cleopatra, A. ii. fol. 58 v°–59 r°.[1]

Vixerat autem sancta Monenna[2] centis et triginta tres annis, et fuit abbatissa[3] quadraginta annis. Pater vero eius nomine Mothait · rex Oneahulud · filius Lilach · filius Lugdach · filius Conalde · filius Ermen[4] · filius Soiro · filius Imchado · filius Fedlemto · filius Maicc. Mater vero eius regina nomine Cumman filia regis Dalbranaig.

Quinta abbatissa post sanctam Monennam fuit Cron · filia Dachoram · xxiiii[5] annis.

Sexta abbatissa Conchen · filia Colmani · filia Aeda regis cognomento Superflun · xxx annis.

Septima Cron filia Erneri filii Feetheni cuius non (?) inperfecto primatu in monasterio numerus peragitur annus unus.

[1] In the same hand as the Vita and preceding hymns.
[2] Space after abbatissa.
[3] Space of three or four letters.
[4] May be Erinen.

Octava Damorir filia Scandlani · avi Dachoram · annis xii · in mortalitate magna moritur.

Nona Gnathat · Chritan filia · annis xxx.

Decima Finan ingen Critan · filii Scanlani · avi Dachoram · una mense fuit.

Undecima Luccan · filia Aedgne · filii Abeil · xi annis prefuit.

Duodecima Femen · filia Fallaich · annis xxxiii.

Tercia decima Allabuir · filia Foidmin · xxxiiii annis.

Quarta decima Flaithgrath · annis xxx.

Quinta decima Medboc · filia Midgasa · abbatissa annis quindecim.

D.

MS. Cotton Cleopatra, A. ii. fol 59 v°–60 r°.[1]

Audivimus a quodam viro religioso et cuius dictis est adhibenda fides, quod in quodam cenobio, quod gloriosa virgo Moduenna in Hibernia construxerat, usque in hodiernum diem lectus ipsius cernitur trans[2] introitum monasterii positus de lapide ad modum sepulcri excisus. In quo post inmensos labores, post multos sudores, post longas vigilias, non cullatis plumeis, non linteis vel lodicibus, sed duro lapidi raro dat membra quieti ut non tantum vigilando, sed etiam dormiendo carnem spiritui cogeret ancillari. De hoc lecto tale contingit fieri miraculum. Virgines ibidem Deo famulantes hoc decretum illesum observant, scilicet nullam in earum admitti societate, nisi prius eis de illius constiterit virginitate, quod hoc modo divino iudicio committunt examinandum. Iuvencula monasterium intratura et sacrum velamen susceptura, primo in illo lecto collocabitur pausatura. Mirum dictu, si virgo fuerit, non tantum nullis affecta molestiis evigilat, verum si antea alicuius morbi molestia se dolebat affligi, mox pristine gaudebit sanitati restitui. Si vero aliqua ausu temerario se virginem mentita fuerit, quod nonnulle faciunt, quia turpe est non esse fateri, et in eodem lecto iacere presumpserit, lectum illum necnon omnia vestimenta sua cruore fedata evigilans inveniet, ac si aliquis ex industria lectum illum cruore animalium in eodem loco occisorum impudenter fedasset.

---

[1] In a court hand of the thirteenth century. [2] Or perhaps post.

E.

MS. Cotton Cleopatra, A. ii. fol 60 r°.[1]

MS. Lansdowne, 436, fol. 131 v°.

Ortum Moduenne dat Hibernia, Scocia finem,
Anglia dat tumulum, dat Deus alta poli.
Prima dedit[2] vitam, sed mortem terra secunda,
Et terram terre tertia terra dedit.
Auffert Lanfortin,[3] quam terra Conallea profert.
Felix Burtonia virginis ossa tenet.

F.

MS. Cotton Cleopatra, A. ii. fol. 60 r°.[4]

Gaude virgo mater Christi qui per.
Gaude quia Deo plena peperisti.
Gaude quia tui nati quem dol.[5]
Gaude Christum ascendentem.
Gaude quod post ipsum scandis
Ubi fructus ventris tui.

---

[1] In same court hand of the thirteenth century. [2] dat Lansd. [3] Longfortin Lansd.
[4] In a larger and coarser hand of the fourteenth century. [5] dol. cod.

I.

INDEX NOMINUM PROPRIORUM.[1]

[1] Some of the place-names are so corruptly written in the MS. that I have not been able to identify them.

II.

INDEX VERBORUM.[1]

[1] The leading orthographical peculiarities of the MS. have been included in this Index. No notice has, however, been taken of such common forms as adfirmant for affirmant, adsimilati for assimilati, conlocutio for collocutio, inplere for implere, inmensos for immensos, nichil for nihil, tocius for totius, vendicat for vindicat, ymnus for hymnus, &c., &c. Words marked with an asterisk do not occur in the glossary of Du Cange (ed. Henschel, 6 vols., Paris, 1840–46).

complangens 211.
completorium 235, *a service containing prayers at the close of the day.*
concendit 242, for conscendit.
confabulatio 209.
congaudeo 241. Cf. Thesaurus Linguae Latinae (s.v.).
consulans 211, for consolans.
conuersatio 207, 212, *conversion.*
coruscatio 228. Cf. Thesaurus Linguae Latinae (s.v.).
crippa 220, not found elsewhere, *a kind of cloth or garment,* French *crêpe,* Italian *crespo.*
*cullatus 245. Probably connected with culla, some kind of garment worn by monks.
cupa 238, *a cask, vat.* Cf. Thesaurus Linguae Latinae (s.v.).

dampnum 218, 219, for damnum.
degressus 226, for digressus.
desertum 213.
despellere 218, for dispellere.
disponsate 210, for desponsate.
dormitorium 232, 235.
dubietas 221, *doubt.*

elemosine 229, for eleemosyne.
eperbolice 220, doubtless for hyperbolice. The Bollandists, who wrongly print eperbolire, suggested ebullire, on the strength of which eperbolire is given as a verb equivalent to ebullire in Henschel's edition of Du Cange (s.v.).
escre 221, an Irish word meaning *a vessel.*
exspers 215, for expers.

familiter 232, for familiariter.
feminii 219, for feminei.
fermentum 238.
ficones 227, 231, *shoes.*
floriger 240.
fluctivagus 233.
fontanei, 219, *springs.*
fontanus 236, 238, *a fountain.*
*fossorius 228 (= fossorium), *a hoe.* Cf. on this word Hessels, Trans. Philol. Soc., 1902, p. 518.

*glutimen 208 (= glutinum), *a connecting tie, bond.*

habundantia 208, 212, 229, for abundantia.
harabat, hararet, for arabat, araret, 228, 240.
hebrii 238, for ebrii.
heremita 208, 228, 240, for eremita.
hiburneis 228, for eburneis.
homunculus, 211.
honus, honusta, 221, 224, for onus, onusta.
hostio 232, for ostio.
hostiolum 232, for ostiolum.

immonis 220, for immunis.
incessabiliter 219, 228.
incessanter, 219.
indumentum, 218.
ineffabilis, 243.
infantulus, 209.
ingen 245, an Irish word meaning *a daughter.*
intactum 212, for intactam.
iocundissimus, 217.
*iubilis 242.
iuxto 216, for iusto.

lactifer 215.
laculus 219, *a little pond or reservoir.*
lampada 244.
lintheamen 234, for linteamen.
lodix 245, *a coverlet, blanket.*

maceria 237, *a walled enclosure.*
mellifluus 221.
melote, melotes, 228, 235, 237, *a sheepskin.*
monasterialis, 212, 219.
monasteriolum 224.
monialis 216, *a nun.*
monticulus 210, 228.
mortalitas 245, *a plague.*
motata 228, 238, for mutata.
neophita 227, 231, for neophyta.

*oblatiuncula 211, 223, *a little gift, offering.*
obtati 232, for optati.
obtimus 208, 234, for optimus.
olosiricis 228, for holosericis, *all of silk.*

papilio 226, *a tent,* cf. Reeves, Adamnan, p. 449.
pars 207, *a province.*
peccora 217, for pecora.
pectina 228, *a comb.*
pectinare 228, *to comb.*

pellicea, pellicia, 228, 235, 237, *a coat of skins.*
percingere, 242.
perrescit 239, for perrexit.
perualidus 239.
petrocleas 237, for per trocleas.
pincerna 226, *a cupbearer, butler.*
*piscinula 208, *a small fishpond.* The word occurs in the MSS. of the Vita S. Hilarionis of St. Jerome, sect. 21; but the editors read *piscina* (Acta Sanctorum, Octobris tomus ix, 1858, p. 53A).
pontifex 213, *a bishop.*
porcarius, 207, 211, *a swine-herd.*
*prediola 224, diminutive from praeda, *little spoil, plunder.*
presbiter 209, 212, for presbyter.
*pronubere 210.

quam 215 for quem.
quasdas 230, for quasdam.

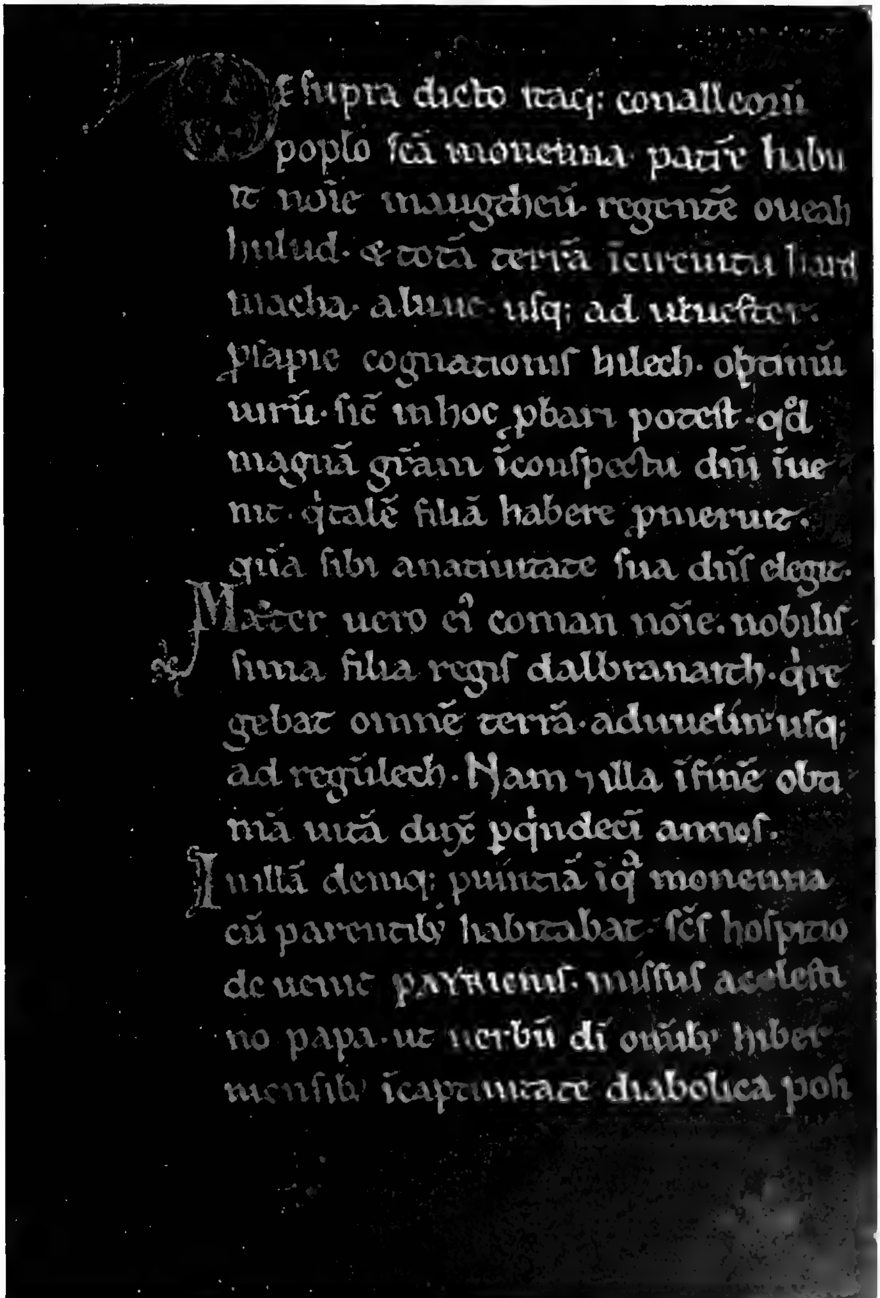
ramusculus 237.
rancor 220.
*rarescentius 212, *rather rarely.*
rediid 215, for rediit.
redito 227, for reddito.
refectio 225.
reliquid 244, for reliquit.
remandare 234.
resurrexio 225, for resurrectio.

saciabantur 211, for satiabantur.
salmos 209, 214, for psalmos.
salterium 228, for psalterium.
*satiamentum 219, *abundance, sufficiency.*
*sceleumata 207, 210. This word, evidently meaning *obscene songs*, appears to be of Greek origin. I cannot, however, trace its derivation.
scicius 240, for scitius.
scolam 220, for scholam.
septimana 212, 236, *a week*, French *semaine.*
sotulares 231, (= subtalares, subtulares) *shoes* French *souliers.*
spalterium 217, for psalterium.
*spinata, ae, 237, *a column.* Cf. spinatum or spaldum, *an outer or projecting wall*, Italian *spaldo.*
subtulares 232, vide sotulares.
sumpmo 209, for summo.
superfulgeo 229.
suplicatio 221, for supplicatio.
suplimentum 218, for supplementum.
*suspicatio 224, *suspicion.*

talliare 237, *to cut, hew*, French *tailler*, Italian *tagliare.* Cf. the Reichenau Glossary printed by M. Paul Meyer, Recueil d'Anciens Textes Bas-Latins Provençaux et Français, 1874-77, pp. 20, 21.
tegorium 232, *a hut*, cf. tegurium, tugurium.
thessauris 235, for thesauris.
tirannus, 212, 213, 215, 216, for tyrannus.
tremulare 232, *to tremble.*

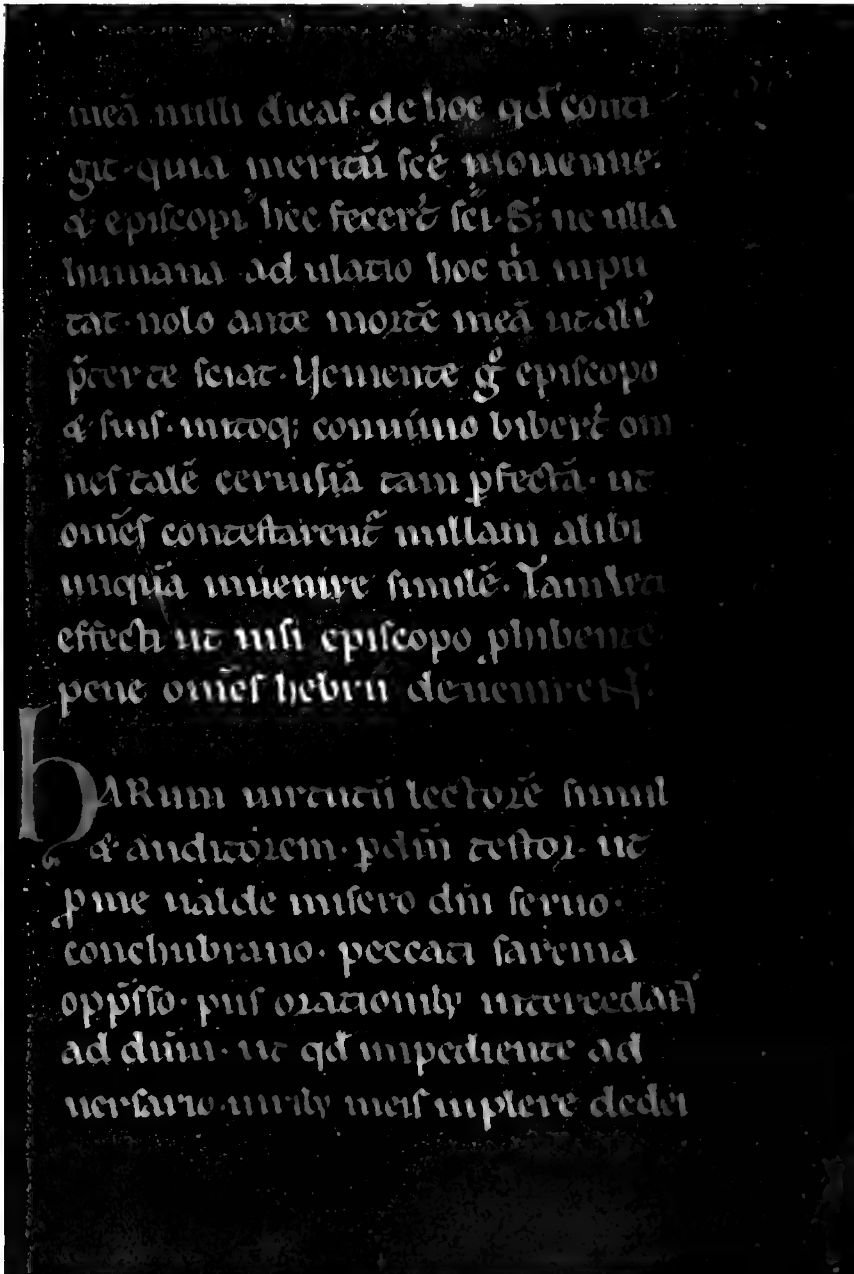
ullatenus 226, 236.
umbraculum 226.
utpute 220, 223, for utpote.

vastitudo 216.
velud 207, 210, for velut.
venenosus 220.
veniad 215, for veniat.
versutia 218.
villula 210.
voluntarie 235.


De supra dicto itaq; conallcorū
poplo scā monenna patrē habu
it noīe maugtheū regentē oueath
hulud. & totā terrā īcircuitu hard
macha. aluic. usq; ad utuefter.
p̄sapie cognationis hulech. optimū
uirū. sic̄ in hoc pbari potest. qd̄
magnā grām īconspectu dñi iue
nit. q̄talē filiā habere p̄meruit.
quā sibi anatiuitate sua dns̄ elegit.
Mater uero eī coman noīe. nobilis
sima filia regis dalbranaith. q̄re
gebat omnē terrā. aduuelin usq;
ad regulech. Nam illa ifinē obti
mā uitā duxī p qndecī annos.
Nullā demq; puinciā iq̄ monenna
cū parentibs habitabat. scs hospitio
deuenit PATRICIUS. missus acelesti
no papa. ut uerbū dī omībs hiber
nensibs icaptiuitate diabolica posi

Codex Cotton Cleopatra, A ii., fol. 5b.

Esposito.—Conchubrani Vita Sanctae Monennae.


meā nulli dicas· de hoc qđ conti
git· quia meritū scē moueñne·
& episcopi hec fecert sci· Sȝ ne ulla
humana adulatio hoc m̄ inpu
tat· nolo ante mortē meā ut ali'
p̄ter te sciat· Ueniente ḡ episcopo
& suis· utroq; conuiuio biberet om
nes talē ceruisiā tam pfectā· ut
omēs contestarent nullam alibi
unquā inuenire similē· Tam lrā
effecit ut nisi episcopo phibente
pene omēs hebrii deuenirent·
hARum uirtutū lectorē simul
& auditorem· pđm testor· ut
p me ualde misero dn̄i seruo·
conchubrano· peccati sarcina
opp̄sso· prus orationib; intercedant
ad dn̄m· ut qđ impediente ad
uersario uirib; meis implere dedi

Codex Cotton Cleopatra, A ii., fo. 56.

Esposito.—Conchubrani Vita Sanctae Monennae.

February, 1910

1

PROCEEDINGS

OF THE

ROYAL IRISH ACADEMY

VOLUME XXVIII, SECTION A, No. 1

ARTHUR W. CONWAY

ON THE MOTION OF AN ELECTRIFIED SPHERE

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