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NOTE.

The authors of the several papers contained in this volume are themselves accountable for all the statements and reasonings which they have offered. In these particulars the Society must not be considered as in any way responsible.

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MEMOIRS.

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M. = Memoirs. P. = Proceedings.

Manchester Memoirs, Vol. lxi. (1916), *No.* **1**.

I. South African Gorgonacea.

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(*Read November 14th, 1916. Received for publication, December 18th, 1916.*)

This paper concludes my report on the South African Gorgonacea, collected by the Government of the Cape of Good Hope, during the years 1898 to 1907.

In 1900 and 1904, Hickson published two papers on the Alcyonaria of the Cape of Good Hope, in which he recorded the following Gorgonaceæ:—Family Briareidæ, Sub-family Spongioderminæ—*Spongioderma verrucosum*, Möbius. Family Melitodidæ—*Melitodes dichotoma*, *Pallas; Wrightella coccinea*, Gray. Family Dasygorgiidæ—*Trichogorgia flexilis*, Hickson. Family Isidæ—*Ceratoisisis ramosa*, Hickson. Family Muriceidæ—*Villogorgia mauritiensis*, Ridley; *Acanthogorgia ramosa*, Verrill. Family Plexauridæ—*Eunicella papillosa*, Esper; *Euplexaura capensis*, ? Verrill. Family Malacogorgiidæ, Hickson; *Malacogorgia capensis*, Hickson. Family Gorgoniidæ—*Gorgonia flammea*, Ellis and Solander; *G. capensis*, Hickson; *G. albicans*, Kölliker; *Eugorgia gilchristi*, Hickson; *Gorgonia sp.* (?), *Gorgonia ? crista*, Möbius. Family Gorgonellidæ—*Gorgonella stricta*, Lamarck; *Juncella elongata*, Pallas; *Juncella spiralis*, Hickson.

In 1911 I described in a paper to the Zoological Society the following species from South Africa:—Family Briareidæ, Sub-family Briareinæ—*Suberia capensis*, St. Thomson; Sub-family Spongioderminæ, *Spongioderma verrucosum*, Möbius. Family Melitodidæ—*Melitodes esperi*, Wright and Studer; *Melitodes nodosa*, Wright and Studer; *Melitodes dichotoma*, Pallas. Family Isidæ—*Ceratoisis ramosa*, Hickson. Family Muriceidæ—*Muriceides fusca*, St. Thomson; *Acanthogorgia armata*, Verrill. Family Plexauridæ—*Eunicella papillosa*, Esper; *Psammogorgia pulchra*, St. Thomson; *Euplexaura media*, St. Thomson. Family Primnoidæ—*Stachyodes gilchristi*, St. Thomson; *Thouarella hicksoni*, St. Thomson. Family Gorgoniidæ—*Gorgonia capensis*, Hickson; *G. flammea*, Ellis and Solander. Family Gorgonellidæ—*Scirpearia furcata* emend, Simpson; *Scirpearia flagellum* emend, Simpson; *Hicksonella spiralis*, Simpson = *Juncella spiralis*, Hickson.

My present paper contains descriptions or records of the following 29 species, of which 11 are new:—

SECTION SCLERAXONIA.

Family Briareidæ, Sub-family Briareinæ—*Anthothela parviflora*, sp.n. Off Cape Recife.
Family Melitodidæ—*Melitodes Faurii*, sp.n. Off Kuskamma Point.
Melitodes grandis, sp.n. Off Cape Seal.
Mopsella singularis, sp.n. Off Cape Morgan.
Acabaria sp. Off Vasco da Gama Peak.
Wrightella trilineata, sp.n. Off Umkomass River mouth.
Wrightella fragilis, sp.n. Off Lion's Head.
Wrightella furcata, sp.n. Off Scottsburgh Lighthouse.
Wrightella, sp. Off Tugela River mouth.

SECTION HOLAXONIA.

Family Isidæ, Sub-family Ceratoisidæ—*Acanella eburnea*, Pourtalès. Off Buffels River.
Family Muriceidæ—*Acanthogorgia armata*, Verrill. Off Vasco da Gama Peak.
Acanthogorgia sp. Off O'Neill Peak.
Acanthogorgia sp. Off Cape Vidal.
Muricella ramosa, Thomson and Henderson. Off Durnford Point.
Family Plexauridæ—*Eunicella papillosa*, Esper. Off East London and False Bay.
Euplexaura parciclados, Wright and Studer. Off Stalwart Point.
Family Primnoidæ, Sub-family Primnoinæ—*Stachyodes capensis*, sp.n. Off Sandy Point, and off Cape Morgan.
Family Gorgoniidæ—*Leptogorgia africana*, sp.n. Off Cove Rock.
Leptogorgia alba, Verrill. *var. capensis*, off Durnford Point.
Leptogorgia rigida, Verrill. Off East London.
Leptogorgia aurata, sp.n. Off Durnford Point.
Leptogorgia sp. juv. Off Umhloti River mouth.
Lophogorgia lutkeni, Wright and Studer. Off Gordon's Bay.
Gorgonia flammea, Ellis and Solander—Lat. 33°—53′—15″, Long. 25°—51′—45″.
Gorgonia albicans, Kölliker. Off Gordon's Bay.
Gorgonia sp. Off Robben Island.
Eugorgia Gilchristi, Hickson. Off Cape Recife.
Eugorgia lineata, sp.n. Off Nanquas Peak.
Stenogorgia capensis, sp.n. Off Algoa Bay.
Family Gorgonellidæ—*Verrucella bicolor*, Nutting. Off Tugela River mouth.

Section Scleraxonia.

Family Briareidæ, Sub-family Briareinæ.

Anthothela parviflora, sp.n.

Plate II., Fig. 5; Plate V., Fig. 4.

Diagnosis of Genus.—Colonies creeping or more usually upright and branched. Polyps large projecting, with a calyx not completely retractile. The upper part of the polyp completely retractile within the calyx, and the latter usually marked out into eight rays or lappets. The coenenchyme of the cortex with large canals, smaller canals present in the medulla. Spicules: thorny spindles, spinous clubs, and rods.

This new species is represented in the collection by three colonies or parts of these. The most complete example has an expanded base, from which a branch arises at a low level, which divides into a larger and smaller secondary. The main stem continues in an upward direction, and gives rise firstly to a branch with a single polyp, and then on the other side to an offshoot with nine polyps. The main axis has then three polyps arranged in a tri-radiate manner around it, and then divides dichotomously into two branches of equal length, the one with seven, the other with ten polyps. The branches are not straight, but are twisted or curved, and they usually come off at an angle of about 45 degrees. The outer surface of the colony is fairly hard and firm, and has a somewhat stony and slightly silvery appearance. When the general surface of the main stem and branches is examined with a lens, a granular appearance is observed, which is due to the spicules. The size of the most complete specimen was 86mm. in height and 50mm. in the other direction. The polyps are very prominent, and the calyces have eight grooves and ridges. The position of the polyps relative to one another is varied owing to the curving and twisting of the branches on which they are situated; as a rule they do not stand opposite to one another, but at one point, however, three polyps originate at the same level around the stem.

A rough transverse section through the primary shoot of the colony shows a dense outer part with numerous small spicules very thickly disposed, within this an area with fewer spicules, and with about twenty-four canals arranged in a more or less circular manner, and in the centre a part of comparatively large diameter, with long spicules and yellowish fibres, surrounding a few small canals.

The branches are approximately cylindrical, the expanded base is about 9 by 5 mm. in diameter. In the most complete specimen the intervals between the branches (starting from the base) are as follows:—5 mm., 16 mm., 3 mm., 3.5 mm., 9 mm., 4.9 mm., 6 mm. The branches vary in length, the two terminal branches are 4.9 mm. and 4.5 mm. The branches terminate in a polyp or polyps. The diameter of the main stem at a slight distance from the base is 3 mm.; near the apex 2 mm. The polyps vary considerably in size; this is partly due to the varying degree of expansion and contraction. They range from about 2.5 mm. in length and 1.5 mm. in diameter to 7 mm. and 2 mm. respectively. The calyx of any one polyp may decrease in diameter to the extent of 1 mm. between base and apex. The polyps are distinctly constricted at the bases of the tentacles, thus the apex is clearly delineated. The tentacles are in some cases fairly well extended but not fully, the pinnules may be seen with a lens. The polyps are cylindrical, rays of longitudinally directed spindles are easily seen on the surface of the calyx. These spicules have a glistening appearance. At the base of the calyces the longitudinal areas of spicules are discontinued, and after a short intervening free space the spicules of the general surface of the coenenchyme commence. The spicules are disposed in eight longitudinal areas on the calyx, and also on the polyp crown; on the former, spicules clearly project beyond the surface. My specimens agree with the diagnosis of the genus Anthothela, as given by Broch and by Studer. *Anthothela grandiflora* (Sars), Verrill, occurs off the coast of Norway, Newfoundland and North America, as far south as Martha's Vineyard, in the upper part of the abyssal zone. *Anthothela argentea*, Studer, was collected during the dredging operations of the Steamer "Albatross," in Lat. 23°—16′N., Long. 107°—31′E., at a depth of 852 fathoms. Professor S. J. Hickson has handed me a type specimen of *Briareum* (*Anthothela*) *grandiflorum* from Trondhjem Fjord, and there is an excellent recent description of this species by Broch, the latter author also giving a useful list of synonyms. In regard to *Anthothela argentea*, Studer, a detailed description is wanting. The general shape of the colony of my species differs considerably from that of *Anthothela grandiflora*, (Sars) Verrill. *A. grandiflora* is much more bushy or shrublike, and has anastomosing branches and a plumper appearance, my specimens being of a more slender and tree-like build. The polyps are in my form not so thickly distributed on the stem and branches. The stem and branches of *Anthothela grandiflora* are not so cylindrical. Studer writes of a chief trunk in *Anthothela argentea;* Broch states that in *Anthothela grandiflora*, a principal stem does not occur, and that the branches anastomose with one another so frequently as to form a thick colony, which sometimes reaches the size of a man's head. In *Anthothela grandiflora* several polyps frequently originate at about the same level on the branches, in my specimens this is rarely the case, as the polyps may be separated from one another by considerable intervals. The polyps is as in *A. grandiflora*, formed of a distinct calyx, and an upper part which can be invaginated into the former. As in *Anthothela grandiflora*, the calyx seems to have to some extent the power of contraction, and in those few cases it appears as a small rounded swelling. In *A. grandiflora* and in my form when the polyp is contracted into the calyx, one sees a small pit, and usually the surface is very distinctly marked out into eight lappets or rays. The spicules of the rind or cortex are of two types or sizes, as in *A. grandiflora.* The larger spicules are straight or curved, and somewhat irregularly spindle-shaped. They have a fairly large number of projecting spines, the number of these spines appearing to be larger in my specimens than in *Anthothela grandiflora.* These spicules, however, appear as a rule to be larger than those of *Anthothela grandiflora*, thus many are 1.110 or 1.8 mm. long, and 0.276 mm. broad, while those of *A. grandiflora* are only about half this length, namely, 0.5 or 0.6 mm. Apart from this difference in size, these spicules resemble those of *A. grandiflora* very much in shape. As in *A. grandiflora*, there is in the cortex a number of spicules of a smaller and different type. These are rods and clubs, which are much better provided with processes than those of the last type; the latter spicules are also larger than the corresponding ones in *Anthothela grandiflora*, ranging from about 0.1 to 0.2 mm. The spicules of the calyx are mostly of one type, namely, broad spindles with numerous large and prominent processes. There are only a few of the longer type of spicule, they are similar in shape to those figured by Broch for *A. grandiflora.* The first type varies considerably in size from about 0.1380 × 0.368 to 0.644 × 0.276 mm. The second type of spicule (which is rare) varies from about 0.644 × 0.276 to 1.840 × 0.276 mm. The spicules of the tentacles are mostly long, thin spindles or rods, with few processes. These tentacular spicules are fairly similar in form to those of *A. grandiflora*, but apparently in some cases at least are much longer. They vary in size from about 0.460 × 0.092 to 1.656 × 0.184 mm. The spicules of the medulla or central part of the stem and branches are usually long, slender rods or spindles, with few processes. They resemble those of the tentacles and the long spicules of the cortex very much in form. They range in size from about 0.462 × 0.092 to 2.116 × 0.276 mm. It will thus be noted that the spicules in my form tend to be larger than those of *A. grandiflora;* and further, the predominance of one type of spicule in the calyx is noteworthy. While it is a simple matter to distinguish my species from *A. grandiflora*, it is not so easily compared with *A. argentea*, Studer. It resembles *A. argentea* in its arborescent form, slender branches and slightly silvery spicules. It differs from *A. argentea* in the branches not arising at nearly right angles, in the tentacular crown being retractile within the calyx, and in the polyps being apparently less abundantly disposed than those of that species, for Studer writes:—"les branches . . . . couvertes de polypes qui sont posés sur la base sous des angles droits." From the briefness of the description and the absence of a figure of *Anthothela argentea*, it is almost impossible to be certain that my specimens do not belong to this species, but this appears to me to be a new form.

Locality, etc.—Pieter Faure, No. 655, S.S.W., off Cape Recife. Depth, 256 fathoms. Taken by dredge. Nature of bottom, rocks. November 14th, 1898.

P. F. 524. Off Algoa Bay. Depth, 100 fathoms. By dredge. Nature of bottom, rocks. Date, November 1st, 1898.

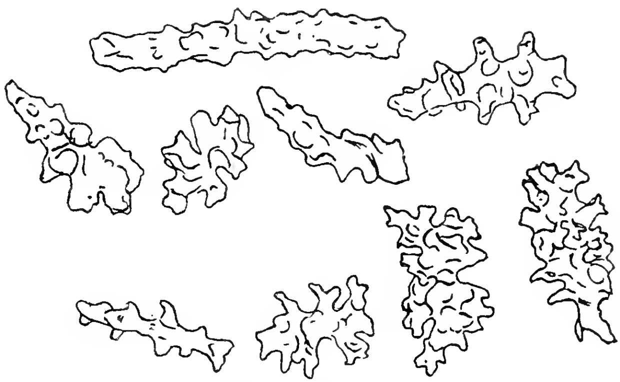
FAMILY MELITODIDÆ.

Melitodes Faurii, sp.n.

General Characters.—The branching is usually from the nodes, rarely from the internodes. The spicules of the cortex are spindles or spinous clubs. The nodes are penetrated by endodermal canals. At one part the polyps are predominant on three surfaces of the branches, and are there thickly distributed; they are not biserial in arrangement. The branching is almost entirely in one plane. The cortex is thin at the base, thicker near the apex. The polyps are retractile within conspicuous calyces.

Specific Characters.—The nodes are large and prominent. The internodes are shorter near the base, longer near the apex of the colony. There is a considerable amount of anastomosis. The branches have a slightly sinuous course. The branches frequently originate at angles of 45°. There is a slight amount of flattening of the branches near the base, but in the upper parts they are cylindrical. The internodes are from 4 mm. in length near the base, to 13 mm. in the upper parts of the colony. The presence of endodermal canals in the internodes is not certain. The nodes are expanded at all parts of the colony; they are brownish or yellowish in colour, the calyces stand at right-angles, or at slightly less than right-angles to the surface, in the lower part they are arranged on three sides of the stem and branches, more apically they are arranged on all sides. The polyps are comparatively high, the anthocodiæ show the 8-rayed arrangement very clearly; the calyx is also very distinctly 8-partite. The polyps frequently originate from the nodes. The spicules of the tentacles are straight spindles, curved spindles, curved spindles with more and larger processes along the outer side of the curve, spinous clubs, clubs with expanded processes, a few of which are nearly of the foliaceous type. The spicules of the calyx are simple and curved spindles, clubs with expanded broad processes, clubs approaching the foliaceous type, a few heads with expanded processes and irregular spicules.

Notes.—The specimen is very fragile, and the upper parts have become broken into a number of pieces; it is white, only relieved by the yellow or brown colour of the nodes. The coenenchyme is slightly rough owing to the spicules. There are faint lines or grooves running obliquely longitudinally on the surface of the coenenchyme of the lower stems and branches. The base is large and encrusting, and the first polyps occur 18 mm. from it. To some extent the main branches, with branchlets, ascend in parallel planes to one another. The nodes at the base are extremely prominent, one is 6 mm. in length and 5 by 4 in diameter. Near the base the polyps are separated by an interval of 1-3 mm.; in the upper branches and twigs they are practically in contact with one another. A polyp in which the pinnules can be seen is 2-3 mm. in length, the anthocodia 1 mm. The spicules of the polyps are arranged in eight longitudinal areas, with a circular band at the base of these, then a slight free space intervenes, and beneath the latter the spicules of the calyx are prominently disposed over its surface.



Text-fig. 1. Spicules of *Melitodes Faurii*, sp. n., upper, from polyp; lower, from coenenchyme near base.

The spicules and their dimensions in millimetres are as follows:—A.: Spicules from the coenenchyme near the base of the colony; (1) straight spindles (a few) with simple processes, from 0.081 × 0.023 to 0.108 × 0.054; (2) curved spindles with simple processes from 0.063 × 0.023 to 0.144 × 0.054; curved spindles with larger processes on the outside of the curve, from 0.126 × 0.072 to 0.144 × 0.081; clubs with expanded processes, from 0.072 × 0.063 to 0.144 × 0.081; clubs (a few) approaching very closely to the foliaceous type, about 0.126 × 0.054; heads which have lost or nearly lost the shaft, about 0.126 × 0.072. B.: The spicules from the coenenchyme of the central nodes. (1) Straight spindles, from 0.108 × 0.036 to 0.288 × 0.054; curved spindles, from 0.18 × 0.036 to 0.270 × 0.036; spinous clubs with expanded processes from 0.081 × 0.036 to 0.144 × 0.072; clubs very nearly foliaceous, about 0.144 × 0.072, and a few heads and irregular spicules. C.: The spicules of the tentacles are as stated previously, with a great preponderance of simple and straight curved spindles, the largest of which are about 0.36 × 0.036. D.: The spicules of the calyx as stated previously, with a greater predominance of clubs, the largest about 0.18 × 0.090. E.: Smooth rods, with rounded ends from the axial part, from 0.063 × 0.006 to 0.104 × 0.009.

Locality, etc. P.F. 13,549. Kuskamma Pt. N.E. by E. 5 mi. Depth, 33 fathoms. By dredge. Nature of bottom, broken shells and rocks Date, August 27th, 1901.

P. F., No. 11,315. Tugela River mouth, N. by W., ¾ W., 15½ miles. By shrimp trawl. Depth, 40 fathoms. Nature of bottom, mud. Date, January 10th, 1901.

I name this species after Sir Pieter Faure, who as Minister of Agriculture at the Cape, showed great interest in the development of the Fisheries, and in the Marine Investigations, and after whom the Government trawler—the "Pieter Faure" was named.

Melitodes grandis, sp.n.

Generic Characters.—The polyps have projecting calyces. The branching is most frequently from the nodes, sometimes from the internodes. The large basal nodes are penetrated by canals, the internodes are not perforated by channels. The polyps are not widely separated, but are close together. The branching is dichotomous, and the branches spread out to some extent in parallel rows over one another. The polyps arise on three sides of the lower stem and shoots, on all sides of the upper branches; the calyces are low. The arrangement of the polyps is not biserial. The upper branches are not flattened.

Specific characters.—The specimen has from its mode of branching a bushy appearance. There is a slight amount of anastomosis. The lower stem and branches are slightly flattened, the upper are more cylindrical. The internodes are 5-12 mm. in length, the longer being in the higher branches. The larger nodes near the base are as much as 9 mm. in length and 8 by 6 mm. in diameter. The nodes are smaller in the upper parts of the colony, in the upper branches they are scarcely visible externally, partly because the brown colour is not present. The polyps vary in size according to the degree of extension, some are 1 mm. in height, and about the same in diameter; the calyces are ½ to ¾ mm. high.

Notes.—This is one of the largest specimens of Melitodes on record; it is at least 24 cm. in height, 12 cm. broad, and 4 cm. wide. It is very strong in habit near the base, but the upper branches are more slender and fragile, many of the latter being broken off in the preserved specimen. The general ground colour is white, the nodes are brown, especially near the base, and covered by a thin white coenenchyme. The latter coenenchyme has a finely granular appearance. The basal stems have a slightly quadrangular appearance. Short branches, which are often expanded at their tips, fairly frequently arise from the internodes above the basals.

The anthocodiæ have the spicules, which are mainly spindles arranged in eight longitudinal areas, and at the base of these lies a circular band of spindles (with almost entire

Text-fig. 2. Spicules of *Meitodes grandis*, sp. n., upper, from coenenchyme of nodes; lower, from polyps.

margins), with about three spicules at any one place, counting in a vertical direction. The calyx is densely protected by spicules, mainly spindles and clubs, which cross and overlie one another in an intricate manner. The basal attachment is large and reptant, it is 3 by 2 cm. in diameter. Three large shoots originate from the base, one of which is 9 by 8 mm. in diameter. The upper branches are very much curved, and are sometimes 2 mm. in diameter, the polyps are there closely adjacent to one another, with less than a millimetre between them. The internodes, when deprived of the coenenchyme, are white.

The coenenchyme covering the axis is sometimes about 1/10th of a millimetre in thickness.

The spicules of the coenenchyme covering the nodes are: (1) straight, curved and kneed spindles, (2) clubs without foliaceous processes, (3) a few irregular spicules, (4) rods with simple processes, and from the inner axial part, rods without processes. The spindles are from 0.090 × 0.018 to 0.252 × 0.072 mm.; the clubs from 0.072 × 0.018 to 0.126 × 0.072 mm.; the irregular spicules smaller than the last; the rods of the inner axial parts, from 0.036 × 0.0036 to 0.108 × 0.018 mm.; The spicules of the polyps including the calyces and anthocodiæ are fairly similar to the above, they appear as a rule to be larger, and some of the straight spindles are bifurcated at the end. The spindles are from 0.072 × 0.018 to 0.252 × 0.054 mm.; the clubs, from 0.072 × 0.054 to 0.198 × 0.054 mm. The spicules of the coenenchyme from the internodes are similar to those of the nodes in shape, except that many of the spindles and clubs having a larger number of and better developed processes. Some of these larger spindles are 0.270 × 0.072 mm. in size, and the clubs are about 0.216 × 0.090 mm. The rods without processes from the axial parts of the internodes are from 0.072 × 0.009 to 0.108 × 0.018 mm. The specimen in some respects approaches *Melitodes flabellifera*, var. *cylindrata*, Kük.

Locality, etc.—Pieter Faure, No. 18.788. Cape Seal W. by N., ½ N., 7 miles. By large trawl. Depth. 30 fathoms. Nature of bottom, mud. Date, April 20th, 1906.

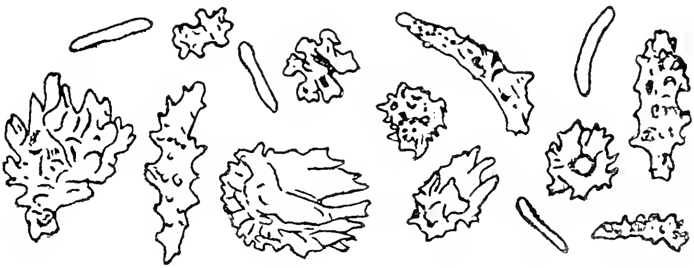
Mopsella singularis sp.n.

Plate II., Fig. 4.

Diagnostic Characters.—The polyps have small projecting calcyes. Foliaceous clubs are present. The branching is from the nodes, several branches arise from a prominent encrusting base, which diverge in planes crossing one another, but in each of these the branching is in one plane. The distinction between nodes and internodes is well marked, the former are yellow, the latter white, the anthocodiæ yellow. The lower internodes are shorter and stouter than the upper, the upper nodes become correspondingly smaller. The coenenchyme covering the nodes and internodes is rough and granular, due to the slightly protruding spicules. There are not many polyps on the basal stems, those on the upper branches are mainly arranged in a biserial manner; a few, however, occur on the two remaining sides. The distribution of polyps, except on the most apical branches, is rather sparse, and there is some interval between them. The polyps are not confined in their origin to the internodes, a number arise from the nodes even near the base. A few faint longitudinal lines occur on the basal stems, but they are never well marked. The specimen is very fragile.

Notes on the Specimen.—The size, when complete, must have been about 7 cm. high, 9 cm. broad, and 1 cm. wide. The basal part is bulky and encrusting, and is 10 by 7 mm. in diameter and 12 mm. in height. The basal nodes are from 3-5 mm. in height, and about the same in diameter, but they are slightly flattened. The basal internodes are from 3-8 mm., the upper about 8-10 mm. in height; their diameter is about 2-3 mm. basally, 1 mm. apically. When deprived of the coenenchyme, the axis is white, and has traces of spicules.

The calyces are sometimes reduced to very minute risings on the surface of the coenenchyme. The polyps, with calyces and anthocodiæ, are sometimes 1.5 mm. in height, and 1 mm.



Text-fig. 3. Spicules from the nodes of *Mopsella singularis*, sp. n.

in diameter. The interval between the polyps is about 2 mm. near the base, but on some of the apical branches they are sometimes almost in contact.

The branching is more or less dichotomous, the branches do not run in the straight manner characteristic of such genera as Acanella, but have a slightly twisted or curved course. A striking character is the flattening of the upper branches in a lateral direction, that is, in the reverse plane to that commonly found in Melitodidæ.

The spicules slightly protruding on the surface of the coenenchyme are seen with a lens as being massed together. The spicules covering the axial part of the nodes are yellow, and the latter a lighter yellow.

The polyps are very well protected by spicules. The anthocodiæ have eight longitudinal areas of fairly long, dark yellow spindles, with simple processes, basally to these areas lies in a circular band of the same type of spicule, with 3 to 4 spicules at any one place counting in a vertical direction; beneath this ring the calyx is mainly protected by foliaceous clubs.

The yellow spicules of the anthocodiæ are fairly long, straight, narrow spindles with simple processes, a few yellow club-like spicules occur among these spindles. These spicules vary in size from about 0.072 × 0.018 to 0.270 × 0.072 mm. The white spicules of the calyx are mainly foliaceous clubs, approximately 0.108 × 0.054 to 0.198 × 0.072 mm. in size. Spinous clubs and spindles are also present, though not nearly so abundantly, and are of about the same size as those of the anthocodiæ. The spicules of the coenenchyme covering the nodes are: (1) mainly yellow, more rarely white foliaceous clubs, in many of these the stalk portion is reduced, and the spicule thus becomes more equally foliaceous in all directions; the foliaceous clubs are from 0.108 × 0.090 to 0.216 × 0.144 mm. in size; (2) spheres with foliaceous processes, about 0.072 × 0.090 mm.; (3) double spheres, about 0.18 × 0.014 mm.; (4) clubs reduced to heads, about 0.144 × 0.108 mm.; (5) spindles, with simple processes, about 0.126 × 0.036 mm.; (6) spinous clubs, about 0.198 × 0.054 mm.; (7) simple usually curved rods, without processes, and rounded at the ends, from 0.054 × 0.012 to 0.144 × 0.018 mm. The spicules from the coenenchyme of the internodes are similar to the preceding, differing mainly in being white.

Locality, etc.—P. F., 13,122. Cape Morgan, N.N.E., 9¾ miles. By dredge. Depth, 47 fathoms. Nature of bottom, broken shells. Date, July 25th, 1901.

Acabaria sp.

Plate V., Fig. 5.

This description is taken from an incomplete specimen, which is of a yellow colour, but darker at the nodes. The branching is in one plane, and the specimen is 93 mm. high, 70 mm. transversely, and 8 mm. thick. The axis, which is brown near the base and yellow near the apex, is horny and calcareous, giving stiffness and rigidity to the specimen. The branches apparently usually originate at the nodes. The coenenchyme on the surface of the axis is thin, and shows faint superficial lines. The nodes near the base are about 5 mm. in height, 7 mm wide, and 6 mm. thick, and are separated from adjoining nodes by intervals of about 3 mm. The nodes are smaller and longer in the upper parts of the specimen, thus these nodes are sometimes 2 by 2 by 2 mm., and the internodes 13 by 2 mm. No calyces are found on the colony, this is therefore presumably only the basal part. The branching is nearly dichotomous, but not regular, rarely branches may be seen originating from the internodes, and there is sometimes a slight anastomosis.

A rough transverse section through the nodes shows (1) a fairly thick cortex, densely crowded with yellow spicules, (2) the great mass of the section consisting of fairly soft brown fibrous tissue, with large canals, and with some small, white, rod-like spicules, and (3) a central part, not very well defined, with a few yellow spicules, and with white rods. The structure of the internodes resembles the last, but the second area is replaced by hard, white, calcareous tissue, without canals, and the central part is better defined.

Most of the spicules are yellow spindles and clubs, but there are also short, narrow, white rods, without processes. The spicules of the nodes consist of a dense mass of clubs, spindles, and more irregular forms, as well as smooth rods. The spindles may be approximately straight, or much curved, their ends are not much pointed. The clubs have broad, expanded processes, and lead on to more irregular spicules, which have lost the lower part of the club, or the latter has become broadened out. The spindles are from 0.075 × 0.027 to 0.198 × 0.057 mm. The clubs are from 0.081 × 0.041 to 0.189 × 0.081 mm. The irregular spicules are from 0.075 × 0.063 to 0.135 × 0.086 mm. The rod-like spicules of the outer part of the axis of the nodes has chiefly rod-like spicules about 0.108 in length, and about 0.013 in breadth. The inner part of the axis has a few yellow spindles, clubs, irregular spicules, and many small white rods. In the internodes the spindles are fewer, and the clubs and irregular spicules are the most conspicuous forms. As in the nodes, there are rod-like spicules in the internodes. The spindles are from 0.063 × 0.039 to 0.162 × 0.054 mm.; the clubs from 0.108 × 0.104 to 0.081 × 0.063 mm.; irregular spicules from 0.079 × 0.054 to 0.147 × 0.072 mm. The rods are approximately the same size as those of the nodes. On account of the incompleteness of the specimen, and the absence of polyps, it appears unwise to give the example a specific name.

Locality, etc.—Vasco da Gama, N.W., ¾ N., 8 miles. Depth, 41 fathoms. Collected by dredge, Nature of bottom, rocks. Date of collection, April 27th, 1900.

Wrightella trilineata, sp.n.

Plate IV., Fig. 1; Plate V., Fig. 3.

The specimen is small, mainly red in colour, but with reddish-brown nodes, and white or yellowish polyps. The colony is 66 mm. in height, and about 53 mm. in breadth.

The branching is nearly dichotomous, but is not completely so, as for example, a slight anastomosis occurs near the base. The branching is almost entirely in one plane, and the distinction between nodes and internodes fairly prominent. The distance between the base and the first node is about

10 mm., and the diameter of the primary stem about 3 mm., that of the branches near the middle of the colony about 2 mm.

The axis of the internodes is solid, hard and dense, without canals, and almost entirely composed of calcium carbonate, with only a trace of fibrous or horny matter; it contains short rod-like or needle-like spicules towards the outside. The axis of the internodes is pink, that of the nodes dark brown in colour. The nodes have no canals, they are composed of: (1) spicular coenenchyme at the outside, (2) a thick area of horny or fibrous tissue, and (3) a spicular or limy part in the centre.

The polyps mainly originate from three sides of the stem and branches, leaving the fourth or ventral side free, although those of the lateral and dorsal surface are seen from this side. The arrangement of the polyps on the stem and branches is not quite uniform, but the general disposition is that of a series of polyps along each lateral surface, and a somewhat intermittent and irregular row between them. They are situated both on the nodes and internodes, and are more numerous on the apical branches. The tentacles are usually almost completely retracted within the calyces, the latter then having an 8-partite dome-shaped appearance, with a small circular opening, within which the minutest portion of eight tentacles can sometimes be seen. The spicules project very much on the surface of the calyces, especially near the apices and are roughly arranged in rings. The polyps are about 2 by 1.3 mm. in diameter, and 1.5 mm. in height. The interval between the polyps varies, some are 1 millimetre apart, others are almost in contact.

The coenenchyme is thin, has a granular appearance, due mainly to the presence of red spicules, but partly to a few white ones. Minute longitudinal, sinuous ridges and grooves occur on the external surface of the coenenchyme, more especially on that from which no polyps originate.

The lower nodes are more distinct than the upper; the first from the base is 4 mm. in height, and 3 by 2 mm. in diameter. One of the upper nodes is 2.5 mm. in height, and 2.5 by 2 mm. in diameter. The base of the colony expands into an enlargement, the exact limits of which it is difficult to determine, owing to the presence of an encrusting Polyzoan.

The spicules of the polyps are mostly white, they are as follows:—(*a*) straight spindles, (*b*) very much curved spindles, (*c*) spindles produced outwards at one end into two or three prongs, tending to become cross-shaped, (*d*) clubs, much shorter than the spindles, (*e*) clubs, approaching the foliaceous type.

The spicules of the coenenchyme are mainly red in colour, they are as follows:—(*a*) straight spindles, (*b*) curved spindles, (*c*) short clubs, (*d*) approximately foliaceous clubs, (*e*) oblong spicules with processes, (*f*) spicules resembling foliaceous clubs, but which have lost the shaft, they are heads or irregular spheres.

The spicules from the outer part of the axis are small rods, without processes, and usually slightly more expanded at their centres than at the ends. The dimensions of the spicules of the polyps in millimetres are as follows:—(*a*) straight spindles, from 0.04 × 0.013 to 0.010 × 0.013; (*b*) curved spindles, from 0.04 × 0.013 to 0.01 × 0.04; (*c*) clubs, from 0.045 × 0.02 to 0.08 × 0.03 mm.; the spicules from the coenenchyme of the internodes are from 0.04 × 0.03 to 0.07 × 0.04; those of the nodes are similar. This specimen comes near *W. variabilis*, Th. & Hend.; but is of a stronger build, and the polyps appear different.

Locality, etc.—Pieter Faure, No 11,125. Umkomass River mouth, N.W. by W., ½ W., 5¼ miles. Depth, 40 fathoms. By large dredge. Nature of bottom, broken shells and stones. Date, December 31st, 1900.

Wrightella fragilis, sp.n.

Plate II., Fig. 2; Plate V., Fig. 1

The specimen is extremely fragile, and the upper branches have unfortunately become broken, but a good drawing had been prepared, and there is sufficient material for a fair description of the species. The colony is white, with yellowish nodes. The surface of the stem and branches has a white, granular appearance, and where this has been rubbed off the axis is ivory-like white. The colony has at the base a slightly shrub-like appearance, owing to the branching of the main shoots not being in one plane, and there is also a slight anastomosis. Above the comparatively thick main shoots, the branches are apparently mostly in one plane, though it is impossible to say from the broken specimen whether the apical branches remain in one plane. The branches usually originate from the nodes, very rarely from the internodes. The nodes and internodes are clearly marked out, and the branching approaches dichotomy, but it is not quite regular. Some of the basal shoots are compressed, the apical are more cylindrical. Longitudinal lines may sometimes be observed on the surface of the branches. The nodes break up when scraped with a needle, and the colony is more liable to break at these parts than at the internodes. The structure of the nodes as seen in rough transverse section is: (1) an external layer with spicules, (2) a thick area within the last, consisting mostly of fibres, and (3) a central axial pillar, built of consolidated spicules. The structure of the internodes is similar to that of the nodes, but the fibrous layer is more sparsely and the calcareous part more prominently developed. The surface has a mass of spicules, which are disposed horizontally or radially to it, and form a feltwork, without leaving any intervening spaces. Within this outer layer of spicules the axis is much consolidated, appearing like a solid limy pillar. This consists of: (1) closely interwoven needle-like limy bodies, (2) a part with amorphous crystals, and (3) a very slight fibrous part. The axis may thus be regarded as mainly of lime. There are no endoderm canals.

No polpys occur close to the base of the colony, the first being about 25 mm. from it. The anthocodiæ are retracted in all cases. The size of the calyces varies considerably, but they stand out very distinctly from the surrounding surface; a large calyx is about 1.8 mm. in diameter, and 1.5 in height. The calyx, which is slightly yellow as compared with the rest of the coenenchyme, is 8-partite, and has a very dense layer of white or yellow spicules, producing a rough granular appearance. As regards the arrangement of polyps on the stem and branches, their origin from all the lower basal shoots is confined to three sides, the fourth side being free, though the lateral polyps may be seen from this side. Apparently there is not any regular arrangement of the polyps on the main shoots and minor branches; this is probably due to the fact that the growth of the shoots and branches is not straight, but is curved or even twisted. The calyces may be opposite or alternate, well remote from or closely adjoining one another; they usually arise from the internodes, but sometimes from the nodes.

The spicules of the coenenchyme are: (1) long, narrow, curved spindles, (2) long, narrow, curved spindles, (3) clubs approaching the foliaceous type, (4) clubs, (5) rod-like spicules, with two pairs of blunt processes on each side, (6) spicules, which with their broad processes, have an almost spherical shape, (7) simple rods, with rounded ends, but no processes.

The dimensions of these spicules is as follows:—(1) curved spindles, from 0.139 × 0.054 to 0.295 × 0.071; straight spindles, from 0.085 × 0.032 to 0.112 × 0.047 mm.; clubs, from 0.095 × 0.054 to 0.234 × 0.085 mm.; rod-like spicules with processes, from 0.081 × 0.040 to 0.1190 × 0.068 mm.; spicules almost spherical, 0.126 × 0.108 mm.; simple rods without processes, on an average, 0.090 × 0.013 mm.

In the polyps there are more long, narrow spindles than in the coenenchyme, and fewer clubs. The spindles are larger than those of the coenenchyme, namely, curved spindles, from 0.340 × 0.064 mm.; straight spindles, from 0.329 × 0.051 mm.

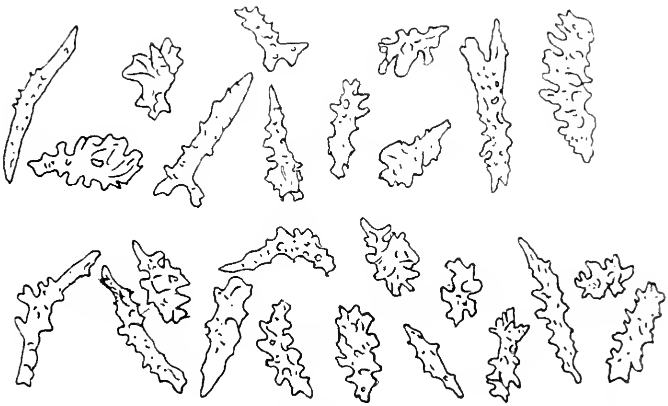
The specimen differs from *Wrightella coccinea*, Gray, recorded by Hickson, from South African waters, in its mode of growth, in the clubs not having such leaf-like processes and in the size and structure of the polyps. There is only a very brief description of *Wrightella chrysanthos*, Gray, collected by Dr. Percival Wright, from the Seychelles, but my specimen agrees with the diagnosis so far as that goes, and rather than create a new species, I hold it as belonging to the above.

Locality, etc.—Pieter Faure, No. 15,010. Lion's Head, S.E. ½ E., 49 miles. Depth, 210 fathoms. By shrimp trawl. Bottom, green sand. Date, April 2nd, 1902.

Wrightella furcata, sp.n.

Plate II., Fig. 1.

The specimens are so fragile that it is almost impossible to prevent their being broken, but fortunately a good figure had previously been prepared. The ground colour of the stem and branches is white, the nodes are yellow, the calcyces white or yellow, the tentacles red. The branching is almost entirely in one plane, is mostly dichotomous, with an occasional anastomosis. The main stem and branches have externally a hard, limy appearance. The colony has two main surfaces, one in which the polyps are well exposed, and the other in which the coenenchyme is mostly free from polyps, and in which the latter are only seen projecting as it were from the other side. The main stem and branches are mostly cylindrical, but the upper branches tend to become slightly flattened. The branches



Text-fig. 4. Spicules of *Wrightella furcata*, sp.n., upper, from polyps; lower, from external part of coenenchyme.

orginate, as shown in the figure in a forked manner from the nodes, and here and there a branch arises from a node and becomes connected with that from an adjoining node; in other parts, more especially in the upper parts of the colony, short simple branches may originate from the internodes. The internodes are white, finely granular on the surface, with faint longitudinal lines, and are shorter and thicker near the base of the colony than apically. At the base the main stem expands into a limy expansion, and the nodes are more prominent slightly above this lower extremity.

The polyps are mostly retracted, they consist of slightly dome-shaped 8-lobed calyces, with the tentacles which are provided with spicules, folded down over the openings. The polyps are arranged in two lines on the stem and branches, with a few intervening polyps between the two lines; they are shown in the figure fairly lateral in position, but so placed as to be seen better from the third than from the fourth side. The length of the internodes near the base of the colony is sometimes 7.5 mm., its diameter 2.8 mm., and apically the corresponding dimensions are about 12 mm. and 1 mm. The length of a basal node may be 3 mm., and its diameter the same; the size of an apical node is about 1.5 by 1.3 mm. The nodes are partly fibrous, partially spiculose, showing numerous small rod-like spicules. The older internodes seem entirely calcareous, but the younger have a fibrous axis.

The axis is not perforated by longitudinal canals. The internodes show small rounded rod-like spicules and other forms of spicules, and a solid calcareous part. The polyps are separated from one another by various intervals, sometimes about 1.5 mm. The calyces are about 0.5 to 0.75 mm. in height and diameter.

The spicules of the tentacles are narrow, red spindles, with spines; in one branch the spicules producing the colour of the tentacles are green. They are 0.072 × 0.018 to 0.288 × 0.036 mm.

The spicules of the calyx are (*a*) spindles similar to those of the tentacles but white, (*b*) broadened clubs, (*c*) ordinary clubs, and (*d*) irregular spicules. The broadened clubs are from 0.072 × 0.024 mm. to 0.144 × 0.081 mm. The spicules of the external part of the coenenchyme are (*a*) straight and curved spindles, with small processes, (*b*) broadened clubs, (*c*) approximately spherical spicules with broadened processes, (*d*) ordinary clubs, and (*e*) a few rod-like spicules without processes and rounded at each end. The spindles are from 0.108 × 0.027 mm. to 0.198 × 0.036 mm. The broadened clubs are from 0.054 × 0.036 mm. to 0.144 × 0.063 mm.; spherical spicules about 0.072; clubs from 0.090 × 0.036 to 0.126 × 0.054 mm.; rod-like spicules with processes about 0.072 × 0.036 mm.; rod-like spicules without processes about 0.090 × 0.009. There are small spicules similar to the last in the nodes, but in the internodes they are much more numerous.

After some deliberation I believe these specimens to be a new species of Wrightella, Gray. Six species of this genus have been previously recorded, namely, *W. coccinea*, Gray; *W. erythroea*, Gray; (*Mopsea erythroea*, Klünzinger); *W. variabilis*, Th. and H.; *W. chrysanthos*, Gray; *W. tongaensis*, Kük.; and *W. robusta*, Shann; the localities of which are the Red Sea, South Africa, Zanzibar, Seychelles, Tonga, and Singapore. Kükenthal holds that *W. Coccinea* and *W. chrysanthos* are the same, and that *W. erythroea* and *W. variabilis* belong to the genus *Acabaria*.

Localities, etc.—F. P., 12,238. Scottsburgh Light House, N.W. by N., 8 miles. Depth, 92 fathoms. By dredge. Nature of bottom, sand and shells. Date of collection, March 7th, 1901.

P. F., 13,158. Cape Morgan N. ½ W., 10½ miles. By dredge. Depth, 77 fathoms. Nature of bottom, rocks and broken shells. Date of collection, July 26th, 1901.

Wrightella, sp.

I have identified several fragments as belonging to this genus, the more detailed characters do not agree with other species of Wrightella which I have examined. I have made a number of preparations from these fragments, but in view of the incompleteness, prefer for the present neither to give a description nor to append a specific name.

Locality, etc.—P. F., 11,276-7. Tugela River mouth. N. by W., ¾ W., 21¼ miles. Collected by large dredge. Depth, 79 fathoms. Nature of bottom, rocks. January 9th, 1901.

Locality, etc.—Pieter Faure, No. 10,525. Cape St. Blaize. N. by E., 10¾ miles. Depth, 39 fathoms. Collected by large dredge. Nature of bottom, rocks. Date, October 24th, 1900.

Melitodid Fragments.

A few small fragments of a species of Melitodid which are not sufficiently complete for purposes of identification.

Pieter Faure, No. 12,063. O'Neil Peak, N.W. ¼ W., 9½ miles. Depth, 90 fathoms. Taken by dredge. Nature of bottom, broken shells. Date, Feb. 28th, 1901.

From this locality there are nine small fragments of one of the Melitodidæ, but the pieces are so small that any attempt at identification would only be like a shot in the darkness.

Pieter Faure, No. 852½. About 25 miles E. of East London. Depth, 22 fathoms. By shrimp trawl. Nature of bottom, mud. Date, Jan. 11th, 1899. From this locality there is a small fragment of a Melitodid, somewhat similar in superficial appearance to the last so far as the fragments allow one to judge, but it remains impossible to accurately identify the species.

Section Holaxonia.

Family, Isidæ—Sub-family, Ceratoisidæ.

Acanella eburnea, Pourtalès.

Plate I., Fig. 1.

The specimen is unfortunately broken, and the base is absent. The mode of branching in the lower part differs from that higher up, namely, in the former it is not in one plane, but in the latter this is approximately the case From a node some little distance from the base three branches originate, equidistant from one another, which diverge outwards, forming as it were an inverted tripod, and from the first node of each of these, three secondary branches arise. In a few cases four branches come off from a node. In the upper parts of the colony in which the branches are thinner, the nodes smaller, and the internodes larger, the branching is nearly in one plane, and from the nodes only one or two branches originate.

The lowest internode present in my specimen is 5.5 mm. in length and 2.8 mm. in diameter; a node from the same part is 2.5 mm. in length and 2 mm. in diameter. One of the upper internodes is 12 mm. in length and 1.5 mm. in diameter, and a node .5 mm. by .1 mm.

The polyps are large, usually originating from the internodes, and at wide intervals from one another, but in rare cases they may arise from or very near the nodes. The distance between them varies, it is sometimes 6 to 8 mm.; there is a slight tendency to their arrangement in a very wide spiral round the central cylindrical axis. The polyps do not originate from the axis at right angles, but in a slightly oblique direction, with their apices projecting upwards; their size varies according to the degree of extension from 1 mm. in height and 2 mm. in diameter near their bases to 3 mm. in height and 1.8 in diameter; in each case they are narrower at their apices. The pinnules of the tentacles can in a few cases be seen, but it is impossible to state their numbers.

The internodes are ivory white, marked by fine longitudinal lines, and with a thin coenenchyme; the nodes are horny, yellow or bronze, with a metallic lustre, and the polyps are white, brownish or pinkish white. The polyps are densely covered with long fusiform spicules, which seem to curve round their bodies, and eight specially large spicules project as points at the bases of the tentacles; the latter are provided with smaller spicules.

The spicules from all parts seem similar in shape, only differing in size; they may be grouped into long spindles and short spindles. These spicules have no processes such as have been figured by Wright and Studer for *Acanella arbuscula*, *A. chiliensis*, *A. rigida* and *A. simplex*. The spicules of my specimen are spine-like, not pointed at either end, and with almost entire margins. The size of the long spindles on the outside of the polyps is about 0.96 × 0.06 mm.; the short spindles from the tentacles and coenenchyme are about 0.24 × 0.04 mm. There can be little doubt that the spicules of my specimen and those of *A. eburnea*, as figured by Wright and Studer, are very similar; their margins are, however, more entire.

Locality, etc.—Pieter Faure, No. 12,850. Buffels River, N. 15 miles. Depth, 310 fathoms. Collected by shrimp trawl. Bottom, coral and mud. Date, April 24th, 1901.

From another locality at about the same depth, I have a second specimen of this species, which confirms my previous identification. In the first specimen I had some doubt about the identity of the spicules, as their margins appeared more entire. The second specimen has the majority of the spicules with margins exactly resembling those figured by Wright and Studer, but the interesting point is that some of them resemble those of the first example in having almost entire margins.

Locality, etc.—Pieter Faure, No. 12,658. Bashee River beacon, N. ½ E., about 15 miles. Depth, 300-400 fathoms. By shrimp trawl. Nature of bottom, rocks. Date, April 9th, 1901.

Family, Muriceidæ.

Acanthogorgia armata, Verrill.

This species has previously been recorded from South African waters by Hickson and by myself. The specimens are rather fragmentary, as they are brittle, and tend to become broken. A point to which I will give further attention later on is the occurrence of blackish spherical masses within the body of some of the polyps. The specimens were found in about the same locality as Hickson's specimen.

Locality, etc.—P. F., No. 2,567. Vasco da Gama. S.75° E. 13½ miles. Collected by large dredge. Depth, 166 fathoms. Nature of bottom, black specks. Date of collection, April 25th, 1900.

Acanthogorgia, sp.

Plate IV., Fig. 4.

The specimen is only fragmentary, and has been much rubbed. The axis is horny, yellow or brown. The polyps are long, cylindrical, and expanded towards the mouth. The spicules are usually curved spindles or club-like forms, forming eight longitudinal rows on the body wall of the polyp, each row consisting of pairs of spicules. At the base of the polyp, each spicule of these pairs is arranged at acute angles with the other, but higher up this changes to an obtuse angle, and finally the position of the spicules becomes altered so that they run round the periphery. The tentacles on retraction are bent over the mouth, and external to them are the circles of protective spicules already mentioned, and then eight far-projecting spicules forming an outermost circle.

The branching, so far as one can ascertain from the incomplete specimen, is in one plane. The central axis is about 1 mm. in diameter; the covering coenenchyme with its projecting spicules is very thin, and the axis can be seen through the tissue. The polyps at some parts are arranged in a spiral round the axis, and are usually closely adjacent to one another, with an interval of about a millimetre, but they are still more closely massed together at the apices of the branches. They are placed perpendicularly on their support, and are about 2.5 mm. in length, and 1.5 mm. in diameter.

The spicules are (*a*) simple curved spindles with only a few processes, about 0.34 × 0.02 mm. in size; (*b*) short club-like spicules, about 0.56 in length, and 0.16 mm. in diameter at the expanded end, and 0.02 at the narrow end, the broad end only bearing processes; (*c*) long spindles or club-like spicules projecting prominently at the apices of the polyps, with a long handle or shaft, without processes, and an expanded head armed with projections. This type of spicule is sometimes 1.14 mm. in length, 0.10 mm. in diameter at the expanded, and 0.04 at the narrow end; (*d*) various shaped spicules.

Owing to the fragmentary nature of the specimen, I have not been able to give this form a specific name.

Locality, etc.—P. F., 11,961. Cape Vidal, N.N.E. ¼ N., 9½ miles. Depth, 80 to 100 fathoms. By dredge. Nature of bottom, rocks. Date, February 27th, 1901.

Acanthogorgia, sp.

This specimen only consists of a small forked twig, and even this is not complete as part of the coenenchyme, and some of the polyps have been rubbed away, but there can be little doubt that it belongs to the genus Acanthogorgia. The spicules are similar to those of Pieter Faure, No. 11,961, but rather smaller. It would be rather incautious to give a specific name to this fragment. The specimen had also become dried during transit from South Africa.

Pieter Faure, No. 12,064. O'Neil Peak, N.W. ¼ W., 9½ miles. Depth, 90 fathoms. By dredge. Nature of bottom, broken shells. Date, February 28th, 1901.

Muricella ramosa, Thomson and Henderson.

Syn. *M. ceylonensis*, Thomson and Henderson.

The axis is brown or black, and is covered by a fairly soft coenenchyme with slightly protruding spicules, the base is expanded, and of a woody texture. The branching is in one plane. The polyps are thickly distributed, but they are irregular, as sometimes they are close together, at other parts separated by a wide interval. The anthocodiæ are in many cases extended beyond the calyces, the latter are minute. There is a slight degree of anastomosis between the branches. The mode of branching is very variable; as a rule the branches do not arise opposite one another, but are alternate, adjoining branches are very unequal in size. The colony is slightly fan-shaped. The upper branches are flexible.

The height of the specimens is about 14 cm., the breadth 10 cm. The large branches have almost as great a height and thickness as the main stem. The lower part of the main stem is cylindrical, the median very slightly flattened, and the upper similar to the lower, but reduced in size. The branchlets generally come off on two sides of the main stem or of the primary branches. The branchlets are cylindrical. The main stem and chief branches ascend in an undulating way. The branches commence to come off at 6 mm. from the base. The branchlets often arise at right angles. Short unbranched twigs arise from various parts, these are generally expanded at the end. The terminal twigs are blunt at the apices, and have two or more polyps at the extreme summits.

The length of the main stem is at least 12.5 c.m., the diameter at the base 2.5 cm., the length of a terminal twig 18 mm., its diameter 1-1.5 mm.

The polyps on the smaller branches and twigs are more thickly distributed on two sides, although they also occur to some extent on the other; still, one can distinguish a central area on which the polyps are less abundant—on the terminal twigs they are almost entirely bi-lateral. The polyps are usually placed at right angles to the surface, the larger are 1.8 mm. in height and 1 mm. in diameter. At the base of the polyps on the surface of the coenenchyme there are long spindles, easily seen with a lens; these are specially prominent on the upper branches and twigs, but apparently do not occur to any extent at the bases of the main stem and branches. The polyps consist of a minute calyx and a tentacular part, the former is hardly distinguishable from the superficial coenenchyme.

The arrangement of the spicules of the polyps consists of spindles arranged "en chevron" in eight longitudinal areas, beneath which spindles are arranged in a circular manner, and basally much larger and broader spindles are arranged in a vertical or oblique manner.

The axis is 3 mm. near the base of the main stem, and 1/10th of a millimetre in diameter in the apical branches; it is black near the base, brown towards the centre, and yellow at the apex of the colony.

The spicules of the polyps (including anthocodia and calyx) are small narrow spindles and larger broader spindles, the former range in size from 0.144 × 0.018 to 0.414 × 0.054 mm.; the latter from 0.360 × 0.090 to 0.630 × 0.108 mm., both of these types of spicules may be straight or curved.

The spicules from the coenenchyme of a main branch are also small and large spindles, straight or curved, the former ranging in size from 0.18 × 0.018 to 0.360 × 0.036 mm., the latter from 0.396 × 0.090 to 0.774 × 0.144 mm. The spicules from the superficial coenenchyme of the upper and smaller branches are similar to the last in shape, some of the larger spindles are as much as 1.080 × 0.162 mm. I have no hesitation in naming these specimens *Muricella ramosa*, Syn. *M. ceylonensis*. This species has been recorded from the Andaman Sea, Persian Gulf, Gulf of Manaar, off Galle and onwards up the West Coast of Ceylon.

Locality, etc.—Pieter Faure, No. 12,165. Durnford Pt., N.W. by N. 11 miles. Depth, 45 fathoms. By dredge. Nature of bottom, shells and stones. Date, February 28th, 1901.

Family, Plexauridæ.

Eunicella papillosa, Esper.

This is an incomplete specimen which I did not at first recognise as *Eunicella papillosa*, which has been previously recorded from South African waters.

The spicules of the calyces are (1) characteristic torch-like spicules, (2) double spindles, and (3) a very few long simple spindles. The torch-like spicules and the double spindles seem to be about equally abundant. The double spindles are usually larger than the torch-like spicules. The spicules of the coenenchyme are all or nearly all torch-like spicules. A few double spindles are seen in my slides, but they are comparatively few in number. The dimensions of the spicules are as follows:—From the calyces: (1) The torch-like spicules, from 0.0782 × 0.034 to 0.0952 × 0.0442 mm.; (2) Double spindles, from 0.1190 × 0.0476 to 0.1598 × 0.0646 mm. From the coenenchyme: (1) Torch-like spicules, from 0.0816 × 0.034 to 0.0918 × 0.0374 mm.; (2) Double spindles, from 0.0782 × 0.0442 to 0.1020 × 0.0408 mm.

Locality, etc.—Pieter Faure, No. 907. Off East London. Depth, 85 fathoms. By dredge. Date, June 28th, 1899. Pieter Faure, No. 457. Buffels Bay, False Bay. Collected by means of tangles. Date, October 13th, 1898.

Euplexaura parciclados, Wright and Studer.

This description is based on one specimen. It is slender throughout, has few branches, and is 10 cm. in height. A short slender stem, originating from a small encrusting base, divides into two secondary branches, from one of the latter four tertiary branches are given off, namely, firstly a short branch passing towards the outer side, then two branches arising almost opposite one another, and lastly a fourth branch towards the inside. The one secondary branch, after giving off these tertiary branches as described above, is continued on for a short distance in an upward direction, the other secondary shoot is apparently incomplete, owing to its being covered by epiphytic barnacles. The branches are mainly in one plane, and have a fairly uniform diameter throughout, though they sometimes expand slightly at their apices, and some have a medianly situated pointed part at the extremity.

The height of the central stem from the encrusting base to the origin of the first branch is 1.6 cm., the diameter of the same 2 mm. The tertiary branches (excepting those which are opposite one another) are separated by an interval of from

1.8 cm. to 2.4 cm. The encrusting base is small, 6 by 3 mm. in diameter, and the merest fraction of a millimetre in height, and is attached to a fragment of shell.

The axis is brown near the base, and yellow at the apex, it is about a millimetre in diameter in the main stem near the base, and very narrow in the highest branches. The coenenchyme is thin, rough and granular, with white spicules.

The polyps are numerous, thickly distributed on all sides of the branches, and commence at a low level on the main stem; they are sometimes separated from one another by an interval of 1 mm. The polyps and tentacles are brown, and have eight bands of needle-like spicules. The anthocodiæ can be retracted within the calyces, which are white, and only slightly raised above the surface until there is only a slight brown swelling, bounded by the calyx. The detailed structure of the stem and axis is as described by Wright and Studer for the genus Euplexaura.

The spicules of the coenenchyme and calyx are spindles, usually with two rows of warts, and a very few quadriradiate forms. The spicules of the polyps are needles or rods, with simple processes. The spicules are smaller than those described by Wright and Studer for this species. The spindles are from 0.06 × 0.05 to 0.14 × 0.06 mm. The needles are about 0.13 × 0.014 mm.

This species was collected during the voyage of the "Challenger," at two stations near Kobé, Japan, at depths of 8 and 50 fathoms. My specimen and its spicules are much smaller, but it otherwise agrees in all essential points with the "Challenger" specimen, leading me to regard this as a young form of *Euplexaura parciclados*, W. and S.

Locality, etc.—Pieter Faure, No. 13,581. Stalwart Point, N.N.W., 9 miles. Depth, 53 fathoms. By dredge. Nature of bottom, sand and shells. Date of collection, August 29th, 1901.

Family, Primnoidæ · Sub-family, Primnoinæ.

Stachyodes capensis, sp.n.

Plate III.

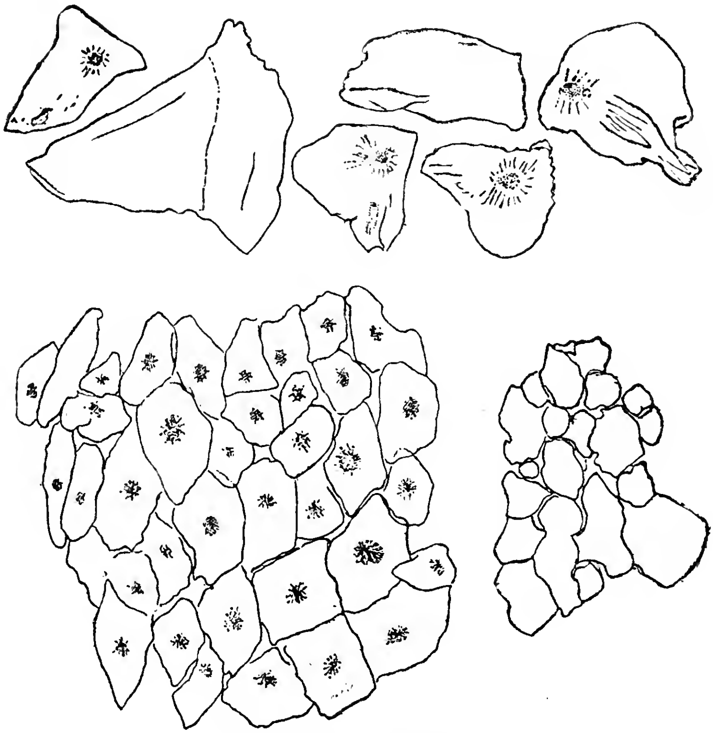
The polyps are arranged in verticils of seven to nine usually. In most cases there is an interval between the verticils. The oral openings face downwards. The branching is nearly dichotomous. Only rarely do the opercular scales of one verticil come in contact with the sclerites of the lower row of polyps.

This species is represented in the collection by one specimen and several fragments. The axis of the complete specimen is 8 cm. in height, about 2.8 mm. in diameter near the base, and 1 mm. near the apex. It is horny, yellow and iridescent, its surface has small grooves running in a circular direction, and its interior has a few calcareous particles. One of the two primary branches into which the main stem divides is dichotomous, the other not so regular. The verticils are closer to one another near the apices than basally; generally 5 verticils occur in a length of 15 millimetres. A point about some of the verticils is that they do not run straight round the axis, but in an irregular or slightly spiral manner. The coenenchyme between the lower verticils, and covering the basal stem, has scale-like spicules of varying shape and size, which fit closely into one another; some of the larger are 1 millimetre in length. The base of the colony is large, namely, 8 mm. in height and diameter. An interval of about a millimetre occurs between the lower verticils, the upper verticils being closer to one another.

The larger polyps are about 3 mm. in height, and 1.75 mm. in diameter. The body or dorsal surface is enveloped by three series of paired scale-like spicules, which overlap one another. The two ad-axials are thick, and hollowed out to form a hood-like part, those of right and left sides form a deep median, wavy, slightly oblique groove, where they meet one another. The median pair of sclerites is smaller, partly hidden by the ad-axials, and their outer borders are slightly sinuous but entire. The ab-axial pair is longer than the last, each sclerite slightly overlaps the other in the median line, and has an entire but slightly wavy margin, sometimes in contact with the polyp lying basal to it. The ad-axials only connect laterally with those of the polyps on either side. There are no sharp projections or spines on any of those sclerites. The exposed parts of the ad-axials are about 1.2, of the medials .75, of the ab-axials 1.1 mm. in length. These three pairs of plates correspond to the basal, medial, and buccal sclerites of Versluys. At the base of the polyp, and partly hidden by the ab-axials, are the opercular spicules, which are generally seven in number, and have frequently a wavy semi-triangular appearance; in some cases they almost come in contact with the upper spicules of the polyp beneath, but do not project beyond the ab-axial sclerites to any extent. The sclerites of the inner or ventral surface of the polyp and surrounding the axis are large, thick, and stone-like, they are very hard, and differ considerably in size. In one verticil of 8 polyps, 21 of these sclerites lay surrounding the axis. This layer of spicules is sometimes 1 mm. in thickness, and has 1 or 2 spicules at any one place, counting in a transverse direction.

The spicules of the coenenchyme near the base form a well-marked layer, a little less than a millimetre in thickness. They differ in shape and size, being quadrilateral, oval, pear-shaped, etc. and ranging from about 0.270 × 0.234 to 0.720 × 0.576 mm. At some parts they slightly overlap one another, at others there is a space on one side between them. The sclerites from the coenenchyme between the verticils are somewhat similar to the last, but are slightly more irregular, and more frequently with spaces between them; they range in size from about 0.270 × 0.324 to 0.90 × 0.54 mm. The opercular spicules vary in shape and size, some have a pointed, spear-like part projecting downwards; the larger, which are situated towards the outer side of the polyp, are about 1.53 × 1.17 mm., the smaller about 0.594 × 0.360 mm.

This species belongs to Kinoshita's Group I. of the genus Stachyodes, but I have been unable to identify it as belonging to any of the species already described.



Text-fig. 5. Sclerites of *Stachyodes capensis*, sp. n., upper, from operculum of polyp; lower left, from the coenenchyme near the base; lower right, from the coenenchyme covering the axis between the verticils in the upper part.

Locality, etc.—Pieter Faure, No. 13,159. Cape Morgan, N., ½ W., 10½ miles. Depth, 77 fathoms. By dredge. Nature of bottom, rocks and broken shells. Date, July 26th, 1901.

I have also identified some fairly large fragments as belonging to this new species, which show a considerable amount of variation from the above.

Locality, etc.—Pieter Faure, No. 13,490. Sandy Point, N., ¼ E., 10 miles. By dredge. Depth, 95 fathoms. Nature of bottom, rocks. Date, August 14th, 1901.

Family Gorgoniidæ.

Leptogorgia africana, sp.n.

Plate V., Fig. 7.

The specimen is yellowish or brownish in colour, and has numerous, densely distributed polyps, usually with prominent calyces. From the colour of many of the spicules of the coenenchyme, I am inclined to think that during life the colour was brighter, probably approaching red. The branching is mostly in one plane, and there is at one part a slight anastomosis. The coenenchyme is fairly thick, finely granular, and has a line or groove on two of the surfaces, which is more pronounced on the lower part of the colony.

The axis, which is fairly cylindrical throughout, is brown near the base, and yellow at the apices. It is composed of very closely interwoven fibres, but also gives a slight effervescence with hydrochloric acid. It is not perforated by canals, but the latter are present in the surrounding coenenchyme. In the centre of the axis of the apical branches, internal to the longitudinal fibres, there is a series of small oblong or square areas, arranged one beneath the other, in a vertical direction. No spicules occur in the axis.

The main shoots are compressed in one plane, so that there are two broad and two narrow surfaces; the diameter of one chief stem near the apparent base is 1.5 by 2 mm. At this more basal part the polyps are disposed up each side of the broad surfaces, and abundantly along the narrow sides, leaving a fairly bare space in the centre. In the more apical branches, however, the polyps are thickly distributed on all sides. The apical branches are sometimes 1.7 by 1 mm. in diameter.

The minor branches originate in a series from a central axis, and are either opposite or alternate to one another; they may have a slightly pinnate appearance. These minor branches varying considerably in length, some being half that of others, arise either at right angles or at slightly less than right angles, and do not terminate in a polyp, but in a small slightly pointed cone.

The polyp consists of raised calyces, out of which extend white tentacles, and beneath the latter a part of the anthocodia with red spindles. In cases in which the tentacles are withdrawn, the red portion only is seen at the apex of the calyx, and on further contraction a mere slit is seen surrounded by the calyx, the latter having sometimes a slightly two-lipped appearance. The calyces, which are usually prominent, being as much as three-quarters of a millimetre in height and diameter, give the specimen a slightly papillated appearance. It has, however, to be noted that they are also sometimes very small, being then reduced to minute elevations of the surface coenenchyme. The long diameter of the calyces in the contracted condition of the anthocodiæ is usually parallel with the long axis of the branch.

In my specimen the polyps are frequently expanded so that the tentacles are visible, and such zooids are about 1 mm. in height, and 0.8 mm. in diameter. They have on their external surfaces narrow, red spindles, which are placed longitudinally "en chevron" in eight groups. At about the centre of each of these eight groups there are four or five spindles, counting in a transverse or circular direction. At the bases of these eight groups there is a ring of red spindles, placed with their length at right angles to the length of the polyp, and forming a band round it. This ring consists of about 4 to 6 spindles at any one place, counting in a vertical direction. It was not possible to count the number of pinnules in the tentacles.

The distribution of the polyps varies in different parts of the specimen. As previously stated, near the base, where the stems are more flattened, the polyps are more abundant on two sides. At this part also there is a tendency to an arrangement of the polyps in a row along each side of the broad surface, with some polyps situated medianly and irregularly between the two rows, but this arrangement cannot be traced any distance. Near the apices there is a tendency towards a wide spiral arrangement, but it is rather irregular and indefinite.

The coenenchyme is fairly thick on the surface of the axis, near the base it is sometimes slightly less than a millimetre in thickness. It is slightly corky in texture.

The spicules of the coenenchyme are (1) double spindles, (2) simple spindles, straight or curved, (3) irregularly shaped spicules, such as quadri-radiate forms (rare), (4) a larger form of spicule more or less oblong, slightly scale-like, and provided with processes (this form is too rare to be taken into account, it may even be extraneous). The double spindles are from 0.032 × 0.030 to 0.102 × 0.047 mm; the simple spindles are from 0.095 × 0.040 to 0.164 × 0.051 mm.; the irregular spicules are about 0.061 × 0.037 mm.

The spicules of the calyces are of the same form and approximate size as those of the general surface of the coenenchyme. The red spindles or rods of the anthocodiæ are from 0.047 × 0.023 to 0.146 × 0.030 mm. The general dimensions are not given, as the specimen is incomplete.

This species has some resemblance to *Leptogorgia floræ*, Verrill, and also with *L. pulchra*, Verrill; but is apparently distinct from both.

Locality, etc.—Pieter Faure, No. 13,235. Cove Rock, N., ¾ E., 5½ miles. Depth, 43 fathoms. By dredge. Nature of bottom, stones and broken shells. Date, August 2nd, 1901.

Leptogorgia alba, Verrill; var. *capensis*.

There is one specimen of this species in the collection which is 15 cm. in height, and 10 cm. in breadth. The branching is in one plane. A cylindrical stem, rising from an expanded base, divides at a low level into two primaries, both of which give rise to branches of a second, third, or even fourth order in an irregular pinnate manner; the secondaries may be almost as strongly developed as the primaries; the branchlets may be opposite or alternate.

The main stem is cylindrical and the two primaries also, but above those the branches are clearly flattened in the plane of expansion, with the exception of the apical, which are almost round. The branches are generally not pointed at the apices, but are blunt or slightly rounded, and in most cases expand in diameter towards their apices. The secondary branches frequently arise from the primaries at angles of about 45°, and curve outwards, and then upwards and inwards, in a slightly sinuate manner. The secondaries are frequently separated from one another at their origin by intervals of about ¼ of an inch. At various points on the secondaries there are short tertiaries only about 5 mm. in length, which have a stunted, almost club-like appearance. The upper branches are flexible, but the specimen has a certain rigidity towards the base.

The axis is strongly developed, is brown or black near the base, and yellow towards the apex. The coenenchyme covering the axis is white and granular, but the colour of the axis shows through it.

The coenenchyme on the lower main stem is 1/10th to 1/20th of a millimetre in thickness, on the apical branches it is, comparatively speaking, thicker. The presence of longitudinal lines or grooves is very clearly marked on most of the two flattened surfaces of the stem and branches except at the apices. Five or six of these grooves occur on each of the flattened sides of the basal stem, but higher up they gradually become reduced in number.

The distribution of the polyps varies to some extent at different parts, but is mainly bilateral. On the lower stem and branches along each of the narrowed sides, there are usually two rows of polyps disposed in each of these, alternate to one another, but polyps also occur here and there on the flattened sides in a more irregular manner. The lateral polyps are separated from one another by an interval of ½ to 1 mm. On the apical branches, which frequently have a slightly curved or twisted course, the polyps are irregularly distributed on all sides.

The polyps are small, even when the tentacles are extended beyond the calyces, which is usually the case in my specimen; when they are retracted the opening of the calyx has a slightly oblong, two-lipped appearance.

The diameter of the basal stem is about 2.5 mm., that of a primary branch 2.5 by 1.2 mm., of an apical .5 mm.

The spicules are mainly double spindles, with large expanded processes; their size is from about 0.054 × 0.027 to 0.081 × 0.036 mm. They do not appear to be so markedly separated into two kinds as those described and figured by Verrill.

Locality, etc.—Pieter Faure, No. 12,164. Durnford Point, N.W. by N., 11 miles. Depth, 45 fathoms. By dredge. Nature of bottom, shells and stones. Date, February 28th, 1901.

Leptogorgia rigida, Verrill.

Plate IV., Fig. 3.

This form consists of (1) a large, basal, encrusting part, with a massive brown axis, (2) a short main stem, which divides at a height of 18 mm. into (3) two primary branches, the latter giving rise to secondary and tertiary branches. The branching is in one plane. The specimen is reddish-yellow in the upper branches, but red in the main stem, and the branches immediately above that. The calyces differ in shade from the general superficial coenenchyme, and the tentacles are white, or pale yellow. The specimen has a slightly fleshy appearance, though the coenenchyme is not thick, as in such forms as *Gorgonia flammea*.

The height of the specimen is about 8.3, the breadth 6.5 cm. The basal encrusting part is 6.5 mm. in height—resting on a stone, and is 11 by 8 mm. in diameter. The main stem is 3 by 2 mm., and its axis is 1.75 by 1 mm. in diameter. A branch about the middle of the colony is 2 by 1.2 mm. in diameter, and slightly larger at the apex.

The main stem and branches are flattened in one plane, and this compression is specially well marked on the lower part, but towards the apices it is not so obvious. The branches are rather brittle, though fairly thick, and their apices are not pointed, but broad and almost straight at the extreme end. Three or four polyps generally occur near the apices of the branches. There is apparently no rule as to the mode in which the minor branches are disposed in regard to one another, they are not systematically either opposite or alternate. There is no anastomosis in this specimen.

The coenenchyme is about 1/6th to 1/10th of a millimetre in thickness on the surface of the axis, but varies slightly in different parts, and appears to be thinner on the surface of the primary stem. The surface of the coenenchyme is studded with partially projecting spicules.

The axis is horny, brown in colour throughout, and remains fairly thick, even at the apices of the branches.

The calyces are fairly prominent, but vary according to the degree of contraction; sometimes they are reduced to minute elevations of the superficial coenenchyme. The aperture at the apex of the calyx generally remains open, and is oval in shape. These openings are generally 1 mm. in length, and slightly less in breadth. In some cases the tentacles, which are white or yellow, are still seen projecting beyond the calyx.

On all the lower parts of the colony, the polyps are disposed on the two narrower sides of the stem and branches, and a space free from polyps is thus left on the two broader and flatter sides, which is sometimes 2 mm. in breadth; on the latter two surfaces there is a faint longitudinal line or groove. Nearer the apices of the branches, the polyps tend to be disposed on all sides, though they are still mainly bi-lateral in arrangement. The lateral polyps are sometimes separated from one another by an interval of .5 to .75 of a millimetre.

The spicules of the coenenchyme are small double spindles, with wart-like processes or tubercles. They are almost invariably of this type, but exceptionally there are crosses and simpler forms of spindles. The size of the double spindles is from 0.05 × 0.04 to 0.08 × 0.054 mm. These spicules of the coenenchyme are usually red.

The spicules of the calyces are also mostly double spindles, very similar to those of the coenenchyme, but with slightly more rounded processes, and yellow in colour.

The spicules of the tentacles and anthocodiæ are narrow spindles or rods, with a few simple processes; they are about 0.08 × 0.02 mm. in size, and yellow in colour. Verrill has recorded this species from the West Coast of America, near Cape St. Lucas.

Locality, etc.—Pieter Faure, No. 907. Off East London. Depth, 85 fathoms. By dredge. Date, January 28th, 1899.

Leptogorgia aurata, sp.n.

Plate I., Fig. 5; Plate IV., Fig. 2.

The colony is fairly flexible, and the branching in one plane. The main axis, which is expanded at the base, divides at a low level into two. The smaller of these two primary subdivisions gives rise on one side only, firstly to simple non-divided branches, and then to a compound branch. The branches have two more or less rounded or blunt lobes, which may be due to regrowth after injury to the part. The second of the two main sub-divisions divides into two, each of which gives rise to simple and to forked or compound branches. The upper branchlets of this second part of the colony are connected with one another at rare intervals, by a simple anastomosis. The branching is neither dichotomous nor regular, as apparently any lateral offshoot may grow to greater dimensions than the others. The branches rarely arise opposite one another, they tend to originate mostly on one side towards vacant space. The axis is brown or black in colour, and cylindrical in that part of the colony immediately above the slightly expanded base, which is free from polyps. The axis of the colony is hard and horny, and its expanded base is light brown in colour. Above the main shoot the branches are slightly flattened but towards the apex of the colony the branchlets tend to become more cylindrical. On the lower branches the polyps are mainly confined to two sides (the smaller or lateral sides), and thus there is a fairly large median area without polyps. Towards the apex of the colony, the polyps tend to become more uniformly disposed on all sides, especially is this the case in the smallest terminal branches. Clearly defined grooves or lines (5 or 6) are present on the lower part of the colony, on those surfaces free from polyps. These grooves become much less obvious towards the apices of the branches, and there only one or two lines occur, or they may be absent. These lines are clearly visible to the naked eye, especially on the lower part of the colony.

The colony is about 13.2 cm. in height, and 14.2 cm. in breadth. The height of the main axis previous to the origin of any branches is 2.65 cm., and its diameter at the middle 2.5 mm. The primary branches which originate from this have a diameter of 4 mm., including the polyps, and 2 mm. without the polyps. The bare areas without polyps on the lower branches are about 2 mm. wide. The apical branches are about 2 mm. in diameter, including the polyps.

The distribution of polyps is as stated above, but even near the base polyps occur occasionally on the surface of the coenenchyme, which is usually free from polyps; on the other two surfaces the calyces are slightly elongated in the direction of the long axis of the colony, and the openings are slightly slit-like in appearance. In most cases the polyps are not completely retracted, and the tentacles may be seen in white, relieving the yellow ground colour of the calyces and coenenchyme.

The distance between the polyps varies, sometimes they are separated by an interval of 1 millimetre, at other times they are so closely adjacent as to be only a fraction of a millimetre apart. The polyps may measure 2 mm. in one diameter, 1.2 mm. in another, and 1.2 mm. in height. In the polyps situated on the apical branches the opening is easily seen lying longitudinal to the long axis of the branch. The longitudinal grooves or lines on the lower part of the colony are about 1 mm., and the slight elevations between them about .7 mm. in breadth. The encrusting base measures 11 mm. in diameter and 3 mm. in height. The coenenchyme covering the central cylindrical axis is about 0.1 mm. in thickness, and does not increase to any extent in the higher reaches of the colony.

The surface of the colony is densely covered with small spicules. On close examination it is seen that the longitudinal grooves have a smaller number of spicules than the elevations between them. Two of the branches end in apical swellings, on which the polyps are thickly distributed; one of the swellings is 7 by 6 mm., the other 9 by 6 mm.; these may possibly be due to regrowth after injury.

On that part of the basal column which has no polyps there is a curious cup-like swelling. This is 8 mm. in length, 6 mm. in breadth, and 4 mm. in height. The wall of the cup is fairly hard, and evidently an out-growth of the axis. The entire structure is probably an abnormality. The spicules of the cortex are as follows:—Spindles from the cortex with wart-like processes in whorls, from 0.075 × 0.041 to 0.090 × 0.036 mm.; spindles from the cortex with wart-like processes irregularly disposed, from 0.072 × 0.037 to 0.090 × 0.037 mm.; smaller spindles with irregular wart-like processes, from 0.037 × 0.027 to 0.055 × 0.037 mm. The spicules of the polyps are fairly similar in size.

The original diagnosis of the genus Leptogorgia, by Milne Edwards, was:—"Les espèces à axe non calcifère, dont le coenenchyme est pelliculaire c'est-à-dire très mince, et d'un tissu serré et dont les calyces n'ont pas les bords saillants. Elles se distingue donc des Gorgones proprement dites, par l'absence de verrucs calcifères et s'éloigne des Plexaures par la disposition du coenenchyme; qui, ches ces derniers est remarquablement épars et d'une texture subéreuse." Verrill (1867-71) defined the genus as follows:—"Spicula of the coenenchyma mostly small double spindles of two forms, longer and shorter. Branches usually slender, sub-dividing in various ways; often reticulate, pinnate or bipinnate. Cells usually prominent, sometimes flat, mostly in lateral rows or bands." In the "Challenger" Report Wright and Studer give the following definition of this genus:—"The colony varies greatly in form, but is more or less ramified in one plane. It often exhibits a net-like structure from an anastomosis of the branches. The polyps sometimes form short verrucæ, and sometimes are completely retracted into the coenenchyma. They are usually disposed in two lateral rows, having between them the naked coenenchyma. Upon the surface of the latter the courses of the larger tubes are indicated by longitudinal depressions. The spicules are usually minute double spindles of variable length."

Close on forty species of the genus Leptogorgia have been recorded, and I have felt reluctant to add another to the long list, but I hold this to be a new species. Thomson and Henderson give a description of *Leptogorgia ochracea* which in some respects is similar to this species. The apices of the branches are, however, more pointed in *Leptogorgia ochracea*, the calyces are smaller, and the spicules are larger than in my form. Thomson and Henderson's description and figure are taken from a dried specimen, but on drying part of my example it is still obvious that it does not agree with their species.

Locality, etc.—Pieter Faure, No. 12,164. Durnford Point, N.W. by N., 11 miles. Depth, 45 fathoms. By dredge. Nature of bottom, shells and stones. Date, February 28th, 1901.

Leptogorgia, sp., juv.

A young specimen which belongs to the genus Leptogorgia.

The characters are those of the genus, but I hold that it would be a mistake to give this small specimen a specific name.

Locality, etc.—Pieter Faure, No. 10,880. Umhloti River mouth, N. by W., ½ W., 8½ miles. Depth, 40 fathoms. Taken by large dredge. Nature of bottom, sand and shells (hard ground). Date, December 18th, 1900.

Lophogorgia lutkeni, Wright and Studer.

Plate I., Fig. 2.

The specimen is not complete, but there is a main axis from which branches arise on two sides, some of which remain simple, and others divide and re-divide. There is a sinuous line running up the flat side of the main stem and on most of the branches, but it is never very prominent, and on the terminal branches becomes indistinct or disappears. The polyps are situated on each side of this line, and when retracted form a slit. The main stem and branches are flattened in the plane of expansion, but the terminal ones are more rounded, and the polyps tend to be distributed on all sides. On the flattened sides, the polyps frequently stand opposite one another. There is a slight anastomosis of the branches, and the terminal ones are slightly expanded at the tips, where two or more polyps are situated. The coenenchyme covering the axis is not thick, and it is finely granular. The axis is brown and flattened near the base, but yellow and more rounded in the upper parts of the colony. The main stem is not, but the upper parts are distinctly flexible. The branches from the main axis do not as a rule originate opposite one another. The main stem is not straight, but has a more or less sinuate form. The calyces are only very slightly raised above the surface of the coenenchyme.

The spicules agree exactly in shape (even to the needles, with short processes in the tentacles) with these described for this species by Wright and Studer in the "Challenger" volume. The specimen is a more typical example of *Lophogorgia lutkeni* than that described by Thomson and Henderson from Ceylon. The spicules are, however, smaller than in Wright and Studer's example. The smaller spindles are from 0.034 × 0.030 to 0.044 × 0.030 mm. The larger spindles are from 0.075 × 0.040 to 0.087 × 0.054. In Wright and Studer's specimen the spicules of the coenenchyme are from 0.2 × 0.04 to 0.34 × 0.02 mm. It is necessary to give a further description, as the specimen essentially agrees with that of Wright and Studer.

Locality, etc.—Pieter Faure, No. 15,724. Off Gordon's Bay, 6-14 fathoms. By dredge. Nature of bottom, rocks. This species has been previously recorded from Prince Edward Island, Zanzibar, Ceylon, and the Gulf of Kutch (Kathiawar Peninsula).

Gorgonia flammea, Ellis and Solander.

Plate I., Figs. 3 and 7; Plate IV., Fig. 6.

The specimen is incomplete. The basal branches are flattened, the upper branches cylindrical, the white polyps occurring profusely on all sides. The branching is in one plane, and the branches do not as a rule stand opposite one another; they are flexible, and do not anastomose. The specimen is well expanded, the mouths of the polyps are frequently open, and the tentacles and pinnules are well extended. The coenenchyme is thick, and this gives the colony a fleshy appearance. The surface of the coenenchyme is only very slightly granular. The horny axis is black near the base, but brown in the upper parts of the colony. The specimen is only part of a colony, and therefore general measurements are not given, but we know that this species may grow to an immense size. The coenenchyme is sometimes about 1.5 mm. in thickness. The distance between the expanded polyps varies slightly, in some cases it was about 1 mm. The apices of the branches are not pointed to any extent, but are more or less rounded, about four polyps usually occur at the apex of a branch. The polyps are apparently arranged in close-set spirals, and the openings through which the white polyps protrude are circular or oval in shape. There are, apparently, no spicules in the polyps, about ten pairs of pinnules occur in each tentacle. The calyces are only minute non-differentiated elevations of the surface coenenchyme, which cannot be distinguished with the naked eye. The horny axis apparently remains flat throughout the different parts of the colony. The spicules are double spindles, and their length is about 0.06 mm.

Locality, etc.—Pieter Faure, No. 706. Lat., 33° 53′ 15″ S. Long., 25° 51′ 45″ E. Depth, 26 fathoms, by large trawl. Nature of bottom, sand. December 6th, 1898. P. F., 18,381. Flesh Point N., $\frac{3}{4}$ W., $6\frac{1}{2}$ miles. By large trawl. January 15th, 1904.

As there are no really good figures of well-preserved examples of this species I have pleasure in using the beautiful sketches made by the late Mr. Davidson at the University of Aberdeen.

Gorgonia albicans, Kölliker.

From Gordon's Bay. Depth, 6-14 fathoms. Collected by dredge. Nature of bottom, rocks. Date, October 20th, 1902.

This species has already been recorded by Hickson from Port Alfred and Cape St. Blaize.

Gorgonia, sp.

Plate IV., Fig. 7.

A single incomplete specimen of a yellow Gorgonia. It has a soft, fleshy appearance, due to the thick coenenchyme. The tentacles are white, and are in some cases extended beyond the calyces. The lower main branches are slightly flattened, the upper are rounded, and with small apices. The axis is horny, and yellow or brown in colour. The calyces are prominent and very numerous, being scattered over the surface of the coenenchyme with little interval between them, except in the lower part of the colony. The base has unfortunately been broken away and lost, but a line or groove is seen in the centre of two of the lower main branches for a short distance. The branching is mainly in one plane, and there is no anastomosis. As far as one can judge from the incomplete specimen, the mode of branching is as follows:—Two main primary branches give off secondary branches on either side, which may be simple and unbranched, or they may divide up and give rise to tertiary branches, the latter also in some cases sending out quaternaries. The surface of the coenenchyme is yellow, and has a granular appearance produced by the yellow spicules. Any statement as to general size is in this case of little value, as the colony is obviously incomplete. The diameter of one of the two main stems is 3.5 by 2 mm.; the diameter of a branch near the apex less than 1 mm.; the calyces may be 1 mm. in height and 1.5 mm. in diameter. The calyces are separated from one another by the merest fraction of a millimetre, the tentacles in some cases extend .75 mm. beyond the calyx. The coenenchyme covering the horny axis near the base is about .8 mm. in thickness. The spicules from all parts of the colony are fairly similar, namely, double spindles, spicules of a club-like form, simple spindles (a few), and irregular spicules (rare). The double spindles range from 0.075 × 0.045 to 0.117 × 0.0396 mm. The club-like spicules of the coenenchyme from 0.10 × 0.065 to 0.127 × 0.054 mm. The irregular spicules and simple spindles are about 0.099 × 0.081 mm. This species comes near *Gorgonia dubia*, Th. and Mac. These authors write, "There is no trace of anything resembling the 'scaphoid' spicules described as characteristic of the genus Gorgonia. In this respect our genus comes nearest to *Gorgonia oppositipinna*, Ridley, and *G. australiensis*, Ridley, where the spicules are mainly whorled spindles, the scaphoids being only slightly developed." *G. dubia* resembles my species in the calyces occurring all over the stem and branches irregularly and in spirals, both are shallow water forms, but the coenenchyme of *G. dubia* is described as thin and white; in my species it is fairly thick and yellow in colour. As my specimen is incomplete, I do not give it a specific name, but as it was collected near Table Bay probably another example will be found later, and the doubt as to its identification will be settled.

Locality, etc.—Pieter Faure, No. 2,887. Robben Island, N.E., ¾ N., 3 miles. Depth, 27 fathoms. By large dredge. Nature of bottom, coral, sand, shells and rocks. May 30th, 1900.

Eugorgia Gilchristi, Hickson.

At first I thought that these specimens belonged to the genus Euplexaura, but the absence of canals round the axis led me to revise my first identification.

The specimens are yellow or orange red, they are branched in one plane, and are fairly flexible. A main stem, arising from a slightly expanded base, after a short upward course divides into two, and these in their turn give rise to branches, and the latter to branchlets. The branches are not straight, but irregularly curved or twisted, they would be cylindrical except that the polyps originate on all sides, and give them a papillated appearance.

The axis is dark brown near the base, and covered by a thin coenenchyme, higher up it is light brown or yellow, and covered by a thicker coenenchyme.

The specimens vary in appearance at different parts, owing to the degree to which the polyps are contracted; at some parts the branches appear papillated, owing to well developed calyces showing on all sides, with minute longitudinal slits at their apices, at other parts the surface of the coenenchyme appears much more uniform, owing to the calyces being more depressed, and in some such cases deep red blotches of colour may be seen, which are due to the red spicules of the tentacles. The polyps or calyces are crowded over the entire surface of the coenenchyme of the branches, and there is some indication of a spiral arrangement, which is, however, of too close a nature to trace out.

The coenenchyme is finely granular, and has apparently no lines or grooves on its external surface, but the calyces are so closely approximated that there is little free intervening space.

The branches expand at their apices sometimes to quite a considerable extent, they do not end in a pointed manner, but are blunt or rounded. As previously stated, the calyces vary in size, according to the degree of contraction from minute almost imperceptible elevations to fairly prominent mound-like swellings; in the first case, their openings with the tentacles are about 1/20th of a millimetre in diameter, in the second case their diameter is about 2 mm., and their height from ½ to 1 mm.

The larger specimen was about 8 cm. in height and 6.2 cm. in the plane of expansion. The diameter of a branch, including the calyces, near the centre of the specimen is about 2 mm. The horny axis is flexible, and its centre is of a different colour from the periphery. The axis of the main stem is 1/20th of a millimetre in diameter, the axes of the terminal branches are thin and thread-like, and have a comparatively thick coenenchyme covering them. The second specimen is smaller, and pure yellow in colour, it is approximately 6 cm. in height, and 4 cm. in diameter; both of the specimens were to some extent concealed by a growth of Porifera and Polyzoa.

Rough transverse sections through a branch show the yellow circular axis in the centre, and surrounding this, three or four cavities containing the anthocodiæ. These cavities are closely protected by spicules which extend inwards towards the axis, but do not invest the latter. The anthocodiæ are completely retractile within the calyces, and the tentacles are marked out by prominent narrow, red spindles, which differ from those of all other parts of the specimen.

The spicules of the outer and inner coenenchyme, and of the calyces, are similar in shape. They have the following forms and dimensions in millimetres:—(1) spindles, with five transverse rows of broad tubercles, about 0.12 × 0.04; (2) spindles of about the same size, but instead of broad tubercles having simpler spines or processes; (3) spindles of the first kind, but with only two rows of broad tubercles, and measuring about 0.08 × 0.04: (4) double wheels (only a few), .04 × .06; (5) a few crosses or stars, and double crosses; (6) long, narrow spindles of the tentacles, with simple processes, about 0.26 × 0.02. The spicules of this specimen are difficult to classify, they vary so much.

In spite of the difference in colour and some other points, I identify these specimens as young forms of *Eugorgia Gilchristi*, Hickson. They were found at the same depth, and in similar ground to those of Hickson.

Locality, etc.—Pieter Faure, No. 618. S.S.W., from Cape Recife, 52 fathoms. Taken by dredge. Nature of bottom, rocks and coral. Date, November 14th, 1898.

Eugorgia lineata, sp.n.

Plate II., Fig. 3; Plate V., Fig. 2.

This description is based on six white specimens. The branching is in one plane, but neither dichotomous nor regular. The axis is thick, horny, non-calcified, brown or black in colour, and the coenenchyme covering it is thin. Longitudinal slightly wavy lines occur on the surface of the coenenchyme of the lower and chief shoots, which are only slightly developed on the upper branches. Anastomosis is rare, being confined to only a few of the branches. The upper branches of the colony are slightly flexible, and their axes when stripped of the white coenenchyme, yellow in colour. The calyces of the polyps occur only as very minute elevations, and the latter are not numerous near the base of the colony. The lower main branches are slightly flattened, but the apical are rounded; on the flattened ones the polyps are slightly more numerous on the narrowed sides. On the more flattened basal branches, the number of longitudinal lines appears to be about five in number, higher up this number decreases, and the polyps also become more equally distributed on all sides towards the apices of the colony.

The axis of the colony expands into a basal attaching part, which is 7 by 7 mm. in diameter, above this it gives off laterally disposed branches almost at once. The axis near the base is brown or black in colour, and extremely hard. Its surface is very smooth, and shows very faint longitudinal lines or striæ. In the flexible apical branches the axis is extremely thin, and has a thickness of less than 1/10th of a millimetre. There is no clear distinction into nodes and internodes.

The branches vary considerably as to their mode of origin, their length, and the number of polyps. They may be simple or compound. One distinguishes in the colony several predominant shoots, which give rise to simple and compound branches, the latter giving rise to undivided branchlets, or to branchlets which may in their turn divide. There is also a rare anastomosis between branches which are fairly remote from one another in point of origin. The simple may come off opposite one another, or nearly opposite one another, or they may be alternate, and the same holds for the compound branches. The simple branches vary in length from 2 mm. up to 34 mm. The longer branches are not as a rule expanded at the end, but the shorter ones are, and thus have a knob-like appearance at the apices.

The dimensions of a colony may be 16 cm. in height by 10.5 cm. transversely. The polyps are very numerous and thickly distributed, the better expanded appear as oval (white) elevations (the calyces) whose long diameter is as a rule in the direction of the long axis of the branch or shoot on which they are situated, though this is not always the case; the opening surrounded by the apex of the calyx appears open in many cases, and the tentacles may be seen within as a whitish or yellowish mass. The calyces project only very slightly beyond the general surface of the coenenchyme. The distance between adjoining calyces varies considerably, sometimes it is about 1 mm. A fairly well expanded polyp is about 2 by 1.5 mm. in diameter, and 1 mm. in height.

The coenenchyme covering the axis is about 0.1 mm. in thickness. The entire surface of the colony is covered with small white spicules. The spicules of the polyp are spindles with tubercles, double wheels, rough stars, warted spheres, crosses, and some more irregular spicules. The spicules of the coenenchyme are similar, but there are not so many, or any of the longer narrow spindles. The long spindles are 0.09 × 0.02 mm. The double wheels are about 0.063 mm. in length, the stars or warted spheres are about 0.045 mm.

This species is distinguished from *Eugorgia Gilchristi* by the calyces being here very much less prominent, by the basal branches being compressed, by a thinner coenenchyme, and other characters. It does not appear to agree with any of the species of Eugorgia described by Verrill. Verrill's diagnosis of the genus is as follows:—" Coenenchyma composed chiefly of three forms of small spicula, which are naked at its surface. There are two kinds of warty double spindles—longer and usually sharper ones, and stouter and blunter ones. These are intermingled with numerous double-wheels, which are usually shorter; sometimes one of the wheels is shorter than the other, or rudimentary, frequently there are four wheels developed. The polyp-spicula are small, slender spindles. The axis is horny. Branches either round or compressed, variously sub-divided, much as in Leptogorgia, surface finely granulous. Cells mostly in a band along each side of the branches, sometimes prominent, usually flat."

Locality, etc.—Pieter Faure, No. 210. Cape St. Blaize, S.W. by W., $\frac{1}{4}$ W., $6\frac{1}{4}$ miles. Depth, 15-18 fathoms. By dredge. Date of collection, July 15th, 1898.

A large example of this species measuring 30 cm. in height and 11-12 cm. in breadth. The specimen is not complete, and shows that this species grows to a large size. The spicules agree with those from the Cape St. Blaize specimens.

Locality, etc.—Pieter Faure, No. 14,080. Nanquas Peak, N. $\frac{3}{4}$ E., $7\frac{1}{2}$ miles to Nanquas Peak, N.E. by N. $\frac{3}{4}$ N., 7 miles. By large trawl. Depth, 50 fathoms. Bottom, mud and sand. Date, November 13th, 1901.

Stenogorgia capensis, sp.n.

Plate I., Figs. 4 and 7; Plate IV., Fig. 5.

This species is represented in my collection by two specimens from Algoa Bay. The axis is entirely horny, showing concentric layers of fibre in transverse section. The specimens are red or pink, with yellow polyps. The colony consists of a main stem, flattened near the base, which gives off branches on either side. In the larger specimen the primary branches are fairly equal on each side of the main stem, but in the smaller specimen they are much more developed on one side than on the other. These primary branches may be simple or undivided, but more usually they give off a series of secondary off-shoots, the latter in a few cases giving rise to others of a third or fourth order. Polyps are situated on the main stem, but for about half its length these are chiefly confined to two sides, namely, those from which the branches arise, the other two sides remaining more or less free from polyps. In the upper part of the colony, however, the polyps are more uniformly distributed on all sides, the bilateral arrangement disappearing. The branches from the main stem do not, as a rule, arise opposite one another. The apices of the branches are frequently slightly pointed, several of the secondary branches, however, have rather a stunted appearance, and terminate in a lobe-like manner. In the lower part of the colony, the main stem is flattened, but in the upper parts it tends to become more and more rounded. The lower primary branches are also flattened, but this flattening rarely occurs among the branches of the upper part of the colony.

The calyces are prominent on all parts on which polyps occur, and their spicules are redder and more abundantly disposed than on the rest of the surface. The polyps can be retracted almost entirely within the calyces, but in most cases, even when the opening is reduced to a small slit, a little of the tentacles can still be seen within the aperture. In the contracted condition the openings of the polyps are grooves, whose long axes are usually parallel to the long axes of the stem or branches on which they are borne. These grooves, when the polyp is contracted, are bounded by lip-like swellings. The polyps vary in my specimens in the degree to which they are expanded, in the best cases the tentacles are not completely extended; they are dark yellow, brown, or red in colour. The polyps on the branches are fairly closely approximated to one another, especially near the apices.

The branches are slightly flexible, the coenenchyme is thin, with a granular appearance, due to the spicules, which are easily seen with a lens lying scattered on its surface. The two specimens differ slightly in colour, one having white and the other red spicules. The spicules are large, and there are usually slight spaces between them.

The dimensions of the specimens are as follows:—The larger colony, 8.5 by 6.5 cm.; horny axis near the base, 1.5 mm. in diameter; the calyx, from 0.5 to 0.75 mm. in diameter; the smaller colony, 6.8 by 5.0 cm.

The spicules of the coenenchyme are spindles, clubs, and minute irregular spicules. The spicules of the tentacles are long spindles arranged in eight areas, giving the colour to the tentacles. The spicules of the calyces are double spindles, clubs, and small irregular spicules.

The size of the spicules is as follows:—(*a*) The spicules of the coenenchyme: spindles, from 0.0756 × 0.045 to 0.1170 × 0.0396 mm.; clubs, from 0.10 × 0.0658 to 0.127 × 0.054 mm.; irregular spicules, from 0.090 × 0.081 mm. (*b*) Spicules of the calyces and polyps: double spindles, from 0.054 × 0.027 to 0.126 × 0.039 mm; clubs, from 0.081 × 0.054 to 0.121 × 0.054 mm.; simple spindles of tentacles, from 0.072 × 0.021 to 0.126 × 0.027 mm.; small irregular spicules, about 0.054 × 0.0342 mm. The type of this genus was described by Verrill under the name *Stenogorgia casta*. N. Lat., 31° 48′ 50″. W. Long., 77° 51′ 50″. Five other species have been described, namely, *Stenogorgia rosea*, by Grieg, from Norway, in 1887; *Stenogorgia miniata*, Studer, from the Azores, in 1901—Syn. *Gorgonia miniata*, Valenciennes, 1855—Syn. *Gorgonia miniata*, Milne-Edwards et Haime, 1857—Syn. *Gorgonia miniata*, Pourtalès, 1868; this species has also been recorded by Nutting, from the Antilles, in 1910. *Stenogorgia ceylonensis*, Thomson and Henderson, from the Indian Ocean, in 1905; *Stenogorgia Kofoidi*, by Nutting (1909), from the Californian coast, off Point Pinos Lighthouse; *Stenogorgia Studeri*, by Nutting (1910), from the Siboga Expedition, Station 310-Lat., 8° 30′ S. Long., 119° 7′ 5″ E., 73 metres. Verrill's diagnosis of the genus is as follows:—"Axis horny, branched. Coenenchyme thin, consisting chiefly of small, warty fusiform spicula, with a few smaller, short, irregular, rough, granule-like spicula next the outer surface, but not forming any regular layer. Calicles scattered or two-rowed, more or less prominent, eight-rayed at summit, and filled with spicula, like those of the coenenchyma. Tentacles filled with fusiform spicula and mostly incurved, commonly not retracted within the calicles, but capable of it."

Locality, etc.—Pieter Faure, No. 608. Near Roman Rock, Algoa Bay. By dredge. November 11th, 1908.

Family, Gorgonellidæ.

Verrucella bicolor, Nutting.

Plate V., Fig. 6.

The specimens are yellow, orange yellow, or almost red in colour. The branching is nearly in one plane. The size varies from about 3.2 cm. by 1.5 cm. to 4 cm. by 4.5 cm. The specimens expand at the base into an encrusting part, from which a short main stem ascends, and gives rise to primary branches, mostly in one plane; the primary branches give rise to secondary, and these to tertiaries, but the branching is not quite uniform in different specimens. The main stem is about 2 mm. in diameter, and has no polyps. The diameter of the upper branches is about the same as that of the primary stem. The branches usually originate at acute angles. The axis is expanded at the points at which the polyps originate, and when the latter are retracted, as is usually the case in my specimens, then the colony has a nodular appearance. The calyces have the shape of low domes when the polyps are retracted, but are blunt cones when the latter are expanded. The polyps usually originate on two sides, leaving two bare areas, which sometimes show two faint lines on the surface, the third side, however, sometimes has polyps. At the apices of the branches the calyces are closer together, and more thickly distributed on all sides than farther down, where they may be separated by an interval of 1 mm.; the branches terminate bluntly. The larger calyces are about 1 mm. in height and diameter, in some cases the tentacles may be seen as an 8-rayed star projecting above the calyx. The polyps do not appear to originate quite perpendicularly from the branches. The axis, when treated with acid, effervesces very freely, and a white lamellar part is left behind, which consists of a darker coloured central and a lighter external part, the latter showing a fine thread-like netted structure.

The colony is slender and slightly flexible, and with a fairly thin coenenchyme. Anastomosis either does not or only rarely occurs. At the apices of the branches the polyps may lie opposite one another, but as a rule further down they are not so disposed. In the basal stem the axis is fairly thick, but in the apical branches it diminishes to a thin filament. The main stem is nearly cylindrical, but the branches are slightly compressed in the plane of expansion.

The spicules are frequently of an ochre colour. They are after the same types as those figured by Kölliker for *Verrucella guadelupensis*, but differ in detail. It appears possible to recognise three types, but these are not sharply differentiated from another, and it seems possible to pass from one to another. In the cortex one finds (*a*) double spheres, (*b*) double spindles, (*c*) simple spindles, and (*d*) a few double stars.

The same types of spicules occur in the polyps, but there is a greater predominance of the simple spindle. The double spheres are from 0.044 × 0.027 to 0.085 × 0.044 mm. The simple spindles are from 0.074 × 0.01 to 0.129 × 0.027 mm. The double spindles are from 0.071 × 0.030 to 0.102 × 0.391 mm.

My specimens were slightly dried during transit from South Africa, but apparently without causing much injury. I am convinced that the genus Verrucella is a very variable one, and that the eleven species which have been described are not all true species: the genus stands in need of revision. My specimens show affinities with *V. guadelupensis*, Duch. and Mich., with *V. guernei*, Studer, with *V. granifera*, Köll. and others. From the size of the spicules and other points, I might easily have constituted this a new species; several of the species described by other authors are probably only varieties of *V. guadelupensis*. It is unfortunate that Nutting gives no figures of the spicules of *Verrucella bicolor* from the Hawaiian Islands.

Locality, etc.—Pieter Faure, No. 11,352. Tugela River mouth, N.W. by N., ¼ N., 24 miles. Depth, 65 to 80 fathoms. Collected by large dredge. Nature of bottom, hard ground. Date, July 11th, 1901.

Pieter Faure, No. 11,586. Amatikulu River mouth, N.W., ¾ N., 20 miles. By large dredge. Depth, 62 fathoms. Nature of bottom, rocks and sponges (hard ground). Date, January 30th, 1901.

I must in conclusion express my indebtedness to Miss A. Dixon, of Manchester University, who kindly made a number of preparations of spicules.

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EXPLANATION OF THE PLATES.

PLATE I.

Fig. 1.—*Acanella eburnea*, Pourtalès, 5/6th nat. size.

Fig. 2.—*Lophogorgia lutkeni*, W. & S., part of, 5/6th nat. size.

Fig. 3.—*Gorgonia flammea*, E. & S., part of, 5/6th nat. size.

Fig. 4.—*Stenogorgia capensis*, sp. n., 5/6th nat. size.

Fig. 5.—*Leptogorgia aurata*, sp. n., part of, 5/6th nat. size.

Fig. 6.—*Gorgonia flammea*, E. & S., part of, 6 times nat. size.

Fig. 7.—*Stenogorgia capensis*, sp. n., part of, 7 times nat. size.

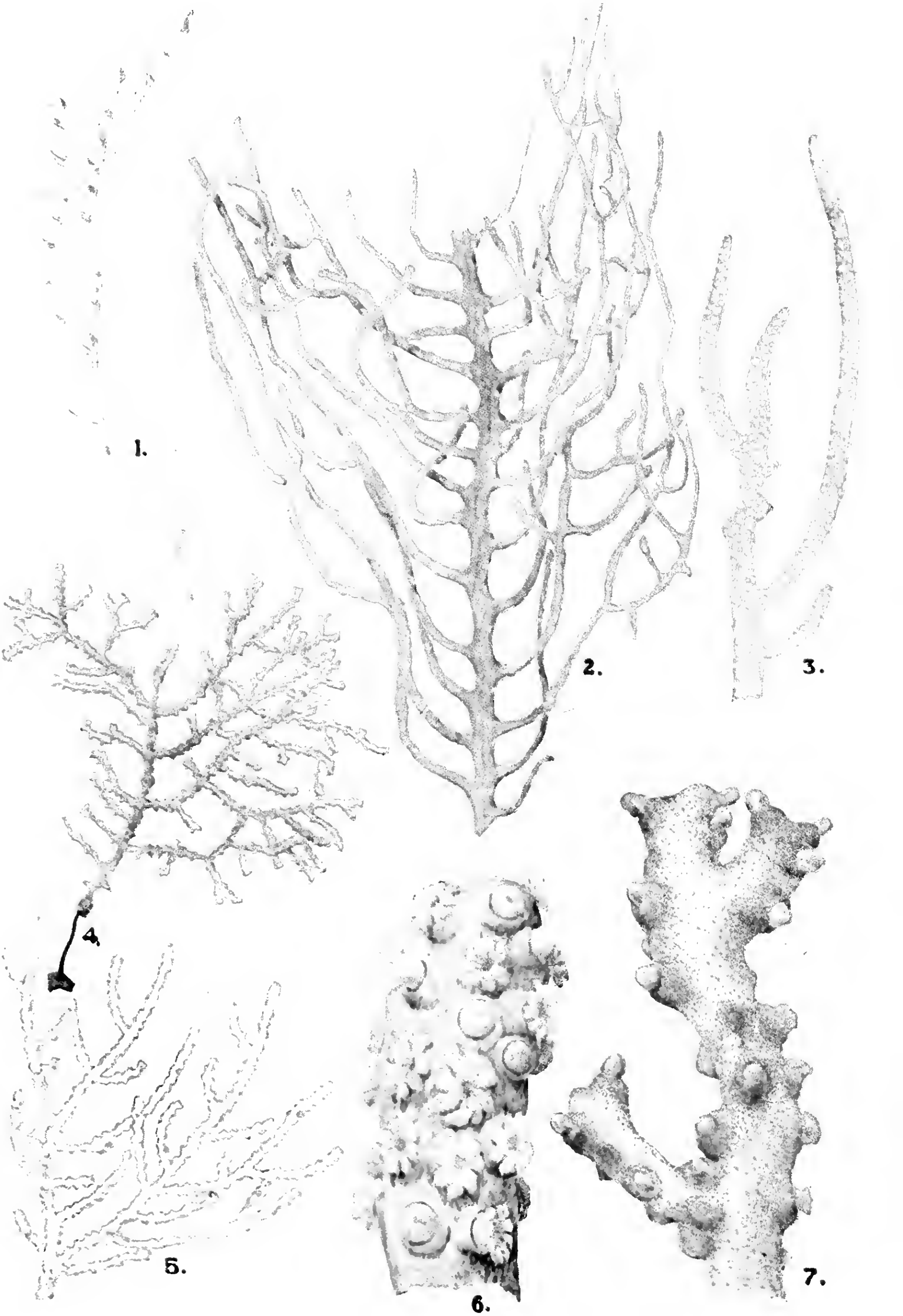
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PLATE II.

Fig. 1.—*Wrightella furcata*, sp. n. part of, 5/6th nat. size.
Fig. 2.—*Wrightella fragilis*, ,, ,, ,, ,, ,,
Fig. 3.—*Eugorgia lineata*, ,, ,, ,, ,, ,,
Fig. 4.—*Mopsella singularis*, ,, ,, ,, ,, ,,
Fig. 5.—*Anthothela parviflora*, sp. n., 5/6th nat. size.

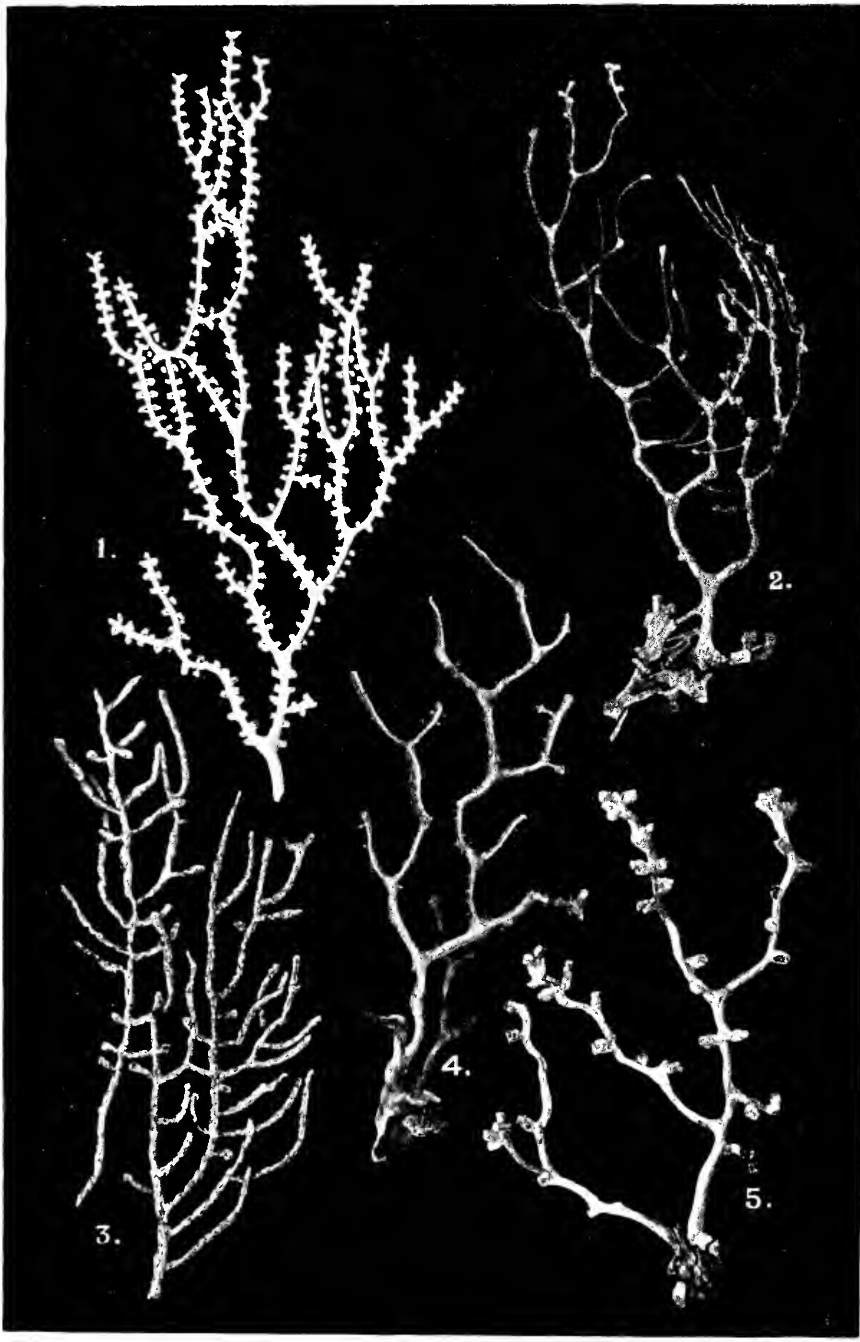
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PLATE III.

Stachyodes capensis, sp. n., nat. size.

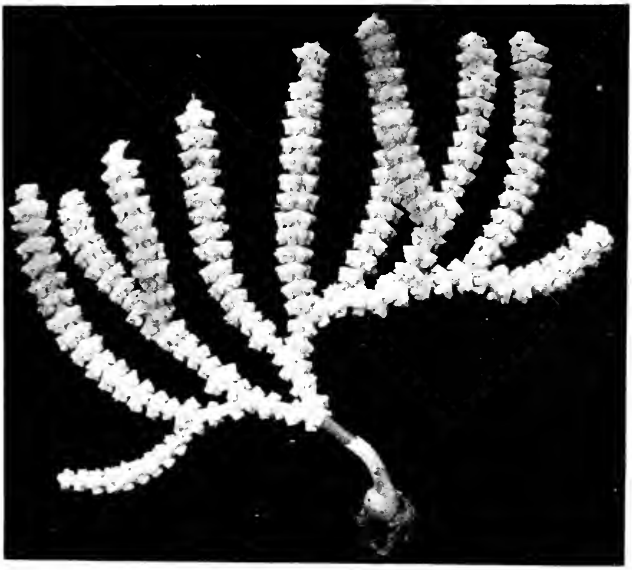

PLATE IV.

Fig. 1.—*Wrightella trilineata*, sp. n.,	spicules	of.
Fig. 2.—*Leptogorgia aurata*, sp. n.	,,	,,
Fig. 3.—*Leptogorgia rigida*, Verr.	,,	,,
Fig. 4.—*Acanthogorgia, sp.*	,,	,,
Fig. 5.—*Stenogorgia capensis*, sp. n.	,,	,,
Fig. 6.—*Gorgonia flammea*, E. & S.	,,	,,
Fig. 7.—*Gorgonia*, sp.	,,	,,

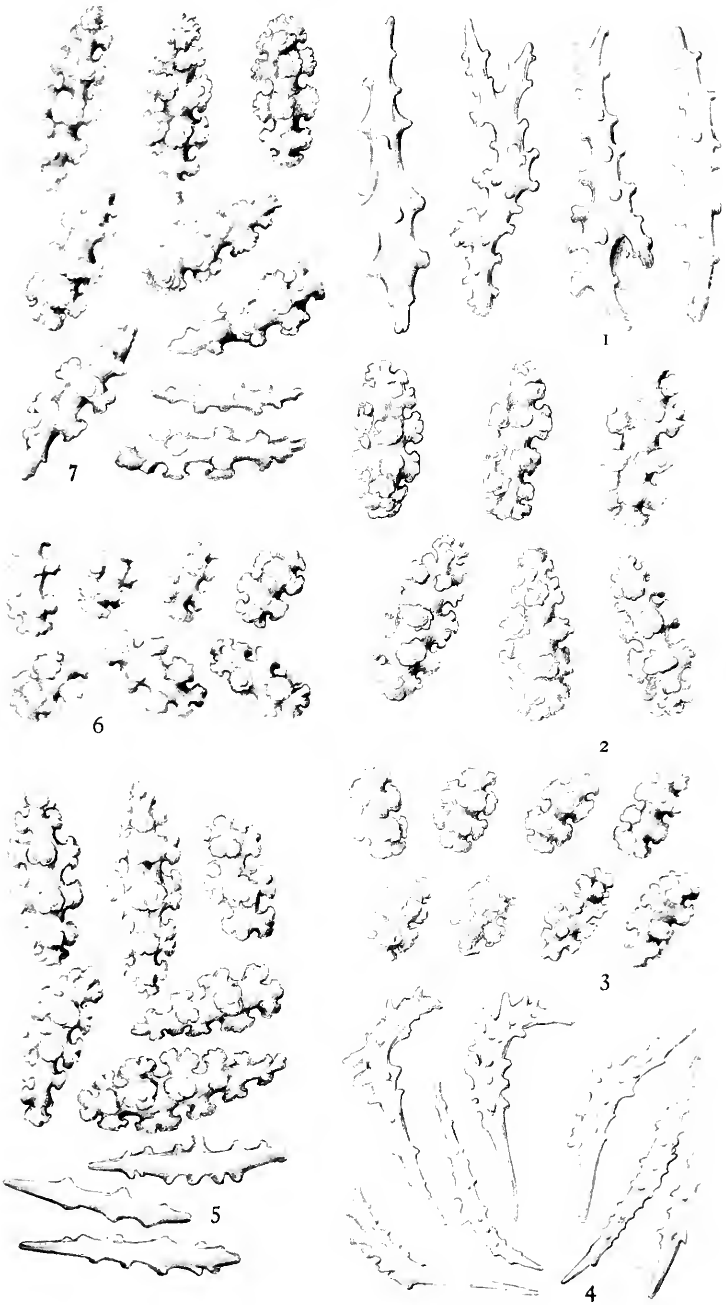
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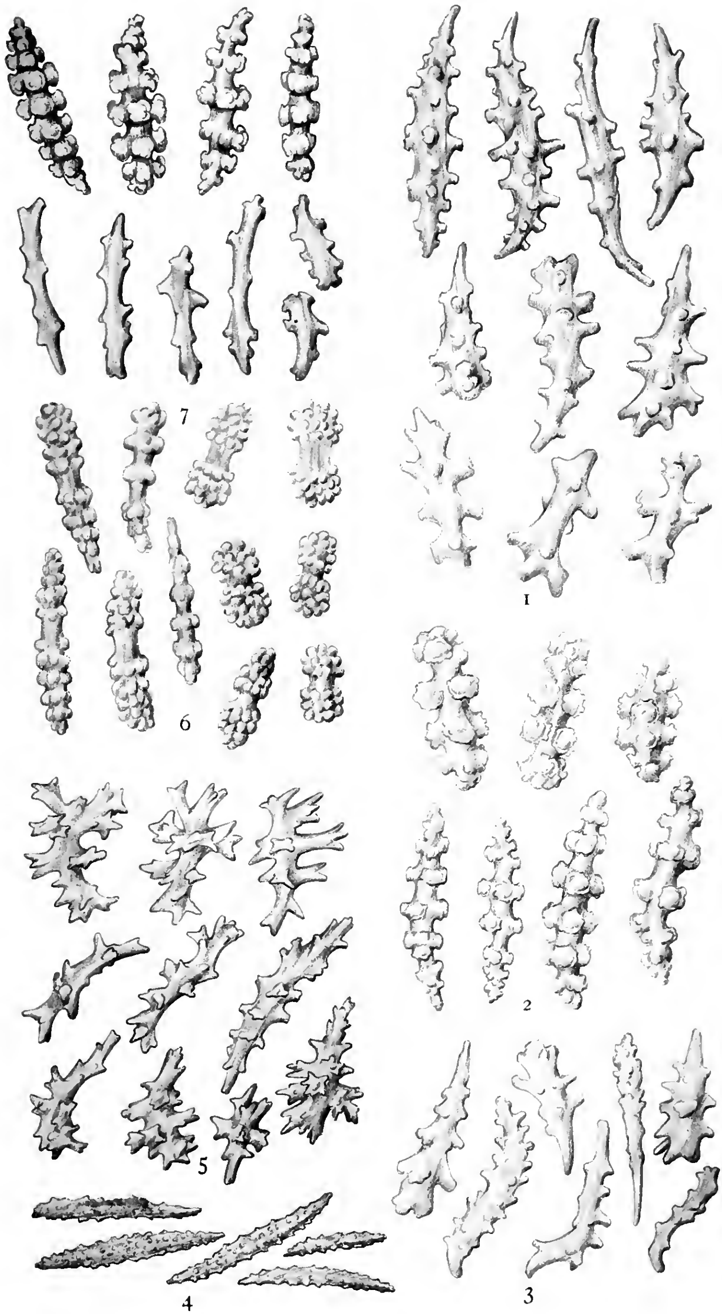
PLATE V.

Fig. 1.—*Wrightella fragilis*, sp. n.,	spicules	of.
Fig. 2.—*Eugorgia lineata*, sp. n	,,	,,
Fig. 3.—*Wrightella trilineata*, sp. n.	,,	,,
Fig. 4.—*Anthothela parviflora*, sp. n.	,,	,,
Fig. 5.—*Acabaria, sp.*	,,	,,
Fig. 6.—*Verrucella bicolor*, Nutting	,,	,,
Fig. 7.—*Leptogorgia africana*, sp. n.	,,	,,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Manchester Memoirs, Vol. lxi. (1917), *No.* 2.

II. The "Mark Stirrup" Collection of Fossil Insects from the Coal Measures of Commentry (Allier), Central France.

By Herbert Bolton, M.Sc., F.R.S.E., F.G.S.,

The Bristol Museum.

(*Received and read November 28th, 1916.*)

The collection of fossil insect remains from the Coal Measures of Commentry (Allier), Central France, which are now the property of the Manchester Museum, were presented by the late Mark Stirrup, and form the "Mark Stirrup Collection." They are representative of the largest insect assemblage known to occur in any of the Palæozoic rocks of Europe, the late Charles Brongniart having recorded no less than 1,300 specimens, and to this number must be added many more discovered since his death. Brongniart's researches upon the fossil insects of Commentry resulted in the publication in 1894 of his now classical memoir, "Recherches pour servir à l'histoire des Insectes Fossiles des Temps Primaires."

All the important discoveries of insect remains in these Coal Measures of Commentry were made later than 1878.

The late Mark Stirrup (Notes on the Carboniferous Insects found at the Commentry Mines (Allier), France, *Trans. Manch. Geol. Soc.*, Part III., Vol. XXI.) has given a brief description of the character of the coalfield, from which it would appear that the coal seams and associated rocks were laid down in long narrow depressions formed in schistose and massively crystalline rocks of a much older period. Monsieur Henry Fayol, the director and engineer of the mines, has by observation and experiment, satisfied himself that the coal seams are made up of drifted vegetation. The rock in which the insects occur is a very fine grained mudstone, which may well have accumulated by the deposition of fine sediment in enclosed or lake-like waters.

During the period in which Brongniart was actively engaged in his studies of the Commentry insects, and indeed until his death, Stirrup was one of his closest friends. The interest

May 11th, 1917.

of the latter found expression in the short papers[1] which he contributed to the *Transactions of the Manchester Geological Society*, and in his review in the *Geological Magazine* of Brongniart's work.

There can be little doubt therefore but that the collection of fossil insects now in the Manchester Museum was formed by Brongniart himself, and given to his friend, Stirrup.

Inasmuch therefore as Brongniart's researches, even more than those of Scudder or Goldenberg, served to establish the study and classification of Palæozoic insects upon a firm basis, and the Mark Stirrup Collection having been brought together by him, it naturally possesses something more than an ordinary value.

That these fossil insects have found a permanent home in the Manchester Museum is a matter for satisfaction.

The Collection consists of nine specimens, of which five are blattoids. Brongniart in his first monograph, "Les Insectes des Temps Primaires," did not fully deal with the blattoid group, reserving them, according to Stirrup, for a special and more exhaustive study in a later work. The early death of Brongniart in 1899, when only forty years of age, prevented this design being carried out, and probably also accounts for the fact that the collection given to Stirrup included species not hitherto described.

Later workers, especially Messrs. Leriche and Meunier, have added to our knowledge of the Commentry blattoids, but I do not know that they had access to the Stirrup Collection.

All the insect remains occur in a compact and thin, flaggy mudstone, containing very little mica, and finely laminated. The rock is one which was evidently deposited in quiet, or stagnant water. The only other fossils found in association with the insects in the Mark Stirrup Collection are fragments of Pecopteris.

Megagnatha odonatiformis, gen. et. sp. n. Pl. 1; figs. 1—4.

Generic diagnosis.—Antennæ of medium length, thorax much elongated, wings broad and delicate, legs long, widely separated, and not adapted for leaping. Abdomen long and broad.

1. "The Fossil Insects of the Primary Rocks," by Charles Brongniart of Paris, translated by Mark Stirrup, F.G.S. *Transactions of the Manchester Geological Society*, Vol. XVIII., pp. 269-292.

"Notes on the Carboniferous Insects found at the Commentry Mines (Allier), France," by Mark Stirrup. *Trans. Manchester Geol. Soc.*, pt. 111, Vol. 21.

"The Carboniferous Insects of Commentry, France," by Mark Stirrup, F.G.S. *Trans. Manchester Geol. Soc.*, pl. XXI., Vol. 22.

"On the Fossil Insects of the Primary Periods," a review of M. Charles Brongniart's book, by Mark Stirrup, F.G.S. *Trans. Manchester Geol. Soc.*, pt. V., Vol. 23.

See also *Geological Magazine*, Decade IV., Vol. 11, p. 233, 1895.

Specific Diagnosis.—Head small, elongated; wings a little shorter than length of body. Sub-costa united with radius in outer third of wing. Sub-costa, radius and radial sector occupy outer third of wing. Wing apex blunt. Median vein much divided, and occupying outer half of inner wing margin. Cubitus small. Anal area small.

One of the most important insects in the Stirrup Collection is an almost complete insect which cannot be referred to any known genus. The insect lies upside down upon the stone, and has a total length of 39 mm. The head is elongated, rounded behind, and bears a pair of diverging antennæ, 9 mm. long. Within the antennæ, a pair of mandibular-like structures are discernible. These are 4 mm. in length. The prothorax is much elongated, and widest posteriorly, anteriorly it is marked off from the head by a slight constriction. The mesothorax is much broader than the prothorax, and bears the remains of the wings. The right pair of wings has been broken away near their base and lost, whilst of those on the right side, little more than the costal margin of the anterior wing is visible.

Fragmentary traces of the chief veins of the wings of the left side can be made out by means of enlarged photographs.

All three pairs of legs are present, the fore and hind legs being well preserved, and the middle pair fragmentary.

The abdomen is broad, well segmented, and about 19 mm. long. A short backward prolongation on the right side may represent a portion of the last segment, or one of a pair of cerci.

Wings.—The venation of the wings presents considerable difficulty. Careful enlargements of the right forewing have been made, and every portion of a vein traced off. By this means, the course of the principal veins can be determined, and portions of the smaller twigs. The junction of most of the latter to the former is not clear. An exact analysis of the wing structure is thus no easy matter. Notwithstanding the fragmentary condition of the veins and associated twigs, certain features are very evident, and I think the following conclusions may be safely drawn.

The costal margin is almost straight, and gently curves into a well rounded and broad apex. The sub-costa is a feeble vein, passing out parallel to the wing margin over two-thirds of the wing, when it joins on to the radius. The radius is a simple structure parallel to the sub-costa, and only separated from it by a very narrow area. It reaches the wing margin at the outer edge of the wing apex. The relations and character of the radial sector, median and cubitus are not so easily understood.

Fragmentary portions of a few principal veins can be traced across the middle of the wing, and portions of a numerous series of twigs are shown in the outer apical area, and between the middle line and the inner margin.

The precise relationship of all these is a matter largely of conjecture. A radial sector is undoubtedly present, and it may possess one to three sub-divisions. In any case the radial sector arises close to the base of the radius, and in all probability gives off the median in the basal fourth of the wing. An important vein giving off three twigs in the middle of the apex of the wing is apparently the innermost division of the radial sector. The median vein bends inwards from its junction with the radial sector, and then passes along the middle line of the wing towards the apex, where it curves inwards and ends upon the margin. From the fragmentary portions of twigs which remain, it clearly gave off a numerous series of parallel and curving simple twigs, which occupied the whole of the outer third of the inner margin of the wing. The cubitus apparently consisted of two or more branches passing first inwards and then outwards in sigmoidal curves. A little beyond the middle of their length, the cubital veins fork, and end upon the wing margin in 8-9 twigs.

Traces of a few anal veins are present. The anal area appears to have been small. The chief features of the wing may be summarised as follows:—Outer and inner wings, margins almost straight and parallel to each other. Apex of wing bluntly rounded. Sub-costa feeble, and joining on to the radius distally. Radius straight, and giving off radial sector low down. Intercostal and radial areas narrow, so that the sub-costa, radius and radial sector lie in the outer third of the wing. Radial sector consisting of two, possibly three, divisions, the innermost giving off a few simple twigs to the wing apex. Median vein large, much divided, and arising in union with the radius and radial sector. Cubitus of two-three branches. Anal area small.

Legs.—The fore and hind pair of legs are fairly well preserved. The middle pair are represented by the femora only. The hind legs are the longest, and as they now lie, have the femora bent back close to the abdomen, and the tibiæ are at right angles. The tarsal segment of the right hind leg seems long, but it is not well defined. That of the left leg is missing. The fore legs show the femora placed at right angles to the prothorax, whilst the tibiæ are directed forwards, and the tarsi bent a little outwards. The tarsi are slender, and the femora show no trace of thickening, such as is characteristic of the *Locustidæ*.

Abdomen.—The general appearance of the abdomen has been already noted. Its segments are clearly discernible. The ventral surface of each bears two low ridges, disposed longitudinally, and placed midway between the middle line and the sides of the segments. It is not quite clear whether the sides of the segments were carried out into blunted tubercles or not.

In two places something of the kind seems present. The cerci-like termination of the abdomen may or may not be actual cerci, or the appearance may be caused by a surface film of the matrix being broken away at this point.

Affinities.—The salient facts of structure which need to be borne in mind in seeking to identify the insect are well marked, and distinctive, notwithstanding its fragmentary structure. I have already summarised the details of wing structure, and they need not therefore be repeated. The general details are as follows:—Head small and bearing well-developed antennæ, and powerful mandibles, thorax large and much elongated, especially the prothorax; legs well developed, wings long and delicate; abdomen long.

This assemblage of characters is not unlike those of certain of the Proto-orthoptera, and it may be that better preserved examples will definitely settle the question of Proto-orthopteron affinities. Should the insect belong to this class, it will probably be found closely related to the family *Spanioderidæ*, or that of the *Sthenaropodidæ*.

With the family *Spanioderidæ*, the specimen agrees in its elongated prothorax, and legs not adapted for jumping. It is still more closely in agreement with *Sthenaropodidæ*, in which the head and thorax are elongated, the legs slender, with the hind pairs the longest, and the wings have a broadly rounded apex. In this family also, the outer branch of the median unites with the inner branch of the radial sector, and separates again. The cubitus gives off many branches to the inner wing margin. Transverse veins are well developed. Whether the radial sector and the median unite in the Commentry specimen which we are considering is not actually demonstrable, owing to its fragmentary condition. Yet a close study of the vein fragments shows that it is quite likely, and we have assumed such to be the case. Before we, however, class the specimen as belonging to the *Sthenaropodidæ*, it may be well to point out that this insect, and certain others classed with the Proto-orthoptera, may possibly yet prove to be neuropterids, somewhat nearly related to the family *Perlidæ*. Brongniart has already shown (Insectes Fossiles, p. 407, 1893) that some justification exists for the supposition that forms allied to the Perlidæ existed in Coal Measure times, and has described a wing under the name of *Protoperla Westwoodi*. The existing forms of *Perlidæ* have a well-developed and elongated thorax; four membranous wings, of which the hinder are the largest, and well-developed and widely separated legs. The venation of the wing in such a living form as *Pteronarcys frigida* is but little removed from that of the Commentry insect, whilst the latter also shows a close resemblance to the wing described under the name of *Protoperla Westwoodi*, by Brongniart. It differs from the latter in that the sub-costa is clearly attached at its distal end to the radius, and does not reach the costal margin at all. The characters of the radial sector, median and cubitus are radically different from those of *P. Westwoodi.*

I am of opinion that the neuropteroid evidences of structure are more evident than any which may be considered proto-orthopteroid, and therefore assign it to a new genus of the family *Perlidæ*, under the name of **Megagnatha odonatiformis.*

[Dr. A. D. Imms, who has kindly read my paper whilst in manuscript form, has suggested that the specimen may possibly come nearer to the *Sialidæ* than to the *Perlidæ;* noting that whilst the possession of great mandibles is a unique feature amongst living and fossil Perlidæ, they are, nevertheless, a prominent feature amongst certain *Sialidæ*. This is certainly the case, but I have attached more importance to the apparent wing structure, and to the extremely long thorax than to the size of the mandibles, the detailed structure of which it is impossible to make out. My own studies have led me to regard the families of the *Sialidæ* and *Perlidæ* as somewhat closely allied in origin. Had the venation of the wings been more complete, something more could probably have been said upon the question of relationships.]

Genotype.—Manchester Museum; Register No., L5,560.

Horizon.—Stephanian.

Locality.—Commentry (Allier), Central France.

Mark Stirrup Collection.

Sycopteron symmetrica, gen. et. sp.n. Pl. II.; figs. 1 and 2.

Derivation: Sycopteron, σνκος = a fig; πτερον = a wing.

Generic diagnosis.—Small insects in which the head is large, rounded, and convex dorsally; wings fig-like in outline; principal veins well developed, with few branches.

Specific diagnosis.—Wings 9-10 mm., costal margin almost straight, sub-costa reaching the inner side of the wing apex. Radius a powerful vein, to which the median and cubitus are attached at the base. Median and cubitus veins simple.

Amongst the insects in the Stirrup Collection is one of special interest. It is a small insect, showing the head, thorax, and the first pair of wings. In all probability it is whole, with the hind wings concealed under the first pair, and the legs and body below. Its total length is 11 mm. from the front of the head to the end of the wings, and its greatest diameter (at the free end of the wings) is not more than 5 mm. Its extreme smallness makes its difficult to determine many details of structure, yet the principal veins are clearly marked. The front of the head is rounded and the sides almost straight. The upper surface is convex, the convexity gradually diminishing to the front margin, and passing down into two flattened postero-

*This generic name has been substituted for that of "Pseudoperla," which I first used.

lateral areas, whilst in the middle of the hinder border, the convexity of the surface is carried out into a short, blunt, peg-like prolongation, which just overhangs the prothorax. The prothorax is short, low, and slightly ridged from side to side. The mesothorax is large, its upper surface raised and slightly convex, and bearing three low boss-like elevations, arranged at the points of a triangle, the posterior one marking the apex of the triangle, and being the most prominent. A small portion of the flattened metathorax lies behind, in a triangular area not covered by the wings. The forewings are folded in a position of rest upon the body, and almost entirely overlap at their free ends.

The wings are very narrow at the point of attachment, and broaden out rapidly to the wing apex. The length of the wings is 9 mm., and their greatest breadth about 4 mm.

The principal veins of the right wing are the more perfect, those of the left wing, so far as they are discernible, being in agreement. For purposes of description we have therefore selected the right wing.

The wing structure of the insect is widely removed from that of all known Palæozoic forms, the nearest approach to a similar wing structure that we know of being found amongst the recent Scorpion-flies (*Panorpidæ*), or the genus *Orthophlebia*, established by Westwood and including several species found in the Lower Lias of England, and the Upper Lias of Mecklenburg.

The Commentry insect has a simple structure, and less branched principal veins than the Liassic forms, but is substantially the same. All the veins appear to spring from a common root, and with the exception of the third vein, none are sub-divided. The costal margin seems to have been extremely delicate, and to have left very faint traces of its presence. Indications of it are present at the base of the wing, and upon enlarged photographs it is possible to distinguish fragmentary portions along its whole length.

The first vein, which one may regard as the sub-costal, separates from the common root in the proximal third of the wing, and passes straight out as an undivided vein to the wing apex. It diverges very slightly from the outer margin along its course, and does not meet the latter until the well-rounded end of the wing is reached.

The next vein, which corresponds to the radius, is the most powerful of all. It follows a parallel course to the sub-costal, giving off a radial sector at the end of the first third of its length, and forks before reaching the margin.

The radial sector diverges inwardly from the radius, and divides up into three branches, which occupy the inner portion of the wing apex.

Midway between the point of origin of the wing and the division of the sub-costal and radius, arises a third vein, dividing immediately into two equal branches, which diverge slightly as they pass to the outer end of the inner wing margin. Traces of two other simple and parallel veins are clearly evident, the innermost either coinciding with the inner wing margin, or being but little removed from it.

On the evidence and character of the principal veins, we cannot but regard the specimen as an archaic type of the family *Panorpidæ*. Regarded as a member of this family, the outermost branch arising from the common root, is the sub-costa, the second the radius, the third the median vein, and the last simple vein is the cubitus. The remaining vein may represent the anal, or be on the wing margin; the evidence is too indefinite to decide.

In *Orthophlebia communis*, Westw., the sub-costa does not proceed quite so far out before reaching the costal margin as in the Commentry insect, the radial sector has seven twigs in place of five, but occupies the same wing area. The median divides in the middle of the wing, giving off three, possibly four twigs. It is unlikely that the median in the present instance is wholly undivided, its course over the free margin of the wing being indistinguishable. The anal veins in *Orthophlebia communis* are few, and the anal area small. The latter corresponds to that area in the Commentry specimen, which cannot be made out. It is inevitable that a new genus be made to receive this specimen, and to this genus we give the name *Sycopteron*, with the species name of "*symmetrica*."

Genotype.—Manchester Museum, Mark Stirrup Collection; Register No., L5,559.

Horizon.—Stephanian.

Locality.—Commentry (Allier), France.

Goldenbergia (*Microdictya*) *hamyi*, Brong. Pl. I.; fig. 5.

Genus Goldenbergia, Scudder, Proc. Amer. Acad., Vol. XX., p. 172, 1885.

Heeria Hamyi, Brongniart, Insectes Fossiles des Temps Primaires, 1893, p. 390, pl. 39 (23), fig. 3.

Microdictya Hamyi (Brong.), Handlirsch, Die Fossilen Insekten, 1906, p. 66, taf. IX., fig. 7.

Genus Sagenoptera, Handlirsch, Die Fossilen Insekten, p. 72, 1906.

Charles Brongniart (Insectes Fossiles des Temps Primaires, p. 388, 1893) created a new genus "*Heeria*" for a group of insects closely related to *Stenodictya*, and described a new species, *H. Hamyi*, of which a wing fragment occurs in the Mark Stirrup Collection.

Handlirsch (Die Fossilen Insekten, p. 65) notes that Brongniart afterwards replaced the name of "*Heeria*" by "*Microdictya*," owing to the former being pre-occupied. (Brong. Insectes Fossiles des Temps Primaires, 1893, footnote to text description of pl. 39 (23)).

For reasons which will appear later, we have removed it to the genus *Goldenbergia*, Scudder (Proc. Amer. Acad., Vol. XX., p. 172, 1885), as that generic name takes precedence of *Microdictya* (1906) and of *Sagenoptera*, a genus created by Handlirsch in 1906 (Die Fossil Insekten, p. 72), for forms which are indistinguishable from species of *Goldenbergia*.

The wing fragment in the Stirrup Collection consists of the distal half only, and is most excellently preserved. Brongniart's figure is on too reduced a scale to do justice to what was one of the most beautiful of insect wings from the Coal Measures. The wing examined by him had a length of 80 mm., with a breadth of 22 mm.

The length of the wing fragment in the Stirrup Collection is 56 mm., and its greatest diameter 28 mm. The length of the complete wing must have been about 95 mm., with a breadth of 30 mm., so that it belonged to a larger insect than Brongniart was aware of.*

The wing fragment shows that the costal margin slopes rapidly backwards to the wing apex, which is bluntly acute, and narrower than in the type figure. The wing apex might be described as a bluntly rounded angle, formed by the union of the inner and outer wing margins. The distal portion of the sub-costa is a well-marked vein, which reaches the costal margin at a point 29 mm. from the extreme tip of the wing.

The radius follows a course parallel to the sub-costa, curving inwards when beyond the point at which the latter reaches the wing margin, and joining the wing margin at the outer side of the wing apex. The radial sector was given off from the radius at about the first third of the latter's length. It diverges slightly from the radius, continuing as a single stem until the distal third of the wing is reached, in which it gives off four inwardly directed twigs, and ends on the wing apex in a short fork. The first or most proximal twig bifurcates 12 mm. from its point of origin, the two twigs diverging slightly as they pass to the inner wing margin.

The remaining three twigs follow a parallel course, passing in a wide sweep inwardly, so that only the two most distal twigs and the end of the main stem reach the wing apex. Brongniart's figure only shows three twigs arising from the radial sector, the proximal one forking as in the present case.

The main stem of the median vein must have passed almost straight out from its point of origin to near the middle of the wing, where it divides, giving off a wide, sweeping, outward branch, which remains simple, and an inner shorter branch, having a somewhat similar curve, and forking into two equal twigs, the proximal of which forks again before the wing margin is reached.

*Prof. A. Lameere, of the University of Brussels, has suggested to me that this increased size may be a sexual difference.

A portion of the cubital area on the wing margin is destroyed, so that the whole course of the cubitus vein is not shown. Parts of the anterior branch of the cubitus are present, and its general course can be determined. The inner branch of the cubitus was probably forked, and but two fragments are left. No anal veins are shown.

The surface of the wing seems to have been slightly coriaceous, whilst the intercalary venation is beautifully preserved over the whole structure.

The intercalary venation consists of a fine reticulated meshwork, enclosing small polygonal cells, which assume a somewhat linear arrangement in the intercostal, sub-costal, and radius areas. A casual glance gives the impression of cross veining passing obliquely between the sub-costa and the costal margin. The minor differences existing in the sub-divisions of the radial sector are not, in my opinion, of specific importance, and I regard the specimen as a beautiful example of Brongniart's species.

Affinities.—A comparison of *Microdictya hamyi*, with other forms shows that a close relationship exists between it and *Sagenoptera formosa*, Goldenberg. The latter species was first described by Goldenberg (Palæontogr. IV., p. 30, taf. 5, fig. 2, 1854), under the generic name of *Termes* (*Entermopsis*), and afterwards removed by him to the Dictyoneura (Goldenberg, Fauna saraep, foss. 11, p. 50, 1877), whilst in 1885, it was removed to *Goldenbergia* by Scudder. (*Proc. Amer. Acad.*, Vol. XX., p. 172, 1885). Still later (1906, Die Fossilen Insekten, p. 72, taf. IX., fig. 19), Handlirsch removed the species to a new genus *Sagenoptera*.

An examination of the figure of *Sagenoptera formosa* shows that the character of the sub-costa, radius, radial sector, and cubitus veins are almost identical with those of *M. hamyi*. The sub-costa runs out on the costal margin at the same point, the radius is a simple vein dividing in the first third of the wing; the radial sector has few (five) divisions, ending on the wing tip, and the distal portion of the inner wing margin, and the cubitus has a long, undivided outer twig. Specific differences are present, but generically, we see nothing to separate the two genera. Neither *Sagenoptera formosa*, nor *Microdictya hamyi*, are far removed from the genus *Dictyoneura*. They differ in possessing a closer and more highly developed intercalary venation, the cubitus is simple and less divided, and the anal area is larger, with more oblique veins.

From the foregoing, it seems clear that Scudder's genus name of *Goldenbergia* must be retained, and that the later generic names of *Heeria*, *Microdictya* and *Sagenoptera* be dropped, and that *Sagenoptera formosa* must be transferred to the genus *Goldenbergia*.

Brongniart's "*Heeria Vaillanti*" (Insectes Fossiles des Temps Primaires, p. 389, pl. XXXVII., 22, fig. 12; pl.

XXXIXX., fig. 1 and 2, 1894), must also be classed as "*Goldenbergia Vaillanti.*"

Manchester Museum, Mark Stirrup Collection; Register No., L5,557.

Horizon.—Stephanian.

Locality.—Commentry (Allier), Central France.

Necymylacris Meunieri, sp.n. Pl. II.; figs. 3—5.

This specimen has becomed entombed with the pronotum and wings still attached to the body. The latter is almost wholly concealed, and but few traces of the segments of the body can be distinguished. The apical portions of both tegmina have been broken away, and the venation is somewhat obscured by their overlapping in the middle line, and by a few veins of the hind wings showing up through the tegmina.

The total length of the insect from the front edges of the pronotum to the broken edges of the wing is 35 mm. About one-sixth of the wing apex is missing, so that the total length of the complete insect would be about 41 mm.

The Pronotum.—The pronotum at first sight is a most unusual structure. It appears to be sub-rotund in outline, and divisible into three parts, two stout reniform lateral areas showing a surface ornament of transverse and anastomosing wrinkles, and a somewhat circular central area, evidently much thinner and membranous, and now much wrinkled, possibly by crushing. The wing shoulders abut closely against the pronotum, the latter appearing to have a well-defined groove, into which the wing bases fit closely. So closely are the wing bases applied to the ridges upon the pronotum that it would appear impossible for them to be opened, except by thrusting the sides of the pronotum bodily forward. As the lateral sections of the pronotum do not meet in the middle line, being separated by a short interval, into which the thinner and probably pliable central portion extends, this seems quite feasible. Nothing of this character is known in any blattoid, living or fossil, and I was wholly unable to regard this view of the structure as a correct one. I therefore submitted the specimen to Prof. E. B. Poulton, of the Hope Museum, Oxford, who, with his assistants, has kindly subjected the specimen to a critical examination. As a result of their examination and of experiments with the tegmen of *Periplaneta americana*, they are satisfied that the pronotum is complete with a rounded posterior border, which *underlies* the bases of the wings, and has been crushed down by them. The apparent socketting of the wings into the pronotum has been brought about by the wings being first dragged backwards, and then thrust forward over the edges of the pronotum, upon which they have since become impacted. This certainly seems the most reasonable interpretation, and it is one with which I agree. The pronotum is therefore normal in shape, and traces of its hinder border can be seen across the anal area of the left tegmen.

The Tegmina.—Of the two tegmina, the left is the most perfect, and has a length of 28 mm. The right tegmen has a length of 32 mm. The total length of the whole tegmen in each case is about 37 millimetres. The left tegmen is selected for detailed description. The costal margin is gently convex, and passes imperceptibly into the apex of the wing. The sub-costal vein is widely separated from the costal margin at its base, and follows an oblique course outwards. Two-thirds of the costal margin are occupied by the sub-divisions of the sub-costal vein. These sub-divisions are few in number (6-7), the first four dividing into three twigs, whilst the fifth and sixth are single.

The radius divides at the first fourth of its length into two equal veins. The outer branch gives off a forward twig, which divides twice by forking into four twigs, which reach the margin. About the middle of the wing, a single unbranched twig is given off, and two, possibly three, others further out.

The inner branch gives off two long unbranched twigs, which pass almost straight outwards to the wing apex. The divisions of the radius occupy the outer part of the wing apex. The median vein arises close to the radius, diverging inwardly as it passes onwards to the inner side of the middle of the wing apex, giving off three forward branches, which go to the wing apex parallel to the inner divisions of the radius. On its inner side, the median gives off a series of five twigs, which go down to the inner wing margin. The first two fork once, whilst the third crosses the fourth, uniting with the latter for a very short distance, and then passing on in front of it to the margin, the fifth twig divides up into four branches.

The anal furrow is strongly marked, and portions of eight anal veins are distinguishable. The anal area occupies one-third of the inner wing margin, the remainder of the margin being occupied by the inner divisions of the median. The venation of the right wing agrees in general character with that of the left, but is simple and less sub-divided. The sub-costal is a little more sub-divided on the wing margin, and the radius has a slightly smaller area. The median and cubitus have few sub-divisions. The anal veins are better shown, and no less than fourteen can be determined. The surface of the tegmina is somewhat coriaceous, and at first sight presents a scaly appearance, owing to the well-developed intercalary venation, consisting of a reticulated meshwork, which becomes transverse where it crosses the divisions of the radius and median.

Hind wings.—Clear traces are present under the tegmina, of the main stem of the (?) cubital element of both hind wings, and of a few of their more distal divisions, but nothing of a definite character can be determined.

Body.—That the body of the insect still lies underneath the wing is clearly evident. The metanotum shows up through the thin anal areas, and there are also visible a few of the anterior segments of the abdomen. In enlarged photographs, at least two segmental furrows can be distinguished. The area occupied by the abdomen seems to be indicated by a darker area of colour, which is also slightly elevated above the level of the tegmina. This dark area has a breadth of 14 mm.

Affinities.—The salient features of the tegmina of this insect are very clearly marked. The sub-costal area is triangular, whilst the subsidiary twigs tend towards a pectinate arrangement. The radius takes little part in the wing apex. The median is an important vein, occupying most of the wing apex, and giving off all its twigs on the outer side. The cubitus is even more developed than the median, occupies the greater part of the inner wing margin, and gives off twigs on its outer and inner sides. Its extension to the wing tip is a strong feature. This assemblage of characters is in agreement with Scudder's genus, *Necymylacris*,[2] and Handlirsch's genus *Eumorphoblatta*.[3]

Scudder's definition of the genus seems sufficiently good to warrant the retention of his genus.

The specimen differs from *N. Lafittei*, Pruvost, and *N. Godoni*, Pruvost, and appears to be more nearly related to *N. heros*, Scudder. It differs from the latter in the presence of a reticulated venation, in a more sub-divided median vein, and in the greater development of the outer branches of the cubitus. We do not know of any other species to which it can be referred, and therefore attach to it the name of Monsieur F. Meunier, who has done so much good work upon the French fossil insects.

Type.—Manchester Museum, Mark Stirrup Collection; Register No., L5,555.

Horizon.—Stephanian.

Locality.—Commentry (Allier), Central France.

Necymylacris Lerichei, sp.n. Pl. III.; figs. 1—5.

The remains of this insect have proved to be of a most tantalising character. The greater part of the pronotum is present in a smashed up condition, the fore and hind wings are partially superposed upon one another, so that the venation can only be unravelled with great difficulty, whilst the hind legs and possibly a part of the abdomen lie beneath all the rest.

Pronotum.—The pronotum is circular, with a small rounded projecting lobe in the median line on the front margin. The

2. Necymylacris, Scudder, Palæozoic Cockroaches, *Mem. Boston Soc. Nat. Hist.*, Vol. III, part 1, p. 52, 1879.

3. Eumorphoblatta, Handlirsch, *Proc. U.S. National Museum*, Vol. 29, p. 273, 1906.

ornament consists of a series of low irregular ridges running from the centre to the margin, becoming feebler as the margin is reached.

Tegmina.—The tegmina are clearly distinguishable, that of the left side being almost perfect, and 33 mm. long. The right tegmen has lost the basal third, owing to the matrix being broken away.

Left Tegmen.—The costal margin is convex, and slopes inwards from the sub-costal area back to the wing apex, the latter being more acutely rounded than in most blattoids. The sub-costa is a short vein passing obliquely forwards at an acute angle to the costal margin, and cutting off a triangular costal field. The sub-costal vein is small, and breaks up into three branches, the first forking twice into three twigs, the second giving off two undivided twigs and then forking, whilst the third is long and remains undivided. The costal field occupies about one-third of the outer margin, and is triangular, being especially wide at the base. The character of the sub-costa, and the shape of the costal area are typically Necymylacrid. The radius is a large much divided vein, occupying the outer two-thirds of the costal margin, and reaching almost to the middle of the tip of the wing. It divides near the base into two main branches, both of which repeatedly fork, ultimately forming ten twigs each, so that the radius ends upon the margin in twenty twigs. The median vein with its sub-divisions lies along the middle of the wing, and ends upon its apex. Owing to the venation of the hind wing having become impressed upon the forewing, the ultimate branching of the median is very difficult to trace. The basal half of the vein is fairly clear, and it is possible to distinguish that it bends inwards along its course to the inner side of the wing apex, apparently giving off three branches, which pass straight out to the wing apex. The outer of the three branches seems to fork once, and the next, twice, so that the branch ends in three twigs. The third branch forks into two equal-sized twigs.

The cubitus is a large vein, going in a long concave sweep from the base of the wing to the inward side of the wing apex. It gives off eight branches on its inner side, all of which divide, except the fifth and eighth. These all pass off obliquely from the main stem, the first, second, and third, forking several times, whilst the fourth, sixth, and seventh, fork once only. The whole of the inner margin of the wing beyond the anal area is occupied by these divisions of the cubitus. The anal area is large, and crossed by about eight-ten veins, two of which fork. The inner margin appears to have been more straight than rounded.

Right tegmen.—The basal portion of the right fore wing being broken away, the course of only the distal divisions of the veins can be distinguished. These are substantially similar to those of the left wing. The divisions of the radius occupy the outer wing margin beyond the sub-costal area, the median ends upon the tip of the wing in nine twigs, whilst the cubitus has the same inner curve as that of the right.

Hind Wings.—Our attempts to determine the structure of the hind wings have not been successful. A few twigs of what seem to be the sub-costa are shown in the left hind wing, together with terminal twigs of the radius, median and possibly cubitus, the outer third of the radius, and a few twigs of the median. The radius would appear to occupy the whole of the wing apex. Of the right hind wing, only a portion of the radius is distinguishable.

Legs.—Traces of the hinder pair of legs show up through the wing. The left hind leg exhibits the femur, tibia, and tarsus; the elements of the latter cannot, however, be made out. The femur is flat, the tibia more rounded, and only about half the diameter of the femur, and it is clothed with numerous short stiff bristles. The tarsus is attenuated, and appears almost claw-like. The right hind leg shows very little of the femur, whilst the tibia and tarsus add nothing further to that seen upon the right leg. The two legs evidently still remain attached to the body, and a slight elevation at the junction of the legs probably marks the end of the abdomen. The latter appears like a broad flat structure, tapering from the sides to a central blunted end.

The whole body of the insect did not exceed a length of 24 mm., measured from the front edge of the pronotum to the end of the abdomen. The width of the abdomen is 10 mm.

Affinities.—Notwithstanding the fact that the sub-costal area of the specimen does not seem to extend over more than one half of the outer margin, in this respect disagreeing with the generally accepted condition in *Necymylacris*, I refer the specimen to that genus. There is close agreement with the genus in the grouping of the branches of the sub-costa, and in their very oblique direction. The radius forks near the base of the wing, the outer branch and its divisions going to the front margin, whilst the innermost divisions of the inner branch of the radius pass out in almost a straight line to the wing apex. The median, the course of which can only be traced with difficulty, occupies the tip of the wing, and its inner border. In its position, and in sending off 3—4 horizontal and simply divided twigs, it differs very little from *N. heros*, Scd. The cubitus, with its many divisions occupying all the inner wing margin outside the anal area, is essentially Necymylacrid. The divisions in the cubitus are more forked than in *N. Villeti*, Pru., or *N. Lafittee*, Pru., and somewhat similar to what obtains in *N. Godoni*, Pru. From the latter, the wings differ in the simpler form of the sub-costal, and in the more numerous divisions of the radius, and in the basal branching of the latter.

The species appears to be a new one, and we attach to it the name of Monsieur M. Leriche, who has added considerably to our knowledge of the insect fauna of the Northern French Coal Measures.

Type.—Specimen in the Manchester Museum, Mark Stirrup Collection; Register No., L5.552.

Horizon.—Stephanian.

Locality.—Commentry (Allier), Central France.

Phylloblatta Brongniarti, Handlirsch. Pl. IV.; figs. 1—5.

Etoblattina sp. Brongniart, Insectes Fossiles des Temps Primaires, t.48, Fig. 4, 1893.

This specimen is one of more than usual interest, owing to the fact that a portion of the hinder pair of wings, as well as the tegmina are preserved. Usually the hind wings are absent, or so obscured by the overlying tegmina as to be impossible of elucidation. A circular area has been impressed upon the base of the tegmina, and may indicate where the pronotum lay. If such were the case, the pronotum was unusually large. The right tegmen and right hinder wing lie with their lower surfaces upwards, those of the left showing the upper surfaces. The hinder pair of wings appear to have been imperfect before entombment, whilst the tegmina have lost the apical portions since the specimen was found. This at least may be inferred from the presence of a broken edge which cuts across the two tegmina, and still retains traces of cement. No definite portions of the body or legs are distinguishable, although an ill-defined mass lies in front of the right hind wing.

Tegmina.—The right tegmen is 29 mm. long, and has lost its outer third, whilst of the left tegmen little more than the basal third is present. The latter shows but minor points of difference, the chief being in the proximal twigs of the sub-costa, two of which fork three times, whilst those of the right in the same region are undivided. It will be sufficient therefore if the right wing is described in detail.

Right tegmen.—The costal margin is regularly and gently convex, merging distally into the blunted rounded apex of the wing. The sub-costa is a strong vein, widely separated from the costal margin, and parallel to it. It gives off a series of simple twigs, three of which are forked. The whole series of twigs, sixteen in number, pass obliquely outwards to the costal margin. The sub-costal, with its numerous divisions, occupies four-fifths of the outer margin. The radius arises close to the base of the sub-costa, and gradually diverges from it in its course to the middle point of the wing apex. It gives off two forwardly directed branches, both of which fork before reaching the broken edge of the wing. Whether additional forking takes place further out cannot be determined, owing to the absence of the apical portion.

The median vein follows a course fairly parallel to that of the radius, and in the portion of wing preserved, gives off an inwardly directed branch, which soon divides by forking into two equal twigs. The divisions of the radius and median together occupy the whole of the wing apex.

The cubitus is an important and well-developed vein. Enough of it is present to show that its final divisions must have occupied the whole of the inner wing margin outside the anal area. The main stem of the cubitus curves inwards, descending low down towards the inner margin, and then continuing towards the wing apex. It gives off on its inner side, a series of long twigs, which pass obliquely inwards to the wing margin. Of these, all shown on the wing fragment are simple and undivided except the first, which gives off three short divisions on its inner side. The anal furrow is well marked, and forms an almost complete semi-circle. Seven anal veins are distinguishable, the second and third being forked in the middle of their length.

The inner margin is almost straight. The intercalary venation consists of a fine reticulation, with a tendency to a transverse arrangement between the veins.

Hind wings.—Both left and right hind wings are very fragmentary. As contrasted with the tegmina, they are extremely thin and membraneous, so that the general wing structure outside the veins is not readily determinable. The two wings are not alike, the left wing fragment being best preserved, and the largest.

Left hind wing.—The costal margin is straight. The subcostal is a feeble vein, giving off a few twigs, which pass out obliquely to the costal margin. It lies somewhat close to the latter, so that the costal area is narrowly strap-shaped. The radius is a strong vein arising close to the sub-costal, and passing straight outwards. Just before reaching the end of the wing fragment, it forks into two branches, both of which again fork. There can be no doubt from the direction in which the main stem continues, but that other divisions of the radius arose further out. The radial sector arises from the radius near its base, and passes obliquely inwards, diverging somewhat widely from it. Four twigs are shown arising outwardly from it, the first of which forks twice.

The median divides near its base into two unequal branches, the outermost of which remains simple for a good portion of its length, forking into two twigs on the broken edge of the wing. The inner branch, by repeated forking, gives rise to five twigs.

The cubitus follows a straight course towards the distal end of the inner wing margin. On its outer side, a single twig is given off, whilst on the inner side, six twigs arise at regular intervals, the third one of the series forking. The next two veins may form part of the cubitus, but this cannot be determined, as both the proximal and distal portions are missing. Outside these is a small rectangular fragment of the wing bearing a close series of five parallel veins, which are apparently anal in character. How much of the wing is missing it is difficult to conjecture.

The right hind wing differs from the left, and is not so easily understood. The sub-costal vein is much the same, as its fellow of the right side.

The radius gives off a feeble twig outwardly, and a longer and more important one from its inner side, which forks. It diverges obliquely from the radius.

The radial sector arises near the base of the radius, and diverges widely from it. It remains undivided for a length double that of its fellow of the left wing, and then gives off an outward twig which forks as it reaches the broken edge of the wing.

The median vein seems to be united to the radius at its point of origin, but the wing area is partially obscured at this point, and the conditions are not clearly determinable. Unlike its fellow the left wing, there is no long undivided outer branch, the main stem remaining undivided for some distance before it gives off the first outer branch, which lies parallel to the main stem of the radial sector and forks. A second outer twig arises a little further out, following a course parallel to the first.

The cubitus seems to consist of two separate parts: an outer stem giving off two forwardly directed veins, and three which pass down to the inner margin. In this respect it does not differ much from the cubitus of the left wing. Lying, however, inwards to the main stem just described, are a series of long veins which may have been given off from an inner division of the main stem of the cubitus, although proximally the two are somewhat widely separated now. This separation may be due to the same cause which has broken away the anal area, and folded two forked veins underneath the hinder branch of the cubitus. If our interpretation of the cubitus be correct, it must have occupied the greater part of the inner half of the wing, and have occupied a greater area than the radius and median veins combined.

The intercalary venation consists of a fine reticulated meshwork, similar to that of the tegmina. The hind wing fragments are 30 mm. long, and 20 mm. wide.

Affinities.—Brongniart figured a somewhat similar form under the name of *Etoblattina sp.* (Brong. Insectes Fossiles des Temps Primaires, pl. XLVII (31), Fig. 4, 1893), and still more recently M. Pruvost has recorded wings of a similar type from the neighbourhood of Lens in the North of France. (P. Pruvost, "Les Insectes Houillers du Nord de la France." Annales de la Société Geol. du Nord T. XLI., p. 323, 1912, pl. X., Figs. 5, 6 and 7). Monsieur Pruvost has, and we think correctly, placed the forms described by him in Handlirsch's genus *Phylloblatta.* The genus was founded by Handlirsch in 1906 (Handlirsch, Revision of American Palæozoic Insects, No. 1441, Proc. United States Nat. Mus. p. 731) to include many species previously recorded by Scudder under the names of *Etoblattina* and *Gerablattina. Phylloblatta* is one of the best defined genera of the Archimylacrid group, with the following general characters. The wings are elliptical in form, two and a half times as long as wide. Costal area narrowly strap-shaped, and extending to three-fifths or two-thirds along the outer margin. Radius in outer half of wing with few outwardly directed branches. Median vein curving down to inner apical margin.

Cubitus extending over the greater part of the inner wing margin, and giving off a numerous series of straight twigs. Intercalary venation rugose-leathery, or more cross-wrinkled. All these general characters are possessed by the tegmina of the specimen now under consideration, and there can be no doubt that the specimen is referable to the genus *Phylloblatta.*

Of the nine species of Phylloblatta recorded from Commentry and Lens by Messeurs. Handlirsch and Pruvost, that of *P. Brongniarti*, Handl., is so closely in agreement with our specimen that no difference of specific importance can be recognised, and we have no hesitation in assigning it to that species.

Locality.—Commentry (Allier), Central France.

Horizon.—Stephanian.

Figured specimen in the Manchester Museum, Stirrup Collection; Register No., L5,554.

Phylloblatta obscura, sp.n. Pl. III.; figs. 6—8.

Species diagnosis.—Median vein dividing beyond the middle of the wing with few branches; diverging widely from the radius. Cubitus large, with 5—6 oblique undivided branches. Anal veins 6—7 in number.

The body of this insect probably floated out upon the water almost whole, and was not completely broken up before it was silted over by mud. The specimen shows the greater part of the pronotum, the two tegmina, and traces of two, possibly three legs. The details of the specimen are more obscure than is usual with the blattoids found at Commentry, and the pronotum and tegmina have suffered loss. In the former, portions of the surface have been carried away, and the latter have lost the outer portions of the wing margin. A few traces of the hind wings show up through the tegmina.

The pronotum is thin, circular, and was apparently slightly convex, the hinder third covering the attachment of the forewings to the mesonotum. Little more than the marginal rim of the pronotum is left anteriorly, whilst the hinder edge has impressed a groove upon the anal area of the wings.

Tegmina.—The base, and about one-quarter of the distal or free end of each wing has been lost, and the outer and inner margins of the right tegmen are not defined. The portion of wing present has a length of 21 mm., and a greatest breadth of 14 mm. The complete tegmina had a probable length of 29 mm.

The costal margin is preserved in the left tegmen. It is gently convex. The sub-costa is widely separated from the costal margin, to which it sends about ten twigs, only one showing forking. The costal field is strap-shaped, and the sub-divisions of the sub-costa occupy the greater part of the outer margin. The radius in both wings is a relatively unimportant vein, running parallel to the sub-costa. In the right wing, the radius forks about the middle of its length, each branch forking again before the broken edge of the wing is reached. The radius of the left wing divides about the middle of its length like its fellow, the outer branch forking again twice. The median vein passes along the middle line of the wing, diverging widely from the radius, and giving off two or more outward branches beyond the middle of the wing. Its final twigs ran out upon the apex of the wing. The cubitus is a large and important vein. Following a course but little divergent from the main stem of the median, it passes down to the extreme end of the inner wing margin, giving off on its inner side, a series of 5—6 simple oblique undivided branches, followed by a branch which forks twice before reaching the margin. The cubitus of the left wing shows that a single outwardly directed branch is also given off at a point beyond the origin of the undivided inner branches. The course of this was probably parallel to the outer part of the median vein. The cubitus with its sub-divisions occupies the outer two-thirds of the inner margin of the wing. The anal area is well defined in each wing, having partially broken away along the line of the anal furrow, and become pressed down upon the body of the insect. The anal veins are 6—7 in number, the fourth in each wing being forked. The intercalary venation is nowhere clearly marked. The pitted condition of the wings rather indicates a reticulate venation. Traces of the venation of the hind wings are present, more especially under the distal portion of the left wing. It is, however, too fragmentary for description, and the vein fragments cannot be definitely identified.

Legs.—Special interest is added to the specimen by the presence under the wings, of portions of the legs of the left side of the body. Remains of two, or of all three legs are present. The anterior leg lies under the main stem of the subcostal vein, and has resulted in that structure being elevated into a ridge. Lying between the fore and hind legs, are the tibia-tarsus elements of the middle one. Possibly a portion of the femur is present also, lying upon the basal part of the femur of the hind leg. The tibia has short stout bristle-like hairs, and still remains attached to the tarsus, of which three segments can be distinguished. Of the hind leg, the femur, tibia, and a small portion of the tarsus are distinguishable. The femur is twice as broad as the tibia, and is now flattened. The tibia appears to be a well-rounded structure, of even diameter throughout, and clothed with numerous short stout bristle-like hairs.

Affinities.—The general characters of the wings are clearly those of the genus *Phylloblatta*, and the relationship to *P. reniformis*, Handl., is somewhat close. From that species however, the wings differ in the character of the median vein. The latter vein does not divide until a point beyond the middle of the wing has been reached, and its branches are few in number, whereas in *P. reniformis*, the median divides before the middle of the wing is reached, and the branches are at least twice as numerous. The character of the sub-costa, radius and cubitus is much similar. The anal veins are more numerous in *P. reniformis* than in this specimen. As my work upon fossil blattoids has increased, I have become impressed with the variability of the wing venation, and am convinced that when it is better understood, it will be necessary to merge several now recognised species into one. Whether this specimen must ultimately be classed as an example of Handlirsch's species, *P. reniformis*, it is not possible to say. For the present it seems desirable to mark its differences by the creation of a new species. We therefore style it *P. obscurus.*

Type.—Specimen in the Manchester Museum, Mark Stirrup Stirrup Collection; Register No., L5,553.

Horizon.—Stephanian.

Locality.—Commentry (Allier), France.

Phylloblatta Stirrupi, nov. sp. Pl. V.; figs. 1—3.

Species diagnosis.—Radius confined to outer half of wing, relatively feeble; radial sector large, much branched; branches of median occupy whole of outer half of inner margin. Anal area extending over one-third of length of wing.

A thin dark grey slab of shale bears upon its surface two wings, the right underlying the left and destitute of the anal area. The right wing has also the underside uppermost. The left wing, which is almost perfect, lacks only a little of the apical margin, and the inner end of the sub-costal lobe. It lies at right angles to that of the right, and overlies the inner third of it. The venation of both wings is clearly defined.

The outer margin of each wing is gently convex, the apex bluntly rounded, and the inner margin almost straight. The general form is that of an elongated oval. The length is 42 mm., in both wings; the greatest breadth is across the left wing, just behind the anal area where it is 19.5 mm.

Left tegmen.—The sub-costal vein is widely separated from the costal margin, and runs parallel to it along almost the whole of its length, its final twigs bending outwards and reaching the costal margin at a point near the beginning of the distal fourth of the wing's length. A considerable number of twigs are given off to the costal margin, the proximal ones being simple, whilst those in the middle and most distal portion are one, and in some instances thrice branched. The general form of the sub-costal is strap-shaped, a typical archimylacrid feature, whilst the multiple division of the distal twigs is suggestive of *Necymylacris*.

The radius is undivided for the first fourth of its length, and then gives origin to the radial sector, beyond which it divides into two twigs, the outer of which forks just before reaching the outer margin, and the inner forks twice, ending upon the margin in three divisions. This portion of the radius takes but a small share in the wing apex.

The radial sector passes to the outer half of the wing tip, forking three times during its course; two of the secondary twigs and two of the tertiary twigs also fork, so that this division of the radius ends upon the margin in eight divisions.

The main stem of the median vein curves inwards, and gives off four branches outwardly. The first branch divides into three twigs before reaching the wing apex, and the second divides into four. The remaining branches are undivided. The divisions of the median occupy the inner half of the wing apex. The main branch of the cubitus follows a parallel course to that of the median, giving off inwardly a series of 8—10 twigs, of which the first, fourth, seventh and eighth again subdivide. These divisions occupy the whole of the inner margin of the wing, outside the anal area. The anal area is best described as an oval, bluntly pointed at both ends. It is crossed by ten veins, one only of which is forked low down against the wing margin.

Right tegmen.—The right wing presents only minor differences. The sub-costal vein is not nearly so well developed as in the right. The sub-divisions of the radius and radial sector are sixteen in number against thirteen in the left wing, and the median has seven divisions as against ten in the right wing.

The cubitus of the right wing is somewhat more developed than in the left, taking a distinct share in the wing apex.

The anal area has been destroyed, two small traces only being left of the first pair of veins. The intercalary venation appears to consist of a fine meshwork, but this is by no means clear; certainly there is no trace of straight cross veins.

Affinities.—The beautiful condition of preservation of these wings renders generic determination less difficult than usual. The following assemblage of characters is at once characteristic of these wings, and also of the genus *Phylloblatta*. Wings little over twice as long as broad, sub-costal area strap-shaped; radius confined to outer half of wing, radial sector much branched. Median vein curving down to the inner end of apex of wing, and sending off a series of straight outer branches, whose divisions end in the inner half of the wing apex. Cubitus occupying almost the whole of the free inner margin, its distal branches reaching to the apical margin of the wing. Anal area extending over one-third the length of the wing.

In the branching of some of the distal divisions of the sub-costa, there is a resemblance to what obtains in *Necymylacris*, but in the latter, the sub-costal area is markedly triangular. A comparison of the two wings with blattoids described and figured by Brongniart from the Stephanian of Commentry is instructive.

Brongniart figures a number of forms under the name of "*Etoblattina sp.*," and of these, four at least are now classed as *Phylloblatta* by Handlirsch. That author has named the species as follows:—*Phylloblattina agnusi* (Brong. Insectes Fossiles des Temps Primaires, t.48, Fig. 7); *P. Brongniarti* (op.cit. t.48, Fig. 4): *P. Stephanensis* (op.cit., t.46, Fig. 5); *P. reniformis* (op.cit., t.47, Fig. 9).

To these Handlirsch has also added two more species from the Stephanian of Commentry, viz.: *Phylloblatta gallica* (Fossilen Insekten, p. 205, pl. XXI., Fig. 17), and *P. alutacea* (op. cit. p. 206, pl. XXI., Fig. 21).

More recently, M. Pruvost (Les Insectes Houillers du Nord de la France. Annales de la Société Géologique du Nord, 1912) has described three new species of Phylloblatta from the neighbourhood of Lens and Lievin.

The wings now under consideration differ in many details from all of these, and in the present state of our knowledge, these differences are sufficient to rank as of specific value.

It is therefore desirable to give these wings a name, and we adopt that of Stirrupi, in honour of Mark Stirrup.

Type.—Specimen in the Manchester Museum, Mark Stirrup Collection; Register No., L5,551.

Horizon.—Stephanian.

Locality. Commentry (Allier), France.

Incertæ sedis.—The ninth specimen in the collection is one which shows traces of a small head, broad thorax, and narrow abdomen, with fragmentary legs. No traces of wings are distinguishable. Its character and relationships cannot be determined.

The preparation of enlarged photographs, which have alone rendered the study and description of these insects possible, has been assisted by a Royal Society Grant. The photographs have been prepared by Mr. J. W. Tutcher.

DESCRIPTION OF PLATES.

PLATE I.

Megagnatha odonatiformis, gen. et. sp. nov. Bolton.

Fig. 2.—*Megagnatha odonatiformis*, as seen lying upon surface of matrix. Mag. 2.15.

Fig. 2.—Drawing showing pincer-like jaws, legs and position of wings. Mag. 1.5.

Fig. 3.—Drawing of left fore-wing showing portions of veins distinguishable. Mag. 1.5.

Fig. 4.—No. 4.—Restoration of venation of left fore-wing.

Fig. 5.—*Goldenbergii Hamyi.* Mag. 1.13.

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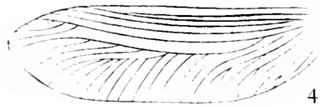

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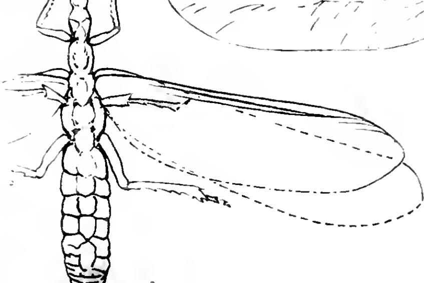

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PLATE II.

Sycopteron symmetrica, gen. et sp. nov. Bolton.

Fig. 1.—Enlarged direct photograph of *Sycopteron symmetrica*. Mag. 5.47.

Fig. 2.—Diagrammatic restoration of *Sycopteron symmetrica*, showing the character of the wing venation. Mag. 5.47.

Necymylacris Meunieri, n. sp. Bolton.

Fig. 3.—Direct photograph of insect lying upon matrix. Mag. 1.66.

Fig. 4.—Restoration and venation of right tegmen. Mag. 1.66.

Fig. 5.—Restoration and venation of left tegmen. Mag. 1.66.

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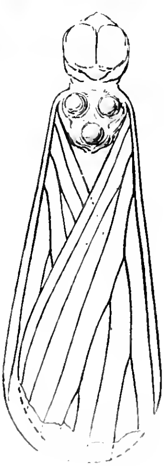

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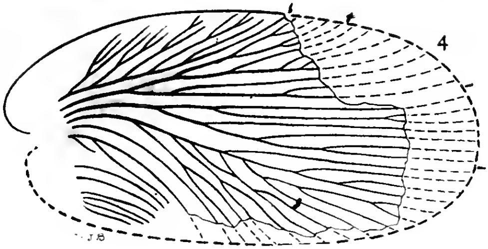

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PLATE III.

Necymylacris Lerichei, n. sp. Bolton.

Fig. 1.—Direct photograph of insect lying upon matrix. Mag. 1.88.

Fig. 2.—Right tegmen restored, and showing venation. Mag. 2.1.

Fig. 3.—Left tegmen, showing the venation. Mag. 2.1.

Fig. 4.—Fragment of right hind wing, showing radius? Natural size.

Fig. 5.—Fragment of tip of left hind wing. Natural size.

Phylloblatta obscura, n. sp. Bolton.

Fig. 6.—Direct photograph of insect lying upon matrix. Mag. 2.0.

Fig. 7.—Fragment of left tegmen showing venation. Mag. 2.0.

Fig. 8.—Fragment of right tegmen showing venation. Mag. 2.0.

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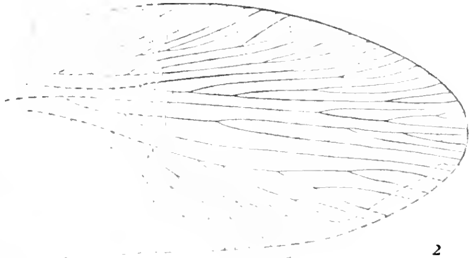

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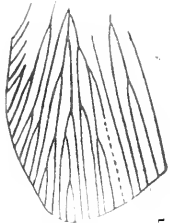

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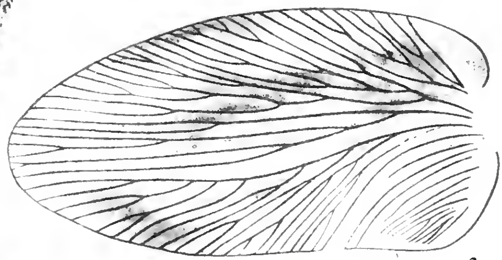

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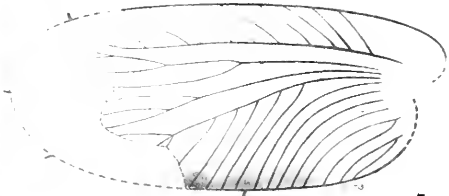

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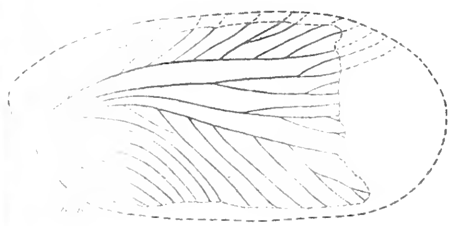

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PLATE IV.

Phylloblatta Brongniarti, Handlirsch.

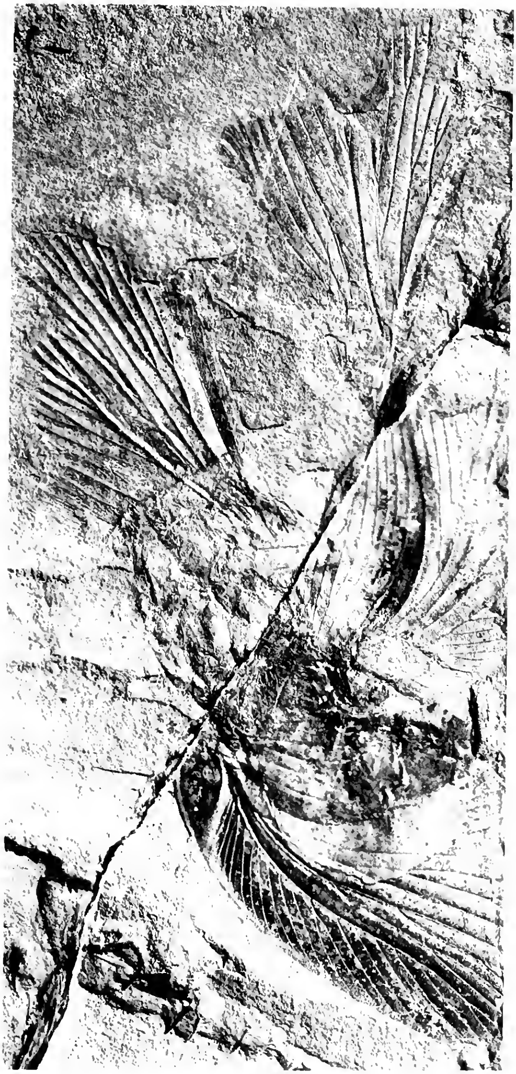
Fig. 1.—Direct photograph of insect lying upon matrix. Mag. 1.90.

Fig. 2.—Right tegmen restored. Mag. 1.8.

Fig. 3.—Left tegmen restored. Mag. 1.8.

Fig. 4.—Fragmentary remains of right hind wing. Mag. 1.36.

Fig. 5.—Fragmentary remains of left hind wing. Mag. 1.36.



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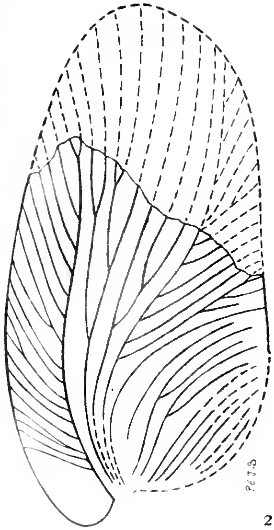

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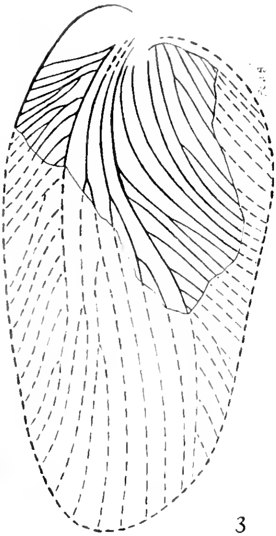

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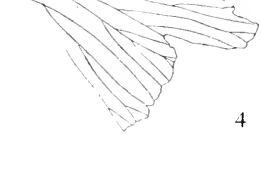

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PLATE V.

Phylloblatta Stirrupi, n. sp. Bolton.

Fig. 1.—Direct photograph of insect wings lying upon matrix. Mag. 2.0.

Fig. 2.—Restored right tegmen showing venation. Mag. 1.85.

Fig. 3.—Left tegmen, slightly restored, and showing venation. Mag. 1.85.

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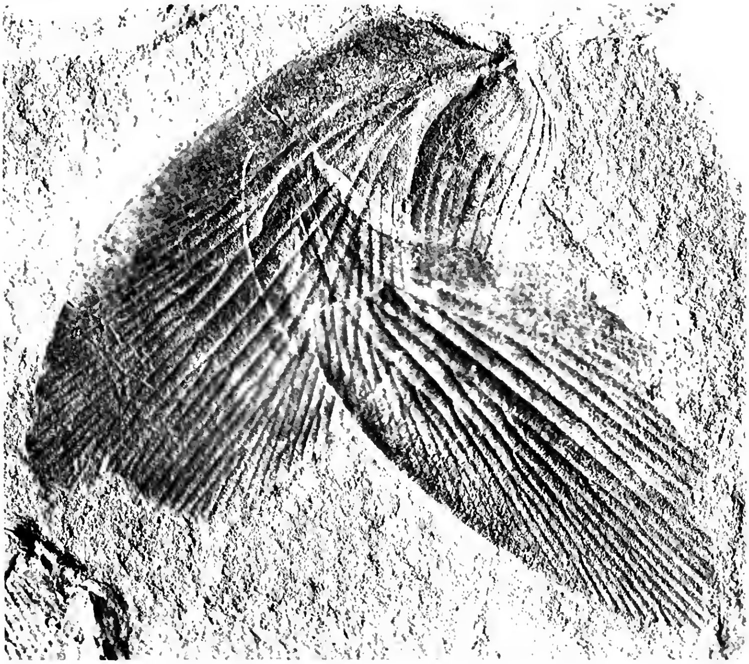

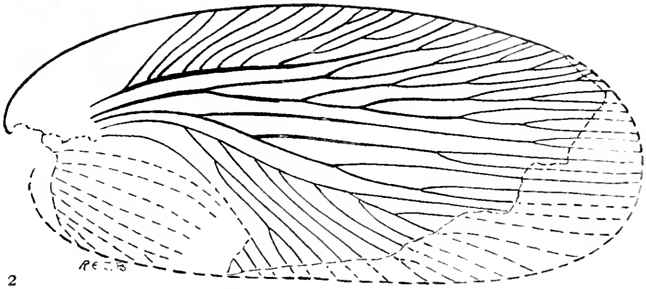

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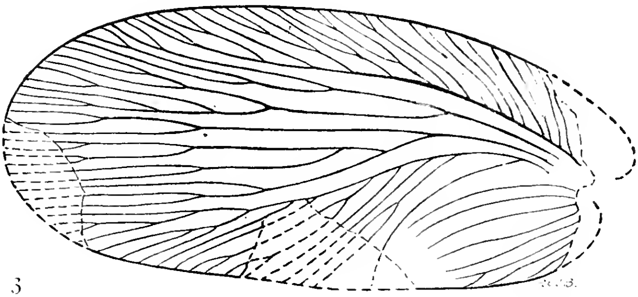

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III. Note on the Action of Hydrogen on Sulphuric Acid.

By Francis Jones, M.Sc., F.R.S.E., F.C.S.

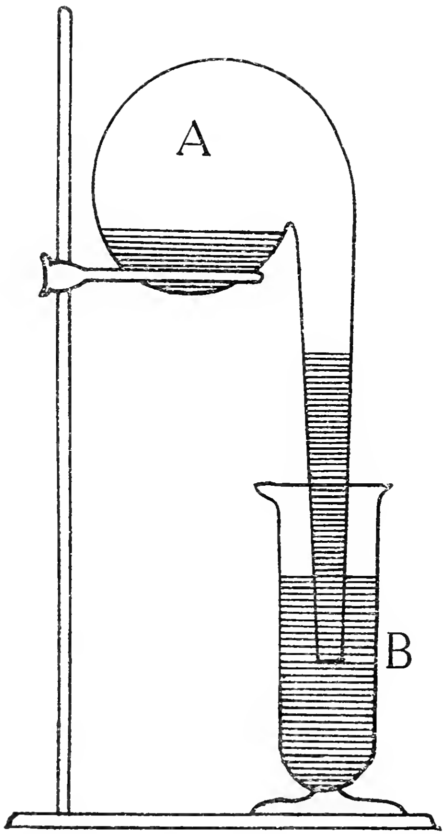
(Read January 9th, 1917. Received for publication January 15th, 1917.)

Many years ago, when working with hydrogen prepared by electrolysis, I noticed that the gas, after being left in contact with strong sulphuric acid, had a distinct odour of sulphur dioxide. It appeared obvious that the hydrogen had reduced the sulphuric acid, and I proceeded to ascertain what work, if any, had been done on the subject. I found that Faraday (Phil. Trans., 1834) had examined the action of *nascent* hydrogen on sulphuric acid. He stated that strong sulphuric acid is a very bad conductor of electricity, but if subjected to the action of a powerful current, oxygen appears at the anode, and hydrogen and sulphur at the cathode. These results were confirmed by Gladstone and Tribe in a paper communicated to the Chemical Society in 1879. They give a detailed account of their study of the behaviour of nascent and occluded hydrogen on sulphuric acid, and arrived at the opinion "that these hitherto supposed different states of the element are very closely related, if not identical—that in fact, the activity of the so-called nascent hydrogen is only the consequence of its intimate association with the metals employed to bring about the liberation of the element." They decomposed strong sulphuric acid (98 per cent. H_2SO_4) with variable battery power, and obtained results agreeing with Faraday's, but when they used one cell only, they obtained very little gas at the anode in ten days, and not a trace of sulphur or gas at the cathode, but the liquid there contained an appreciable amount of sulphurous acid. A similar reduction of sulphuric acid was effected by occluded hydrogen.

G. T. Warner, in 1873 (*Chem. News*, XXVIII., 13) found that sulphur dioxide was evolved in quantity when sulphuric acid was distilled in a current of hydrogen, and that the reaction began at a temperature of 160° C. He also found that sulphuric acid and hydrogen, when treated together for twelve hours in a sealed tube to 205° C. also yielded sulphur dioxide.

Berthelot, in the Compt. Rendu for 1897, also examined this reaction. He found that a slow current of hydrogen passed for an hour through concentrated sulphuric acid at the ordinary temperature did not produce sulphur dioxide, but that prolonged contact between the acid and the gas brought about the reaction. Further, that no reaction occurred with the dilute acid heated to 250° C., whereas at that temperature the concentrated acid was rapidly acted on. He also found there was no reaction between hydrogen and sulphur dioxide heated either to 100° or 280° C.

The last paper to which I will refer is one by Jaroslav Milbauer (Zeit. Phys. Chem., 1907, 649) who maintains that impure hydrogen bubbled through sulphuric acid at the ordinary temperature contains appreciable quantities of sulphur dioxide, while pure hydrogen gives none. Further, the rate



of oxidation of pure hydrogen by sulphuric acid was studied in detail at 174° C. at constant pressure. For a given rate of passage of the hydrogen the amount of sulphur dioxide per minute is constant for acid containing 91 to 97 per cent. of H_2SO_4. Also, that the amount of sulphur dioxide produced is increased by catalytic agents, notably by the presence of metals of the platinum group. These results are in close agreement in so far as the action of *nascent* hydrogen is concerned, they differ as to the action of *free* hydrogen on sulphuric acid particularly in two ways: (*a*) as to temperature, (*b*) as to the effect of impurities in the gas.

It seemed to me worth while to endeavour to devise an experiment that would settle the points at issue.

The bulb A of the non-tubulated retort (*see sketch*) contains strong sulphuric acid, and the rest is filled with pure hydrogen, the point dips under water in the test glass B, and the whole is left at the ordinary temperature for several days. If sulphur dioxide is produced, it will be dissolved by the water, which ought to rise slowly in the neck of the retort. This is exactly what occurs. The reaction is slow but steady. Even a slight impurity in the hydrogen would not account for the gradual diminution in the volume of the gas, which can only be accounted for by the supposition that hydrogen acts on the sulphuric acid at the ordinary temperature in the way suggested by the equation—

$$H_2SO_4 + H_2 = SO_2 + 2H_2O$$

The height of the liquid in the neck of the retort (*see sketch*) represents approximately the result of an experiment continued for twenty days.

IV. An Egyptian Meteorite.

By Henry Wilde, D.Sc., D.C.L., F.R.S.

(*Received and read March 6th, 1917.*)

In the month of October last year an interesting communication was made to me by Capt. Cyril Norbury, of the 7th Manchester Regiment, respecting the fall of a meteorite which he observed in August, 1916, while engaged in military operations in Egypt at the extreme north of the Sinai Peninsula.

The fall occurred in the early afternoon, and was attended by a loud whizzing followed by a great thud. It was at once decided that the sounds were caused by an enemy bomb that had failed to explode, but on further search of the spot with a spade where the body had disappeared it was unearthed.

That the body was an erratic was evident from the fact that no stones of any kind are found in that part of the trackless desert. Capt. Norbury noticed that a portion of the meteorite was missing, but although a careful search was made, the missing portion could not be found. He also mentioned in this connexion as a singular coincidence that a similar occurrence took place at the same time 14 miles away, though the meteorite in that case was never found, but the 6th Manchesters heard a similar buzzing through the air. Capt. Norbury returned to England in the autumn of last year, when he kindly placed the meteorite at my disposal.

I was able to confirm his statement respecting the separation of its parts after entering the atmosphere from the irregularity of its natural lines of curvature. The weight of the meteorite is nearly 3.5 lbs., and the missing parts would be about the same weight. The thin pellicle on the surface of the stone (0.02in. deep) through which it becomes vividly incandescent during its passage through the atmosphere, is indubitable evidence of its identity with those in the collection of similar meteorites in the British Museum.

The Egyptian Meteorite is an amorphous silicate, grey in colour, and contains microscopic particles of iron which are diffused throughout the mass, and cause a magnetised needle to adhere to any part of its surface.

March 23rd, 1917.

A spectroscopic examination of chippings from the meteorite was made with the arc light and the direct vision spectroscope of five prisms with which I discovered the new lines of thallium* and oxygen. The following experimental results for some of the principal lines, in wave lengths, were obtained:—

Iron.—4414, 4404, 4382, 4250, 4186, 4045.
Magnesium.—5183, 5172, 5167, 5527.

The spectral lines of magnesium were probably derived from the resolution of *olivine* into its ultimates, silicon, oxygen and magnesium, as this crystalline mineral is frequently found in meteoric stones.

* *Proc. Roy. Soc.*, Vol. 53. April 20, 1893.

V. On the Contents of a Herbarium of British and foreign Plants for presentation to the Victoria University, Manchester.

By CHARLES BAILEY, M.Sc., F.L.S.

(*Received and read March 20th, 1917.*)

Every herbarium represents part of the autobiography of its founder. It will show his weakness and strength; his preferences, idiosyncrasies, and fads. It will disclose his accuracy, or otherwise, in the records which it includes; his acumen, or the lack of it, in appreciating the facts and ways of nature. It embalms the friendships of his life, the botanical stimulus which he has received, the countries which he has visited; it tells of hairbreadth escapes by land and water; it reminds him of threatened arrests for trespassing or poaching. Its accumulations testify to the life-giving and life-sustaining pursuits with which its collections have been brought together. It has undoubtedly introduced him to a long roll of the most worthy and lovable of his fellow-creatures.

The foundations of a good herbarium rest upon a thorough grounding in the main facts of structural and physiological botany. And of this particular herbarium it may truly be said to have been laid, more than sixty years ago, in the dingy lecture-room of the late Professor W. C. Williamson, in the old Owens College, in Quay Street, Manchester. My revered teacher was therefore its mainspring, and it is fitting, that when I have done with it, it should revert to the University of which Owens was the forerunner. Some particulars, therefore, of its composition will be of interest to future users of this herbarium.

It consists of four portions:—(*a*) British plants, with examples of many non-native plants cultivated in this country; (*b*) native European and Mediterranean plants, with some plants cultivated on the Continent; (*c*) mosses and lower cryptogams, British and foreign; and (*d*) American, East Indian, and exotic plants.

During the course of its formation its ultimate destination had been the subject of frequent consideration with my friend, Dr. J. Cosmo Melvill, formerly of Manchester, now of Meole Brace Hall, near Shrewsbury, who possessed a like extensive herbarium. At one time we were in the habit of subscribing for the same sets of plants from botanists who were collecting in European and other countries, but as we had resolved to present our respective herbaria to the University of

Manchester, it was needless for both to continue acquiring the same sets of plants; from that time, now many years ago, we resolved to work on different lines.

Dr. Melvill's herbarium contained large numbers of type specimens of well-known botanists, collected in all parts of the world, of which details were given in "A Brief Account of the General Herbarium formed by James Cosmo Melvill, 1867-1904," upon the occasion of its presentation to the Victoria University, Manchester, on the 31st October, 1904. It also contained an extensive collection of British plants, many of which came from the same sources as my British herbarium. Dr. Melvill, therefore, decided that the British portion of his herbarium should go to Harrow School, on the understanding that my British plants would find their resting place in the Victoria University.

As the other portion of Dr. Melvill's herbarium contained large collections from all parts of the world, while mine was mainly confined to the plants of European and Mediterranean countries, we resolved that any subsequent additions to our respective herbaria should be in the following directions:—That my additions should be confined to plants from Great Britain and Ireland, from the European Continent, and from the African countries bordering upon the Mediterranean; while Dr. Melvill's additions should be restricted to plants from all countries other than European and North African. This course would obviate much overlapping, and increase the value of the two collections when they became united.

In my own herbarium the method of housing the specimens has been to adopt a uniform size of sheet, measuring $17\frac{1}{2} \times 11\frac{1}{2}$ inches. The sheets are enclosed in boxes with wooden frames and pasteboard lids; the boxes measure, externally, 18×12 inches, and the lids are made as deep as the boxes. The boxes stand on shelves 13 inches above each other, and are enclosed in cupboards 10 feet in height; a separate room attached to the house at Haymesgarth, Cleeve Hill, and measuring 42 feet by 25 feet, has been built to accommodate the herbarium. The cupboards stand seven inches from the walls, to admit a set of hot-water pipes, which runs round the room; a space of a quarter of an inch being left free from the floor, to admit a constant current of air between the walls and the cases. Only a small portion of the herbarium has been mounted, but £500 has been offered to the University towards the cost of mounting the plants comprised in this herbarium. Every six or eight years the growth of the herbarium has necessitated the renumbering of the boxes, to provide for the additional material which had accumulated in the interval; the revision which it is now receiving (on the completion of my 78th year) will be the last before it reaches its final destination.

The herbarium has been in the course of formation since the year 1861. The British portion is arranged according to the sequence of species adopted in Druce's "List of British Plants"; each box is labelled with Druce's numbers (Oxford, January, 1908), and with the numbers in the 10th edition of the "London Catalogue"; the Continental portion follows the sequence of Nyman's "Conspectus Floræ Europææ" (Orebro, 1878-1882), and its supplements (1883-1890). The various numbers which occur on the labels, etc., of individual plants are the numbers of Natural Orders adopted in Balfour's "Class Book of Botany" (published in 1859); thus 28 stands for Caryophyllaceæ, 74 for Leguminosæ, 120 for Compositæ, 161 for Labiatæ, 209 for Salicaceæ, 273 for Lichenes, etc.

Non-localised plants have generally been destroyed, but when any such are included it is either because their source was expected to be traced, or because they furnished good characters of an infrequent form or species. Undated plants, though undesirable, could not always be deleted when such excellent examples as those issued in the "Flora Exsiccata Austro-Hungarica" were sent out without any record of the month or year of their collection.

In the British portion of the herbarium a large use has been made of printed labels recording the localities where the plants were collected, and the surplus—often large—has been distributed to botanists and botanical exchange clubs, in this country and on the Continent. The principal aim sought was to get together, from as many different localities as possible, the common British and European species, rather than to accumulate the less frequent plants. At the close of each season, after supplying home wants, the rest of the plants were dispatched to Continental exchange clubs, which returned me Continental species in exchange for British, lists of obtata, or desiderata, being rarely exchanged on either side.

Besides this feature of the growth of the herbarium, it has been increased by purchase, especially of the published exsiccata of special groups of plants, or of selected European countries. When these exsiccata occur in the herbarium in duplicate or triplicate, it has generally been through presentation, or by purchase of other herbaria incorporated with my own. Some species were duplicated intentionally on account of their excellence; the scrappy character of others frequently necessitated a double or larger supply; while there were some that promptly found their way to the fire for unreliability as to locality, or fraud, or other circumstance. The sources from which most of the plants have been drawn are summarised on pages 11 to 16, but such summary does not profess to be a full record of its varied sources.

The British species, and named varieties and forms, in Druce's "List," and the sequence of the sheets under each species, follows the order of counties, or vice-counties, adopted by H. C. Watson, in his "Topographical Botany"; while the Irish localities follow the divisions of the Irish flora adopted by D. Moore and A. G. More in their "Cybele Hibernica." A nearly complete set of plates contained in the second edition of Sowerby's "English Botany," is included in the herbarium, as well as the plates of "Fryer's Potamogetons," "Hanbury's Hieracia," etc.

Some attempt has been made to catalogue the contents of the British portion of the herbarium, but a busy life has not lent itself to furthering this intention. Whether I shall have the time to do so now is doubtful. One volume only has been compiled, bringing up the data to the end of the *Caryophyllaceæ*.

A record has been kept of every British plant which I have collected during the last fifty-five years, the entries being contained in two volumes, of foolscap size, lettered, "Dated Collections of British Plants," Vol. I. being from 1862 to 1898, and Vol. II. from 1899 to the present time. The plants have been entered in the exact sequence in which they were gathered, the use of a collecting book in place of a vasculum facilitating this arrangement. At the end of every year a systematic summary is given of all the British gatherings of the year.

In the Continental portion of the herbarium the species stand in the exact order of Nyman's "Conspectus," and their position is shown by the numbers stated on the outside of the boxes; thus, box 1,825 contains *Achillea*, species Nos. 18 to 20, on page 368, viz.:—*Achillea Gerberi*, M.B., *A. micrantha*, M.B., and *A. leptophylla*, M.B. A copy of Nyman's "Conspectus" is marked with the corresponding numbers of the boxes, and of their contents. Nyman's index of species would have been greatly increased in usefulness if the names of the authorities for the species had been given; their absence necessitates the making of an independent index for all the larger genera. Nor does Nyman print at the beginning of each page the name of the genus indexed, a fact which often renders the references very irritating, and time consuming.

When the species, native or cultivated, belong to a genus or species not included in the "Conspectus," a place has to be found, by intercalating such plants according to the position assigned to them in Bentham and Hooker's "*Genera Plantarum*" (London, 1862-1883), as summarised in Th. Durand's "Index Generum Phanerogamerum" (Bruxelles, 1888). Use has also been made of De Candolle's "Prodromus"; Ascherson and Græbner's "Synopsis der mitteleuropaïschen Flora" (Leipzig, 1896-1913); Richter and Gurke's "Plantæ Europææ" (Leipzig, 1890-1903); Boissier's "Flora Orientalis" (Geneva and Basle, 1867-1888); W. D. J. Koch's "Synopsis der deutschen und schweitzer Flora" (Leipzig, 1890-1906); Rouy's "Flore de France," Vols. I.-XIV. (Asnières, 1893-1913); Willkomm and Lange's "Prodromus Floræ Hispaniæ" (Stuttgart, 1870-1893);

Coste's "Flore de France" (Paris, 1901-1906); Battandier and Trabut's "Flore de l'Algérie" (Paris, 1888-1910); Gandoger's "Novus Conspectus Floræ Europæ" (Paris, 1910); and any other standard floras.

Where no sufficiently comprehensive list of European species was available, a manuscript list has been compiled, especially of such polymorphic genera as *Rubus*, *Rosa*, *Hieracium*, *Salix*, etc. Even these, however, require expanding when they do not include all the European and Mediterranean countries professing to be represented in the herbarium, as also when new forms are described. To meet such cases, the most complete flora, or monograph, is made the basis of a manuscript linear arrangement of the species of the genus, and into it are dovetailed additional species in their approximate places. In many cases where the additional names occur in works where the arrangement of species differs from that of Nyman's fundamental list, no special care has been taken to fix their exact places in the manuscript list; the main point ensured being that the names are included and indexed, and are made readily accessible under the sequence of the numbers assigned to them in the manuscript index. Many of the additions consist of geographical forms which are practically endemic in their districts, and such names must be duly indexed if the full value of an alphabetical index is to be made available.

Where no manuscript index has been made, the first box of each genus contains a rough alphabetical list of the species not contained in Nyman, and such lists indicate the positions of the intercalated species. The leisure of the past few years has been spent in putting the herbarium in the exact sequence of Nyman's species.

The catalogue of the Continental portion of the herbarium was originally intended to have expressed, in a condensed form, the data furnished by the herbarium itself, by giving the country, locality, published numbers of the exsiccata, date collected, and the collector's name. The time which this method of making records entailed was, however, more than could be found for it, and it was subsequently abandoned. It was, however, followed for all the families from *Ranunculaceæ* to *Fumariaceæ*, for the whole of the *Cyperaceæ* and *Characeæ*, and for the following genera:—*Alyssum*, *Viola*, *Cerastium*, *Medicago*, *Trifolium*, *Symphytum*, *Primula*, *Alectorolophus*, *Euphrasia*, *Salvia*, *Teucrium*, *Ajuga*, *Thymus*, *Mentha*, *Statice*, *Cyperaceæ*, and *Equisetum*. Altogether there are fifteen volumes of these indices, belonging to this herbarium, and there are others partially completed.

In such catalogues the entries are made on alternate lines or pages, according to the size of the page, the alternate lines or pages being reserved for later entries. The rotation number adopted for the species precedes the name of the species and the synonyms follow immediately after. The collector's name, when known, is given in the last column of the page, the next to it being reserved for the date when the example was collected. The column which precedes these two is reserved for the abbreviated titles, and published numbers, of such exsiccata as are included in the herbarium. When there is more than one sheet of a species, collected at the same station and date, the number of sheets in the herbarium is expressed by a small figure in brackets, thus (2), (3), (4), etc.

A shortened form of the larger size of catalogue was adopted for such extensive genera as *Rubus*, *Rosa*, and *Hieracium*, and may yet be carried out for *Salix*. Here the systematic list is first made out, and then the alphabetic list, but the other detailed information of collectors' names, dates, numbers of the exsiccata, are omitted. It will give some idea of the labour involved in preparing even this shortened form of catalogue, by stating that the number of entries of the mere names in my manuscript catalogues is, for—

Rubus,	4,000,	with 6,900	separate	entries,	occupying	377	pages.
Rosa,	2,700,	,, 10,500	,,	,,	,,	507	,,
Hieracium,	5,200,	,, 17,600	,,	,,	,,	663	,,

Whether catalogued or not, with Nyman's marked "Conspectus" at hand, the position of any box in the herbarium is found without loss of time. All the boxes are arranged sunwise, and the numbers of the boxes in each compartment of the herbarium are painted on the doors of the cases which hold them.

When the linear arrangement of the species has been completed, an alphabetical list is drawn up of all the specific names which it contains, together with those of any sub-species, varieties, forms, and the like to which a separate number has been applied. Besides the usual binary names imposed upon the plants, the tertiary, quaternary, and quinary names are also included in the alphabetical arrangement. The inclusion of such varietal names very largely increases the length of the alphabetical list; thus, to take the instance of, say, *Hieracium onosmoides*, Fries—a sub-species of *H. saxifragum*, fully stated it would stand as *H.* (*saxifragum*) *onosmoides*, Fries; and its variety *subnuda*, Arv. Touv., or its sub-variety *porphyritæ*, F. Schultz, would require entering under the letters S, O, S, and P in their respective places, to meet the cases where the collecting botanist uses the shortened name, viz., *H. porphyritæ*, F. Schultz. The only varietal names excluded from this index would be those of such frequent names as *genuinum*, *normale*, *typicum*, *verum*, and the like, which are not worth the labour of indexing alphabetically.

In the alphabetical arrangement every individual name corresponds with the number given to it in the linear arrangement. This enables it to be immediately traced in the herbarium, as the external label on each box gives the name of the genus, and the progressive numbers of the manuscript catalogue. As new, or other unenumerated, forms come to hand, they are arranged a place in the serial list which belongs to them, when their relationships are known; failing this information they are put at the end of the section to which they appear to belong, and often in alphabetical order, their indexed number and name making them readily accessible. Every named form is not necessarily written up in the linear series; but each can be traced in the alphabetical list of the forms belonging to the genus. At whatever point in the linear series at which they are intercalated in the herbarium, they take the same numeral as the form which precedes them, with a, b, c, or other distinguishing letter.

The distinction between super-species, sub-species, race, variety, form and the like, although recognised in the catalogue, is not maintained in the index. All the names are thrown into one alphabetical order, designed to find quickly their position in the herbarium, and, as is explained further on, its representation in the herbarium of the different areas in which the species occurs.

The index includes the chief synonyms, but the indexing proper is, in the main, confined to the names under which the species is most generally circulated by collecting botanists. Its purposes are to ensure easy reference to the place of any plant in the boxes; to record the geographical areas from which the examples in the boxes have been derived; and to show at a glance what lacunæ require filling up when any species is offered.

Besides the sequence of species, a sequence of the geographical areas has been observed throughout the entire herbarium. As has been already indicated, Watson's divisions have been followed for the British areas; and all Continental species are arranged in the like sequence. In such large genera as *Rubus* and *Rosa*, where the number of boxes is considerable, it would take up too much time to hunt for any species sought unless the county areas were strictly followed; in the British section alone there are 111 boxes of *Rubi*, and 65 of Roses, and in the European section 91 and 89 respectively.

The same principle of maintaining a geographical sequence for all the species included in the herbarium has been followed in the Continental portion of the collection. Every species is marshalled in one geographical sequence, which is maintained throughout the herbarium. To effect this in the simplest manner, Europe and the Mediterranean countries have been broken up into sections according as their centres stand west or east of the 11th degree of west longitude, and north or south of the 50th degree of north latitude, Germany and Austria being placed by themselves in a central group. Each area is represented by a numeral, or letter, to economise space when indexing the areas represented in the herbarium.

These areas stand in the following sequence, viz.:—

NORTH-WEST GROUP.

1. Iceland.
   Arctic regions.
2. Norway (except Lapland).

[3 to 5. The British Isles, in separate catalogue.]

6. Denmark.
7. Holland.
   Belgium.
   Luxembourg.

NORTH-EAST GROUP.

15. Sweden.
16. Lapland.
    White Sea.
    Finland.
17. Russia.
    Poland.
    Crimea.
    Caucasus.
    Siberia.

CENTRAL GROUP.

18. A. Schleswig, Holstein, Lauenburg, Hamburg, Altona, and Lubeck.
    B. Hanover, East Friesland, Osnabruck, Oldenburg, Brunswick, Lippe Detmold, and Lippe Schomburg.
    C. Westphalia, Waldeck, Hessen Cassel, Hessen Darmstadt, and Nassau.
    D. Rhenish Provinces, Palatinate-Rhenish Bavaria, Alsace, and German Lorraine—Lothringen.
    E. Baden and Wurtemburg.
    F. Bavaria.
19. G. Mecklenberg Schwerin, and Mecklenburg Strelitz.
    H. Brandenburg.
    I. Saxony Province, Anhalt, Weimar, Coburg, Gotha, Meiningen, Altenburg, Schwarzburg, and Reuss—collectively, Thuringia.
    J. Saxony Kingdom—Leipzic, Zwichau, Dresden, and Bautzen.
    K. Pomerania.
    L. Prussia, West and East.
    M. Posen.
    N. Silesia, including Siebenburgen (Silesian Bohemia).
20. O. Bohemia.
    P. Moravia.
    Q. Austria, Upper and Lower.
    R. Vorarlberg, and Tyrol.
    S. Salzburg.
21. Hungary.
22. Galicia, Bukowina, and Transylvania.

SOUTH-WEST GROUP.

8. Switzerland.
9. France, north of the Loire.
10. France, south of the Loire.
11. Portugal.
12. Spain, north and central.
13. Spain, east and south.
    Balearic Isles.
14. Corsica.
    Sardinia.

SOUTH-EAST GROUP.

23. Italy, north and central.
24. Calabria, Sicily, and Malta.
25. Croatia, Slavonia, and Istria.
    Dalmatia, Bosnia, Herzegovina, Montenegro, and Servia.
26. Moldavia, Wallachia, Bulgaria.
27. Albania, Thessaly, Macedonia, and Roumelia.
28. Greece.
29. Crete, Cyprus, Cilicia, and Syria.
30. North Africa, Madeira, and the Canaries.

To facilitate quick indexing these areas are thrown into a shortened alphabetical index of countries, provinces or other areas, as is shown in the following table, these numbers or letters being frequently used for the various areas named.

All the geographical data belong to a period in use prior to the year 1900.

ALPHABETICAL INDEX OF COUNTRIES, PROVINCES, OR OTHER AREA.

30	Africa, N.
27	Albania.
D	Alsace.
I	Altenburg.
A	Altona.
I	Anhalt.
1	Arctic Regions.
Q	Austria, Lr.
Q	Austria, Upr.
E	Baden.
13	Balearic Isles.
F	Bavaria.
7	Belgium.
O	Bohemia.
H	Brandenburg.
B	Brunswick.
22	Bukowina.
26	Bulgaria.
24	Calabria.
S	Carinthia.
S	Carniola.
C	Cassel, Hessen.
17	Caucasus.
29	Cilicia.
I	Coburg.
14	Corsica.
29	Crete.
17	Crimea.
25	Croatia.
29	Cyprus.
25	Dalmatia.
C	Darmstadt, Hess.
6	Denmark.
B	Detmold, Lip.
16	Fennia.
16	Finland.
9	France, N.
10	France, S.
B	Friesland.
22	Galicia.
I	Gotha.
28	Greece.
A	Hamburg.
B	Hanover.
C	Hessen Cassel.
C	Hessen Darmst.
B	Hessen Schombg.
25	Herzegovina.
7	Holland.
A	Holstein.
21	Hungary.
1	Iceland.
25	Istria.
24	Italy, Calabria.
23	Italy, Central.
23	Italy, North.
S	Krain.
16	Lapland.
16	Lapponia.
A	Lauenburg.
B	Lippe Detmold.
B	Lippe Schom.
17	Livonia.
D	Lorraine.
A	Lubeck.
7	Luxembourg.
27	Macedonia.
24	Malta.
H	Mark Brandenb.
G	Meckl. Schw.
G	Meckl. Strelitz.
I	Meiningen.
25	Montenegro.
P	Moravia.
S	Mountfort.
C	Nassau.
30	North Africa.
2	Norway.
B	Oldenburg.
B	Osnabruck.
D	Palatinate.
17	Poland.
K	Pomerania.
11	Portugal.
M	Posen.
L	Prussia, E.
L	Prussia, W.
I	Reuss.
D	Rhenish Prov.
D	Rhine, Palatinate.
O	Rieseng., Bohem.
N	Rieseng., Silesia.
27	Roumelia.
17	Russia.
S	Salzburg.
14	Sardinia.
J	Saxony, King.
I	Saxony, Prov.
B	Schaumburg.
A	Schleswig.
B	Schomburg H.
I	Schwarzburg.
G	Schwerin, Mk.
25	Servia.
17	Siberia.
24	Sicily.
22	Siebenbergen.
N	Silesia.
25	Slavonia.
12	Spain, N. & C.
13	Spain, S. & E.
S	Steiermark.
G	Strelitz, Meckl.
S	Styria.
N	Sudeten.
15	Sweden.
8	Switzerland.
29	Syria.
27	Thessaly.
I	Thuringia.
22	Transylvania.
R	Tyrol.
R	Vorarlberg.
C	Waldeck.
26	Wallachia.
I	Weimar.
C	Westphalia.
16	White Sea.
E	Wurtemburg.

Explanation of Signs Used in Compiling the Index.

The entry of a number, or letter, in its appropriate column indicates that the species is represented in the herbarium from the area assigned to such number or letter. If the sign is not underlined it means that there are specimens from 1 or 2 localities, or gatherings; if underlined once—3 to 5 localities; if underlined twice, 6 to 8 localities; if underlined thrice, 9 to 11 localities; and so on.

These sections are by no means of equal area; in fixing their boundaries regard was had to the relative frequency with which plants from these areas would be likely to be available. Thus, nearly the whole of European Russia and Siberia is represented by a single number (17), whilst Germany and Austria, to which numbers 18, 19, and 20 are assigned were, from the greater accessibility of the plants therefrom, subsequently broken up into smaller areas; Western Germany (18) into six divisions (A to F); Eastern Germany (19) into eight (G to N); and portions of Austria (20) into five (O to S). It would have been more symmetrical to have re-numbered the areas from 18 onwards, but so much use had been made of them, as originally planned, as to render it undesirable to change them, and it is immaterial whether letters or numbers are adopted, as they are merely symbols of the areas represented in the herbarium.

In the index each of these 43 geographical areas has a separate column assigned to it, the columns being distinguished from each other by coloured ruled lines. When the herbarium contains a plant from any of the allotted areas, its presence is indicated by the symbol assigned to it, every symbol being entered under its own column in the index. If there are three sheets of examples from the same area, its symbol is underlined once; when there are from four to six sheets from the same area, it is underlined twice, and so on, each underline representing three sheets.

When an index of species has been made, it is used in two sizes; in one the page measures 8 × 5¼ inches, in the other 12 × 10 inches, according to the length of the index, the octavo size being the one generally adopted. In the smaller size the species are entered in the first part of the index in systematic order on the left-hand page, the right-hand page being reserved for later additions. Then follows the alphabetical part, which is written up across both pages on alternate lines, so as to allow of any additional entries being made in their proper places.

When the quarto page is used no detailed list is given of the localities from which the examples have been derived. But when the alphabetical list is made out, each page is independent of the other, and runs on continuously, the alternate lines being left for additional entries.

It may be as well to put on record the principal sources from which the plants have been derived. They are arranged alphabetically, the British portion being separated from the Continental, and both these from the exotic section. The dates specified are either those of publication, or when they came into my possession. The list does not profess to be a complete one.

BRITISH PLANTS.

Andrews's Saxifrages, 1805 and later.
Baker's Roses, 1865.
Baker's North Yorkshire, 1866.
Bailey's English, Welsh, Scotch, and Irish.
Barrow's plants, 1879, and later.
Bickham's cultivated plants, 1898—1900.
Bladon's Pontypool, 1876.
Bloxam's Roses and Rubi, 1866, and 1875—1876.
Botanical Exchange Club, London, 1869—1878.
Botanical Exchange Club of the British Isles, 1879—1917.
Braithwaite's Sphagnaceæ, 1877.
Brody's Kent, 1892.
Carrington and Pearson's Hepaticæ Britannicæ, Fasc. I.—V., 1878—1890.
Cooke's Fungi Britannici, Cent. I.—VII., 1864—1872; Ed. 2, 1875—1879.
Crespigny's herbarium, chiefly of the southern counties (Cos. 15—17, 20, and 21.)
Fisher's Lancashire and Cheshire plants.
Friedlander's Hepaticæ, 1870.
Fryer's Cambridgeshire plants, 1888—1889.
Groves's Characeæ, Fasc. I., 1892; II., 1900.
Hardy's herbarium, mostly Yorkshire localities, 1884.
Irvine's Middlesex, 1864.
Kentish Orchids (L.C.'s), 1866.
Leefe's Salices, Fasc. I.—III., 1869—1874.
Lewis's herbarium, mostly from Lancashire and Cheshire, 1895.
Lewis's Rubi, 1876; Fasc. I.—IV., 1891—1894.
Linton's Hieracia, Fasc. I.—VII., 1896—1905.
Linton's Rubi, Fasc. I.—IV., 1892—1895.
Linton's Willows, Fasc. I—IV., 1894—1898. Supp. 1—2, 1912—1913.
London Botanical Exchange Club, 1866—1868.
Lucas's Derbyshire and other plants, 1868.
Molineux's (Mrs.) Ipswich and other plants, 1864.
Moseley's (Miss H.), about 1836—1844, per Mr. Spencer H. Bickham.
Mott's herbarium, of flowering plants.
Notcutt's herbarium, Fareham, Fakenham, and Cheltenham plants, 1844 to 1871.
Rimington's plants, per Mr. Spencer H. Bickham.
Robinson's Frodsham and other plants, 1866.
Science Gossip Exchange Club, 1878—1880.
Sidebotham's Llandudno, 1865.
Sole's Mints, about 1798.
Stratton's Isle of Wight, 1866.
Tempère's plants, per Mr. Spencer H. Bickham.
Thirsk Botanical Exchange Club, 1864—1865.
Ward's herbarium, mostly Yorkshire plants in the early sixties, 1904.
Waters's Cheshire, 1885.
Waterfall's British, 1879.
Windsor's Derbyshire and Settle, 1865.

CONTINENTAL PLANTS.

Ahlberg's Scandinavian, 1899 (per Dr. Boswell Syme).
Austro-Hungarian exsiccata, Cent. I.—XXXV., 1885—1899.
Bænitz's Dalmatian, 1899.
Bænitz's European herbarium, Cent. I.—CXXII., 1868—1900.
Bænitz's Herbarium Dendrologicum, I.—XXX., 1906—1910.
Bænitz's Juncaceæ and Cyperaceæ, 1875.
Bailey's Norwegian (1865), Rhenish (1872), and Swiss (1909).

Baker's Critical plants of Continental Europe, Fasc. I., 1865.
Balducci's Italian, 1890.
Barrow's, 1879, and later years to 1890.
Becker's Violæ exsiccata, Fasc. I.—VIII., 1900—1909.
Berlin Botanical Exchange Club, 31st to 39th years, 1900—1908.
Billot's Flora Galliæ et Germaniæ, Fasc. I.—XLI., 1868—1883. (Continued by Bavoux, Guichard, Paillot, and Vendrely.)
Bordère's Pyrenean, 1870, etc.
Bornmuller's Anatolian, Asia Minor, Persian, Syrian and Trojan, 1889—1898.
Boswell's Scandinavian, 1899 (chiefly Ahlberg's).
Boulay's Ronces Vosgiennes, Livr. I.—VII., 1868—1880.
Boulay's Rubi præsertim Gallici, Fasc. I.—III., 1895—1897.
Bové's Algerian, 1839.
Braun's Herbarium Rosarum, Lief. I.—X., 1882.
Braun's Herbarium Ruborum, Fasc. I.—VII., 2nd Ed., 1877—1881.
Brotherus's Caucasian, 1882.
Bubela's Moravian, 1884.
Burchurd's Canaries, 1904.
Callier's Crimean, 1895—1902.
Carrier's Arabian, Cicilian, European, Kurdistan, and Russian, 1876—1877.
Charrel's Plantæ orientales, 1876—1877.
Chevallier's Plantæ Saharæ Algeriensis, Fasc. I.—V., 1897—1905.
Conrad's Norwegian, 1884.
Cornaz's Roses of Switzerland, 1891—1893.
Costa's Catalonian, 1864.
Coste's Herbarium Rosarum, Fasc. I.—VI., 1894—1900.
Coward's Leguminosæ (Hurst's herbarium), 1868.
Crespigny's European herbarium, 1895.
Cuerca's Spanish, 1900.
Dahlstedt's Hieracia.
Dorfler's Herbarium Normale, Cent. XXXI.—LIV., 1894—1911.
Dorfler's Spitzbergen, 1896.
Dulau's European Artemisiæ, 1877.
Du Parquet's French and Lazistan (named by Boissier), 1868.
Durando's Flora Atlantica, 1852—1866.
Duthie's Maltese, 1874.
Enwald and Knabe's Flora Lapponica, Fasc. I. (1-50), 1881.
Favrat's Swiss Rubi, 1883—1884.
Fontanesium, herb., about 1859.
Friderichsen and Gelert's Rubi exsiccati Daniæ et Slesvigiæ, Fasc. I.—III., 1885—1888.
Friedlander's Cyperaceæ and Juncaceæ, 1874.
Gandoger's European Roses, 1881.
Gandoger's Tunisian, 1908.
Gautier's Narbonne, 1878.
Giraudias's, 2nd to 20th years, 1892—1910.
Goiran's Plantæ Veronensi, 1875.
Haglund and Kallstrom's, Swedish, 1897—1902.
Hamond (The Misses Susan Maria Hamond, and Almeria Hamond), collected at Geneva, 1834 (90 sheets).
Hamond (Miss Almeria), Madeira Plants, 1836 (50 sheets).
Hardy's Californian, 1884.
Hayek's Flora Styriaca, Fasc. I.-XIV., 1906—1908.
Heldreich's Greek, Cent. I.-XV., 1877—1898.
Helvetique, Société, 1892—1897.
Herbarium Umkraute, 1882.
Hohenacker's Cerealia, 1880.
Hunt's Azores, 1846—1848.
Hurst's Egyptian, 1876—1877.
Hurst's Gibraltar, 1868.
Hurst's herbarium of Leguminosæ, 1878.

Hurst's Madeira ferns, 1868.
Hurst's Maltese, 1877.
Huter's Adriatic and Dalmatian, 1868, 1872, 1876, and 1886.
Huter's Ægean, 1891.
Huter's Balearic and Dalmatian, 1886.
Huter's European, 1868—1898.
Huter's Italian, 1880.
Huter's Spanish, 1880—1891.
Huter's Tyrolese, 1870, 1875, 1879, 1881—1898.
Huter's Venetian, 1879.
Huter, Porta, and Rigo's Spanish and other collections, 1878—1889.
Hylten-Cavallius's Swedish ("Linnæa"), 1882—1892.
Irvine's South European, 1864.
Jensen's Danish and Sleswig Rubi, 1887.
Jujuvensis, Horti, 1909.
Karo's Polish and Siberian, 1883—1892.
Kheck's Balkan, 1892.
Kheck's Centuria Normale, Cent. I.-XXX., 1879—1893.
Kerner's Austrian Willows, Fasc. I.-IX., 1863—1869.
Kneucker's Carices exsiccatæ, Lief. I.-X., 1892—1902.
Kneucker's Caricum Badensis, Lief. I.-VII., 1892—1900.
Kneucker's Cyperaceæ et Juncaceæ, Lief. I.-VIII., 1900—1903.
Kneucker's Gramineæ, Lief. I.-X., 1900—1909.
Kœhne's Herbarium Dendrologicum, Lief. I.-V., 1895—1905.
Kronig's Algerian. (Ex H. A. Hurst. Recd. 13th Sept., 1879).
Kuczynski's South European, 1866—1867.
Kumzerow's Russian, 1883—1908.
Lerou's French and Algerian, 1855—1861.
Letourneaux's Egyptian, 1877—1878.
Lewis's Continental herbarium, 1895.
Lindberg's Herbarium Ruborum, Fasc. I., 1882.
Lindberg's Hieracia Scandinaviæ, Fasc. I.-III., 1868—1878.
Lindberg's Hieracia Scandinaviæ, Fasc. I.-III., 1893 (Ed. 2.).
Lindberg's Norwegian, 1884.
Linnæa, Swedish, 1882—1892.
Lo Jacono's Plantæ Siculæ, Fasc. I.-VI., 1880—1886.
Loscos's Aragon, Cent. I., 1875.
Lowne's Palestine, 1864.
Mabille's Herbarium Corsicum, 1868—1873.
Magnier's Flora Selectæ, Fasc. I.-XVI., 1881—1897.
Magnier's Plantæ Galliæ et Belgii, 1897.
Malinvaud's Menthæ, Fasc. I-IV., 1881.
Martini and Van Heurck's Belgian, 1866—1868.
Munby's Plantæ algerienses.
Murray's Canary Islands, 1882—1898.
Murray's Portuguese, 1889.
Nægli and Peters's Hieracia, Cent. I.-IV., 1884.
Neuman, Wahlstedt, and Murbeck's, Violæ suecica, 1886—1893.
Nurnberger Botanischen Tauschverein, 1904—1909.
Ohl's Holstein, Hamburg, 1907.
Orphanides's, Greek, 1872—1887.
Paillot's Flora Sequaniæ, Fasc. I.-III., 1861—1868.
Paillot's Herbarium Fontanesium, 1868.
Palmer's (Miss) South European, 1904.
Payot's Mont Blanc plants.
Phytological Society of Antwerp; Danish and Belgian, 1862—1867.
Pichler's Bulgarian, 1890.
Pichler's Dalmatian, 1880—1882.
Pichler's Greek, 1876.
Pons's Herbier des Roses de France, Fasc. I.-VI., 1894—1900.
Porta and Rigo's Bosnia and Herzegovina, 1868.
Porta and Rigo's Spanish and Balearic, 1890.
Pyrenean Association, 1st to 20th years, 1890—1909.

Rabenhorst's Equisetaceæ, Lycopodiaceæ, etc., 1895.
Ragowitz's Russian, 1901.
Reichenbach's Artemisiæ.
Reichenbach's Flora Germaniæ, Cent. I.-XXIII., 1830—1843.
Reineck's European, 1907—1909.
Reuss's Austrian, 1872.
Reverchon's Algerian and Kabylie, 1896—1898, 1907.
Reverchon's Andalusian, 1866—1867.
Reverchon's Balearic, 1885.
Reverchon's Corsican, 1872—1873, 1878—1883, 1886.
Reverchon's Cretan, 1883—1885.
Reverchon's French, 1867—1907.
Reverchon's Hautes Alpes, 1867—1871.
Reverchon's Sardinian, 1881—1882.
Reverchon's Spanish, 1883—1907.
Richter's, K., Austrian, 1877—1880, 1887—1892.
Richter's, L., Algerian, Persian, 1881.
Richter's Austrian and German, 1877—1880.
Rigo and Porta's Abruzzi, 1875—1876.
Ritter's Austrian, 1872.
Rostan's Piedmontese, 1864, 1869, 1897.
Ruhmer's Cyrenaican, 1884.
Schemman's Hieracia, 1882.
Schemman's Ronces Europ., 1882.
Schemman's Ruborum Europ., 1882.
Schemman's Salices Europ., 1882.
Schonach's Tyrolese, 1886—1887.
Schultz-Bipontinus's Cichoriacetheca, 1862—1866.
Schultz's Herbarium Normale, Cent. I.-LIV., 1855—1911. (Continued by Winter, Khek, Scriber, and Dorfler.)
Schultz's Flora istriaca, 1875.
Schultz's F.T. Tauschvermettung, 4th and 5th lists, 1903—1904.
Schwöder's Herbarium, 1883; chiefly Austrian and Moravian.
Sennen's Spanish, 1906—1914.
Siegfried's Bormio, Swiss, and Istrian, 1896—1899.
Siegfried's Filices, Equisetaceæ, and Lycopodiaceæ, 1900.
Siegfried's Potentillas, 1893—1898.
Siehe's Cilician, 1902—1903.
Silesian Botanical Exchange Club, 18th to 26th years, 1879—1890.
Sintenis's Armenian, 1886, 1899—1902.
Sintenis's Asia Minor, 1889.
Sintenis's Cyprus, 1880—1887.
Sintenis's Greek, 1896.
Sintenis's Mesopotamia, 1890.
Sintenis's Paphlagonia, 1893.
Sintenis's Thessaly, 1897, 1907.
Sintenis's Transcaspia, Cent., I.-VI., 1901—1903.
Sintenis's Trojan, 1884.
Sintenis's Turkish and Armenian, 1892, 1895.
Steinitz's Hungarian, 1883.
Stribny's Bulgarian, Fasc. I.-III., 1894—1903.
Strobl's Flora Nebrodensis, 1874—1886, and Flora ætnensis, 1875.
Sudre's Batotheca Europæa, Fasc. I.-X., 1903—1912.
Sudre's Rubi rari vel minus cogniti exsiccati, Nos. 1—140, 1908—1910.
Swiss Plants (unknown collector) (250 sheets).
Syme's Scandinavian, 1899 (chiefly Ahlberg's).
Taylor's (Miss) Icelandic, 1896.
Tempère's French, about 1879 (ex herb. Rimington and Bickham).
Thompson's French and Italian, 1909.
Thuringian Exchange Club, Lists 4 to 22, 1890—1909.
Tiselius's Scandinavian Potamogetons, Fasc. I.-III., 1894—1897.
Todaro's Flora Sicula, Cent. I.-XIV., 1879.
Tœpffer's Salicetum, Fasc. I.-VII., 1906—1912.

Tœpffer's Silesian Exchange Club, 1881.
Tœpffer's Tyrolean, 1884.
Treffer's Tyrolean, Lists IX.-XXII., 1888—1902.
Tripet's Swiss, 1894—1896.
Uechtritz's Silesian, 1866.
Van Heurck's Herbier des plantes de Belgique, Fasc. I.-VIII., 1864—1867.
Van Heurck's French, 1865.
Van Heurck's Spanish and Italian, 1866—1870.
Van Heurck's Tuscan, 1865—1866.
Wagner's Rhodopean, 1893—1894.
Waters's Swiss and Italian, 1885.
Weiss's European, 1883—1886.
Wiener Botanischen Taucshverein, 1895—1905.
Wimmer's Salicetum Europæum, 1858—1867.
Winslow's Herbarium Rosarum Scandinaviæ, 1880—1883.
Wirtgen's Herbarium Mentharum Rhenanæ, Fasc. I.-III., 1855, 1866, 1879, 1893.
Wirtgen's Herbarium Rhenanorum, Edit. 2, Fasc. I.-XII., 1866—1873.
Wirtgen's Herbarium Ruborum Rhenanorum, 1866, 1881—1882.
Wittrock's Erythrææ, Fasc. I.-IV., 1885, 1886.
Zahn's Hieraciotheca Europæa, Cent. I.-VI., 1906—1911.
Zetterstedt's, Russian and Lapponian, 1873.
Zetterstedt's, Swedish and Norwegian, 1871.

CRYPTOGAMIC PORTION OF THIS HERBARIUM.

(British and Foreign.)

Ahlberg's Scandinavian Characeæ, Fasc. I.-IV., 1899.
Allen's American Characeæ, Fasc. I.-IV., 1899.
Austin's Hepaticæ boreali Americanæ.
Bænitz's Characeæ, 1890.
Bauer's European Mosses, Series 1—16 (Nos. 1—800), 1906—1911.
Braun, Rabenhorst and Stizenberger's, Fasc. I.-V., 1857—1878.
Brébisson's Algæ of France, 2nd Series, 1865 (100 sp.).
Brébisson's Mosses of Normandy, 1825—1833. Fasc. I.-VI. (150 sp.).
Carrington and Pearson's British Hepaticæ, Fasc. I.-IV. (1—293), 1878—1890.
Closter's New Jersey Hepaticæ, 1873.
Cooke's Fungi Britannici, 8vo. series, Cent I.-VII., 1865—1873.
Cooke's Fungi Britannici, 4to series, with lithographed dissections, Cent. I.-VII., 1875—1879.
Dietrich's Mosses, and other cryptogams, Jena, 1861—1864.
Friedlander's British Hepaticæ (136 sp.).
Hardy's (John) Mosses, Sphagnaceæ, and Hepaticæ, 1884.
Hardy's (J. Ray) Algæ of the Pacific Coast of North America, 1872.
Herpell's German Agarics, Fasc. I.-VI., Nos. 1—135, 1880—1892.
Hulme's Scarboro Algæ, 1842 (31 species).
Jersey Algæ (45 species, collector unknown).
Larbalestier's Lichens of Jersey, Fasc. I.-II., 1867—1868 (100 sp.).
Leighton's British Lichens, 1869, Nos. 1—380.
Lewis's British Desmids.
Migula, Sydow, and Wahlstedt's Characeæ, 1889—1906.
Mott's Lichens, British and Foreign.
Mott's Mosses, 1908.
Mott's Seaweeds and other cryptogams, 1908.
Mudd's British Cladoniæ, 1865 (80 sp.).
Mudd's British Lichens, Fasc. I.-III. (300 sp.), 1861.
Nordstedt and Wahlstedt's Characeæ Scandinaviæ, Fasc. I.-III. (1—120), 1871—1874.

Pearson's British Hepaticæ, 1878—1904.
Plowright's Sphæriacei Britannici, 1873 (100 sp.).
Prost's Mosses of the Lozère (260 sp.)
Ralf's Marine and Freshwater Algæ, Desmids and Diatoms, Vol. I (40 sp.).
Schærer's Lichenes Helvetici, Bern, Fasc., 1—12, Nos. 1—250, 1823—1836.
Schærer's Lichenes Helvetici, Bern, Ed. 2, 1—26, 1842—1852.
Schimper's Swiss and other Mosses, 1865.
Schopke's Algæ and Sphagna, 1886.
Sydow and Migula's Characeæ, 1892.
Unknown collectors, British, 142 sp., 15 sp., 30 sp., 14 sp., and 108 sp.
Vize's Fungi Britannici, Parts I.-II., 1873—1875 (3 copies of I., and 2 of II.).
Vize's Microfungi Britannici, Fasc. I.-VI. (and 2 additional copies of I.-III.).
Wagner's German Cryptogams, Bielefeld, 1854—1855, Lief. I.-IV.
Westwood's Algæ of the Isle of Wight (49 sp.).
Wyatt's Algæ of the Devonshire and Cornwall Coasts, Vols. I.-V., and Index (236 sp.).

AMERICAN, EAST INDIAN, AND OTHER EXOTIC SPECIES.

Billing's Canadian, 1865—1868.
Calcutta Botanical Gardens, East Indian, 1884.
Clarke's Australian, 1868.
Crespigny's East Indian herbarium, 1895.
Eggers's Argentine, 1880—1882.
Hall and Harbour's Rocky Mountains, 1864.
Hardy's Californian, 1884.
Hurst's East Indian, 1878.
Hurst's Indian Leguminosæ, 1878.
Kirk's New Zealand, 1884.
Kuczynski's Cape and Swan River, 1880.
Lewis's American, 1895.
Lewis's Chinese, 1895 (Ex herb., Dr. Shearer).
Lindstedt's East Indian, 1884.
Lloyd's Cincinnati, 1884.
MacOwan's South African, 1866.
Maiden's (J. H.), Sydney, 1884.
Port Elizabeth (East African), ex herb., F. T. Mott.
Pringle's Arizona and Oregon, 1881 and 1884.
Pringle's Californian, 1881 and 1884.
Pringle's Mexican, 1885—1888.
Pringle's Pacific Slope, 1881.
Ravenel's South Carolina, 1866.
Richter's Cape and Australian, 1881.
Richter's East Indian, 1878.
Richter's North American, 1877—1878.
Zeyher's Cape of Good Hope, 1866.

SUMMARY OF BRITISH, CONTINENTAL, AND EXOTIC PLANTS, NATIVE AND CULTIVATED.

BRITISH.

	Boxes Nos.		Boxes.		Boxes containing.	
Phanerogams ...	1 to 714	...	710	...	72,699	sheets
Mosses ...	3,069 to 3,088	...	20	...	7,735	packets or sheets
Hepatics ...	3,116 to 3,122	...	7	...	1,637	,, ,,
Lichens ...	3,125 to 3,136	...	12	...	1,814	,, ,,
Fungi	3,144 to 3,150	...	7	...	3,832	,, ,,
Algæ	3,156 to 3,159	...	4	...	1,105	,, ,,
			760	...	88,822	,, ..

CONTINENTAL.

	Boxes Nos.	Boxes.	Boxes containing.
Phanerogams ...	716 to 3,068 ...	2,353 ...	197,368 sheets
Mosses	3,089 to 3,115 ...	26 ...	6,322 packets or sheets
Hepatics ...	3,123 to 3,124 ...	2 ...	729 ,, ,,
Lichens (+3) ...	3,137 to 3,143 ...	10 ...	1,177 ,, ,,
Fungi	3,151 to 3,155 ...	5 ...	990 ,, ,,
Algæ	3,160 to 3,162 ..	3 ...	1,431 ,, ,,
Boxes containing Swiss, Mont Blanc, Payot's French plants, and Dr. Wallich's East Indian plants ...		18 ...	580 ,, ,,
		2,417 ...	208,597 ,, ,,

EXOTIC.

South African—	Sheets.
General	366
Cape of Good Hope ...	1,046
East African	303
Natal	227
South-east African ...	148
	2,090
East Indian—	
Crespigny's herb. ...	2,182
Calcutta	447
Hurst's Leguminosæ, etc.	282
Himalayas	593
South Indian & Ceylon	481
	3,985
Chinese—	
Lewis's herb.	495
Java, Sumatra, etc. ...	271
	766
Australian—	
General	1,078
Swan River, Van Dieman's Land	621
New Zealand ...	979
	2,678
Canadian—	
General	742
	742
North American—	
Rocky Mountains ...	553
Mott's herb.	346
Pringle's Arizona, etc.	963
Pringle's Pacific Slope	171
Pringle's Mexico ...	508
South Carolina ...	315

North American, Contd.—	Sheets.
Lewis's herb.	2,816
Lloyd's Cincinnati ...	798
Hardy's California, etc.	1,045
Crespigny's herb. ...	959
Utah	648
Isthmus of Panama ...	99
	9,221
South American—	
General	905
Argentine	175
	1,080
Jamaica, West Indies, Oceania, etc. ... (Parcels, 3,164 to 3,267.)	677
	677

Summary.

South Africa	2,090
East Indies	3,985
China	766
Australia	2,678
Canada	742
North America	9,221
South America	1,080
Jamaica, Oceana, etc. ... (In 119 parcels, 3,174 to 3,267).	677
	21,239

General Totals.

British	88,822
Continental	208,597
Exotic	21,239
	318,658

Haymesgarth, Cleeve Hill, near Cheltenham.
26th February, 1917.

It may be as well to put on record what will become of the duplicates of this herbarium. All the duplicates of Continental plants, amounting to about 6,000 sheets, were sent to the Queen's University of Belfast, as per my letter to Professor R. H. Yapp, of the 19th June, 1917. By "deed of gift," dated 3rd of June, 1917, I have conveyed to the University of Manchester my British, Continental and other dried plants, library, microscopical slides, diagrams, models of plants, etc. The herbarium was dispatched to Manchester on the 3rd July, 1917, and three following days. Of the duplicates of British plants there may be 20,000 sheets; some of which may, later on, be offered to the Universities of Birmingham, Cardiff, Liverpool, Louvain, Oxford, etc.; but there will still be a residue to be dealt with if strength permits. [Note added during the course of printing, 6th July, 1917.]

Manchester Memoirs, Vol. lxi. (1917), *No.* 6.

VI. An Ethnological Study of Warfare.

By W. J. PERRY, B.A.

(*Communicated by Professor G. Elliot Smith, M.A., M.D., F.R.S.*)

(*Received and read April 24th, 1917.*)

The world is accustomed to think that warfare is a normal feature of savage life. It is conjectured that the struggle for existence between human societies has been partly conducted by this means, the stronger and better organised community enslaving, exterminating, or driving out the weaker. The earliest records of history tell of wars and conquests, and it is inferred that warfare was also a feature of pre-historic times.

The assumption that warfare is the result of the natural pugnacity of mankind is made so universally and confidently that it may seem rash to endeavour to approach the study of human warfare from any other standpoint.[1] Mr. William McDougall says, "the instinct of pugnacity has played a part second to none in the evolution of social organisation. . . . . a little reflection will show that (pugnacity) far from being wholly injurious, has been one of the essential factors in the evolution of the higher forms of social organisation, and, in fact, of those specifically social qualities of man, the higher development of which is an essential condition of the higher social life."[2] This is an authoritative and representative opinion regarding the effect of human pugnacity on the development of society. Mr. McDougall also says, "The races of men certainly differ in respect to the innate strength of this instinct."[3] In other words, the pugnacious instinct of certain peoples has led them to advance in culture, while races less endowed with this instinct have been left behind, and have not developed "specifically social qualities." The relations of savages to-day, according to Mr. McDougall present the phenomenon of "the uncomplicated operation of the instinct of pugnacity."[4] He

1. In dealing with the so-called instinct of pugnacity, I am not concerned with sporadic examples of personal combat, as in the case of two males who struggle for the possession of a female, but with organised conflicts into which the element of personal grievance does not necessarily enter.

2. "An Introduction to Social Psychology," 9th ed., London, 1915, pp. 279, 281-2.

3. *Op. cit.*, p. 279, 117, *e.s.*

4. *Op. cit.*, p. 280.

speaks of "perpetual warfare, like the squabbles of a room of quarrelsome children."[5]

Many people still exist on the earth who do not indulge in the "uncomplicated operation of the instinct of pugnacity," or in "perpetual warfare." The negrito tribes of Africa live generally on friendly terms with their neighbours; they are peaceful, and, when kindly treated, are very useful to their friends. Gifts of food placed by the sides of gardens will result in a strict watch being kept by these small people.[6] The Bushmen of Africa, who formerly, with the Negritos, occupied vast areas of the continent, were peaceful people.[7] The Lapps squabble, but do not use the knives which they carry; the Eskimo, as a rule, are ignorant of warfare.[8] Dr. Rivers records that warfare was unknown in the Polynesian islands of Tikopia.[9] This was also the case in the Lu Chu islands south of Japan. The natives told the traveller Hall that they knew nothing whatever of warfare, and the sight of a Malay *kris* caused them great astonishment.[10] The warlike tendencies of New Guinea tribes vary greatly. Many of the peoples of the coast are cannibals, and exhibit extreme ferocity towards their captives. But the British and German expeditions of 1896-8 found "intelligent, peaceful, and friendly tribes in the interior." Sir W. Macgregor found Papuans on Mt. Scratchley who, "showed themselves amiable and peaceful, and the state of their arms showed that they had not been engaged in any warlike undertaking for years."[11] Similar examples could be found in Indonesia.

Therefore pacific peoples still exist in various parts of the earth, and it is possible that such peoples once occupied regions where only warlike tribes are now found. For example, the history of Africa shows that the group of peoples of warlike habits, called the Bantu, have swarmed over much of southern, western and eastern Africa, enslaving and exterminating weaker tribes, and driving others in front of them.

It is curious that those tracts of the earth which are least touched by outside influences, central New Guinea, Greenland, and elsewhere, should be inhabited by unwarlike peoples. This distribution can be explained by the pressure exerted by warlike peoples, but it causes a definite question to be put:—How is it that some peoples are warlike, while others are pacific? Why should branches of the same people differ in their pugnacity? Why should Papuans of central New Guinea be peaceful, while their kinsmen of the coast are truculent and

5. *Ibid.*
6. Keane, "Man, Past and Present," p. 117, *e.s.*
7. Haddon, "Races of Man," p. 32.
8. Letourneau, "Sociology," p. 199; Joyce, "Handbook to the Ethnographical Collections (British Museum), p. 248.
9. "History of Melanesian Society," Cambridge, 1914 I., 329.
10. Letourneau, *loc. cit.*
11. Keane, pp. 132-4.

ferocious? It is easy to say that races differ in pugnacity, but variations in the pugnacity of different groups of the same race present a difficult problem.

Mr. McDougall discusses the variations in the pugnacity of different branches of the same people in Borneo:—"As one travels up any of the large rivers, one meets with tribes that are successively more warlike. In the coast region are peaceful communities which never fight, save in self-defence, and then with but poor success; while in the central region, where the rivers take their rise, are a number of extremely warlike tribes, whose raids have been a constant source of terror to the communities settled in the lower reaches of the rivers. And between these tribes at the centre and those in the coast region are others that serve as a buffer between them, being decidedly more bellicose than the latter, but less so than the former. . . . . It might be supposed that the peaceful coastwise people would be found to be superior in moral qualities to their more warlike neighbours; but the contrary is the case. In almost all respects the advantage lies with the warlike tribes Their houses are better built, larger, and cleaner, their domestic morality is superior; they are physically stronger, are braver, and physically and mentally more active, and in general are more trustworthy. But, above all, their social organisation is firmer and more efficient, because their respect for and obedience to their chiefs, and their loyalty to their community, are much greater . . . . . the moderately warlike tribes occupying the intermediate region stand midway between them and the people of the coast as regards these moral qualities.

"Yet all these tribes are of closely allied stocks, and the superior moral qualities of the central tribes would seem to be the direct result of the very severe group-selection to which their innate pugnacity has subjected them for many generations. And the greater strength of their pugnacious habits, which displays itself unmistakably in their more martial bearing and more fiery temper, is probably due ultimately to the more bracing climate of the central region, which by favouring a greater bodily activity, has led to more frequent conflicts, and a stricter weeding-out of the more inoffensive and less energetic individuals and groups."[12]

The statements of Mr. McDougall are clear and precise. The superior mental and moral qualities of the central tribes are ascribed to the "severe group-selection" to which the effects of their innate pugnacity have subjected them for many generations. Since these words were written, Dr. Hose and Mr. McDougall have published a work on the Pagan Tribes of Borneo, where they describe a tribe called the Punan, who live "in the central highlands wandering through the upper parts

12. *Op. cit.*, pp. 289-90. These statements are to be found in the ninth edition of Mr. McDougall's work, published in 1915.

of the basins of all the large rivers."[13] The authors tell us that "From the point of view of physical development, the Punan are among the finest of the peoples of Borneo," yet, "the Punan is a likeable person, rich in good qualities, and innocent of vices. He never slays or attacks other tribes wantonly; he never seeks or takes a head, for his customs do not demand it." In spite of this lack of pugnacity, "he will defend himself and his family pluckily . . . . courage is rated highest, and a woman looks especially for courage in her husband." Morals are good; "public opinion and tradition seem to be the sole and sufficient sanction of conduct. . . . . Marriage is for life, though separation by the advice or direction of the chief, or by desertion of the man to another community occurs. Sexual restraint is probably maintained at about the same level as among the other peoples, the women being more strictly chaste after than before marriage." Summing up, the authors say, "Yet, although in culture (the Punan) stands far below all the settled agricultural tribes, there is no sufficient reason for assuming him to be innately inferior to them in any considerable degree, either morally or intellectually."

The account of the Punan shows that a people physically "among the finest of Borneo" exist in the country at the head-waters of the rivers. These people have had no severe "group-selection," yet they are "rich in good qualities," intellectually as good as any tribe in Borneo, and harmless as long as they are treated properly. The warlike tribes, such as the Kayan, are therefore superior only in material culture, for the authors have demonstrated the high standard of physique, behaviour, and morality of the Punan. It consequently seems that "group-selection" has been inoperative as a civilising factor, since a peaceful nomadic jungle tribe has qualities, law-abidingness, courage, morality, all of them "specifically social qualities of man, the higher development of which is an essential condition of the higher social life." The Punan and Kayan live on perfectly friendly terms; the warfare of central Borneo is therefore not incessant, nor does the pugnacity of either people seem to cause strife. If the least advanced people of Borneo is pacific, how comes it that warfare ever began in Borneo?

Most people are aware of the nature of the "warfare" of the Borneo tribes. It is head-hunting. This is the chief form of warfare among many peoples, including those of the Himalayan region, Assam, Upper Burma, South-west China, the East Indian Archipelago, Formosa, New Guinea, and parts of Oceania. Heads are also taken in America, and the North American custom of scalping is akin to head-hunting. Not only are heads sought by these peoples, but slaves are sometimes brought back from head-hunting expeditions. The

13. *Op. cit.*, II., pp. 178, *e.s.*, for the quotations concerning the Punan.

method of getting heads is similar among many of the head-hunting tribes. Small parties of warriors set out and either ambush people, men and women indiscriminately, or rush a village just before dawn. Little open fighting takes place, for directly a few heads are taken the party at once sets off for home. The Kayan of Borneo go out to seek heads on the occasion of the death of a chief, and sometimes they take revenge at the same time for some injury or insult. But they generally leave an injury unavenged for years, and wait until it is necessary to procure heads for ceremonial purposes.

The Kayan differ from the Punan in that they need heads for the funeral ceremonies of their chiefs, and formerly they sacrificed slaves on these occasions. The Punan have no hereditary chiefs, they do not keep slaves, neither do they hunt for heads. A profound difference therefore exists between the social organisation of the Punan and that of the Kayan, and it is a striking fact that only the chiefly class of the Kayan should need heads and human sacrifices for their funerals. Some of the Kayan chiefs differ from the commoners in that they claim to be descended from people from the sky. Not only are Kayan chiefs distinguished from the commoners, but warriors who die fighting, and women who die in childbirth, go to live in the more desirable parts of the land of the dead, and become rich there without working.

One Borneo tribe says that a frog told them first to get heads.[14] Many may consider this a frivolous reason, but it would not be so to some Indonesian peoples. Men have, according to them, been petrified for laughing at frogs.[15]

The Borneo people therefore claim to have been taught their head-hunting, in which case it would not necessarily be due to innate pugnacity. This claim is not fanciful; the Bontoc of Luzon in the Philippines also say that they were taught warfare by a being, Lumawig, who came from the sky and taught them many things in addition to warfare. The Bontoc say that the ghost of a warrior whose head has been taken goes up to the sky, and there has a head of flames; the ghosts of all others go to the mountains. In a tale concerning the first Bontoc man whose head was taken, the "children of the sun" are the authors of the deed.

The Bontoc are therefore quite definite about the matter; they once had no warfare, and someone came who taught them to get heads. The two cases, Bontoc and Kayan, are similar in that a warrior is considered to go to a special home of the dead. Since Kayan chiefs are descended from the sky, and since the Bontoc got their knowledge of warfare from the sky, it would seem that the existence of a sky-born chieftainship

14. The Sebop, a Klemantan tribe. Hose and McDougall. *Op. cit.*, II., pp. 138-9.

15. The story of the frog as an element of comparative religion has yet to be told, and the telling will reveal many curious things.

among the Kayan is of importance in relation to their head-hunting.

Who are the "children of the sun" who took the first Bontoc head? The traditions of Indonesia tell of the coming into various places of people who claimed to be descended from the sun. These "children of the sun" produced a tremendous cultural upheaval in Indonesia.[16] Our knowledge of Indonesia is still scanty, but such facts as we have show that the "children of the sun" formed a chiefly class in several places. The social organisation in these places consists of sacred chiefs, nobles who are warriors, commoners and slaves. These chiefs and nobles are descended from the sky, and they return there at death, while the commoners go elsewhere. It is an invariable belief in Indonesia that the descendants of these immigrants go to the sky, and the only commoners who can go to the sky after death are warriors. It is the prerogative of sky-descended people to return to the sky at death, and the fact that warriors alone of the commoners share this privilege is suggestive of the relationship between warfare and these immigrants.

In referring their head-hunting to the sky people, the Bontoc are making a claim in accordance with the results of the examination of the influence of the "children of the sun" in Indonesia, for it can be shown that head-hunting has been introduced by these people into Indonesia. Such an explanation accounts satisfactorily for the pacific nature of the Punan; they have not learned the practice of warfare because they have not acquired the requisite social organisation.

It is now conceded that cultural influences have moved from Indonesia into Melanesia. Dr. Rivers, in his great work,[17] has given good reason to conclude that migrations (not necessarily of any considerable numbers) have produced profound changes in the cultures of the peoples of Melanesia. In this region hereditary chiefs and slavery are found in those parts where warfare is constant: the western Solomons, Fiji, and New Caledonia. The social organisation of Fiji consists of sacred chiefs, war chiefs, commoners, and slaves. Only those who die a violent death can gain admittance to the land of the dead. Human sacrifices formerly were common in this island.[18] In New Caledonia a sacred chief is found at the head of each tribe. He is a priest rather than a chief, and when he dies it is said that "the sun is set." Then comes a warrior aristocracy, then commoners and slaves.[19] In the rest of Melanesia no hereditary chiefs are found, and there are no aristocracy or slaves. Dr. Rivers has found no record of any serious fighting in Tikopia, although the people have hereditary sacred chiefs.

16. I propose shortly to put forward a detailed examination of the effects of these people upon the indigenous cultures of Indonesia.
17. *Op. cit.*
18. Joyce, *op. cit.*, pp. 127, 131.
19. M. Glaumont, Rev., d'ethnographie, VII., 1888, pp. 75, 129.

In the Banks Islands no definite warfare seems to be carried on.[20]

The old communities of Polynesia, New Zealand, Tonga, Samoa, Tahiti, Hawaii, Niue, and so forth, were warlike. At the head of the community was a sacred chief; then came a nobility who governed and fought; then commoners, and sometimes slaves. The nobility went to a special land of the dead, while the commoners usually died outright, and had no future life.[21] Human sacrifices were common. The chief occupation of the men in New Zealand was warfare, the more desirable parts of the land of the dead being reserved for great warriors, who spent their time in fighting, which was only interrupted by feasts.[22]

Students are agreed that the ancestors of the Polynesians were immigrants. Dr. Rivers has given good reason to believe that head-hunting and the institution of chieftainship were introduced into Melanesia by people who, he supposes, arrived there later than the previous immigrants, who had penetrated still more widely into Melanesia; also that the wave of culture which brought in head-hunting did not reach the New Hebrides or the Banks Islands.

The conditions in the Pacific therefore suggest that the institutions connected with warfare, sacred chiefs, nobles who are warriors, and slavery, were brought into Oceania. This would explain the pacific nature of the peoples of the interior of New Guinea, for the migrants would have missed them; also that of the Tikopians, for they have no hereditary warrior class, and no war chiefs.

The social constitution of Peru under the Incas was somewhat similar to that of the Polynesians. At the head of the State was the Inca, a sacred being, descended from the sun. He was the chief priest of the sun-cult, and also the head of the army. Then came nobles of royal blood, who held all the chief offices in the State, and the chief military commands. After death the Inca returned to the sun, and warriors went to the heavenly plains. Human sacrifices were made on the death of an Inca.[23]

The Aztec of Mexico had a social organisation "similar in its principal features to that of ancient Egypt." The king was at the head of the State, as the representative of the sun-god. Then came the hereditary aristocracy, whose principal occupations were governing and warfare. Below them were the commoners, and finally slaves. Human sacrifices took place on an immense scale. 60,000 victims were slaughtered on the occasion of the dedication of a new temple to the war

20. Rivers, *op. cit.*, II., pp. 86, 100, 452; I., p. 329.
21. Letourneau, *op. cit.*, p. 259.
22. Joyce, *op. cit.*, p. 176; Letourneau, p. 259.
23. Letourneau, "Sociology," p. 479; Prescott, "Conquest of Peru," Chap. I-III.; Tylor, "Primitive Culture," II., pp. 391-2.

god, and 20,000 victims were sacrificed annually to the same god.[24] The ghosts of Mexicans, high and low, went to Mictlan, the underground world; but warriors and women who died in child-birth went to the sky, and accompanied the sun on his daily journey.[25] The same social hierarchy without the king was found in the states tributary to Mexico.

Some of the less developed peoples of America had similar social organisations. For example, the Natchez of Louisiana had a solar hierarchy, headed by a great chief called the Sun. Then came a hereditary nobility, whose ghosts, together with those of warriors, went to the sun after death. Human sacrifices accompanied the funerals of nobles.[26] The social organisation of the peoples of the north-west coast of America consists of hereditary chiefs, commoners and slaves. Sun worship is found among some of these tribes, and slaves were formerly sacrificed.[27]

Agreement has not yet been reached with regard to the immigrant nature of the cultural influence which has been responsible for the pre-Columbian civilisations of America, and the battle between opposing views is still being fought. But the similarity between the social constitutions of America and those of Polynesia is striking and suggestive.

The constitution of the Japanese Empire was similar to those of other warrior peoples. The Mikado is at the head of the State. He is sacred, being descended from Jimmu Tenno, who entered Japan about 600 B.C., Jimmu Tenno being descended from the sun-goddess. The Mikado is the high priest of the national religion. Then came a hereditary nobility, which governed and fought; then commoners and slaves. Human beings were formerly sacrificed in Japan.[28]

The caste system of India seems to have developed out during and after the struggles between the Aryan invaders of India and the peoples whom they found there. The chief caste was that of the Brahmans, who were priests; then came the Kshattriyas, rulers and warriors; then Vaisyas or traders, and finally the Sudra, who were the descendants of the captives made by the conquerors.[29] The Kshattriyas were descended from the sun; Manu, who gave the code of laws, was a Kshattriya, and so was the Buddha.

The history of Africa is one of conquest. On the arrival of the Europeans at the Cape of Good Hope, they found only Hottentots and Bushmen.[30] But further to the north, in

24. Prescott, "Conquest of Mexico," Chap. I.
25. Brinton, "Myths of the New World," 1896, p. 286.
26. Tylor, "Prim. Cult.," II., pp. 69, 88; Letourneau, *op. cit.*, p. 475.
27. Joyce, *op. cit.*, pp. 261-2.
28. Keane, *op. cit.*, p. 308, *e.s.*; Letourneau, "L'évolution de l'esclavage," Paris, 1897, p. 242, *e.s.*
29. A. A. Macdonnell, "Imperial Gazetteer of India, The Indian Empire," vol. II., p. 220.
30. Haddon, "Races of Man," London, p. 32.

Rhodesia, dwelt people of the Bantu race which has spread over such an immense area, owing to its military prowess. The land between the Zambesi and the southern coast was once peopled by Bushmen and Hottentots, but they were driven away or reduced to slavery by the Bantu peoples. The Mashonas and Makalaka were the first to achieve supremacy in South-east Rhodesia, but ever since the history of this part of Africa has been one of conquest. The military tribes of the southern Bantu had a social organisation, consisting of a chief, who was regarded only by such warrior people as sacred; a warrior nobility, commoners, and slaves.[31] Such people as the Bushmen and the Hottentots had no hereditary chiefs.

The numerous stone forts in the Rhodesian hills were built by people, probably from Arabia, who were working the gold mines at a very remote period.[32] Prof. Keane tells us that "the Makalakas, with the kindred Banyai, Basenga, and others, may well have been at work in the mines of this auriferous region, in the service of the builders of the Zimbabwe ruins" (p. 102), and this is probably true, for the Mashonas and Makalakas are skilled in metal working and mining. The stone forts of the gold-mine region show that the country was held under military tenure, and it is not risking much to claim that the builders of the forts would have pressed the neighbouring peoples into their service as warriors. The miners were sun-worshippers, and they have left their traces on the peoples of Rhodesia in that the chiefly houses sometimes claim descent from the sun. The presence of sun-worshipping, war-waging people at Zimbabwe and elsewhere is quite sufficient to account for the warlike tendencies of the military Bantu tribes, and the localisation of these tribes is such as to make it probable that they acquired their knowledge of warfare in this way.

It may be claimed that the Bantu peoples spread from North-east Africa. The Bantu are negro in type, but in the north the military tribes are ruled by an alien aristocracy of Galla stock, the Gallas being Hamites.[33] The warrior states are ruled by sacred chiefs; then comes a warrior aristocracy, commoners and slaves. Only the warrior states have sacred chiefs, and in British East Africa are numerous tribes without this form of social organisation, these tribes in some cases being serfs.[34] The peoples with Hamitic aristocracies, or mixed Hamitic and Bantu peoples, also differ from other Bantu peoples in another remarkable way. Mr. A. C. Hollis says, "As a general rule it may, I think, be said, that prayer and sacrifice to the sun or deities in the sky are un-

31. Joyce, p. 214.
32. Sir H. Johnston, "The Opening up of Africa," p. 86, *e.s.*; Schoff, "The Periplus of the Erythraean Sea," London, 1912, p. 97, *e.s.*
33. Keane, p. 93.
34. Keane, p. 94.

known among the Bantu tribes of Eastern Africa, whilst this form of worship is followed by all the Nilotic or Hamitic tribes."[35]

The past history of the Bantu peoples and their social organisation are such as to suggest that the northern group at least learned the art of warfare and acquired their religion from the Galla, who formed their hereditary fighting aristocracy, for Hamitic peoples have formed many of the fighting tribes of Africa. The southern group perhaps learned their fighting from those who originally introduced the methods of architecture represented in the Zimbabwe ruins. The possession of the knowledge of the art of warfare would explain the ability of the Bantu to conquer the greater part of Southern Africa, and to found in many places warrior empires of similar social constitution.[36]

The warlike nature of the Hamitic peoples of Africa thus seems to have effected immense changes in the ethnography of that continent. How comes it that such a powerful social ferment was at work in the north-east, whence the Galla came? Whence had the Galla peoples acquired their social organisation? From the headwaters of the Nile southwards we find a succession of warlike peoples who possess similar social organisations and religious beliefs, these peoples alone having such organisations. In the Nile valley the Egyptian civilisation persisted for thousands of years. The social organisation of Egypt under the Pharoahs consisted of the king, who was descended from the sun, and was the high priest of the sun-cult; then came a military and governing aristocracy, commoners and slaves. Have we any reason to believe that the Egyptians taught the African peoples to fight and to overrun the continent with a military organisation similar to their own? Prof. Elliot Smith has lately published evidence which puts the matter beyond doubt.[37] He has shown that some of the Bantu peoples who possess hereditary chiefs, i.e., the warrior peoples, subject the bodies of their deceased chiefs to a process of preservation, and the methods employed are directly copied from those practised in Egypt. Only hereditary chiefs are so treated in Africa, and, as the institution of hereditary chiefs is accompanied so closely by the warrior nobility and a sky-cult, the presumption that the social organisation of the warrior peoples was ultimately derived from Egypt becomes very strong. Since the bodies of the chiefs of the Baduma and Barotse in Rhodesia are mummified, we have further evidence for the Egyptian origin of the civilisation of the builders of the Zimbabwe ruins, and therefore of the social organisation of the warrior tribes of the southern Bantu peoples.

35. "The Religion of the Nandi," *Proceedings of the International Congress of Religions*, Oxford, 1908, p. 90.

36. See Sir H. Johnston, "The Opening up of Africa," p. 134. "A Sketch of the Ethnography of Africa," *Jourl. Roy. Anth. Inst.*, XLIII.

37. "The Migrations of Early Culture," Manchester, 1915.

The great kingdoms of West Africa, Bene, Dahomey, Ashanti, with sacred kings, a warrior nobility, commoners and slaves, and a sun-cult, were in a region which has most probably been subjected to Egyptian influence, both directly and by sea round the west coast. Human sacrifices were common in these states.

The evidence gained from Oceania, America, Asia, and Africa, affords support for the results obtained from the consideration of Indonesia. All over the world warfare is bound up with a social organisation consisting of sacred chiefs or kings, a hereditary governing and warrior aristocracy, commoners, and slaves captured in war; it is also accompanied by a sun-cult or a sky-cult. In these communities slaves are sacrificed, often on the death of chiefs, and heads are sometimes sought for the funerals of chiefs, and for other purposes. Warfare among many of these peoples is also the means of entering a specially desirable home of the dead, generally situated in the sky. We have found that it is not possible to explain the warlike or pacific spirit of peoples by postulating an instinct of pugnacity. We have now seen that a warlike spirit is associated with a military aristocracy. We also see that the social organisation connected with warfare was introduced into Indonesia, Oceania, perhaps America, Japan, India, Africa, by immigrants who, in India, Africa, New Caledonia, Indonesia, and perhaps America (native traditions tell of the coming of culture heroes), were called the "children of the sun." Warfare was introduced among the Bontoc and Luzon and other Indonesian peoples by the "children of the sun"; it was also introduced into South Africa, and probably elsewhere. The facts suggest, therefore, that the practice of warfare was introduced into various parts of the world by peoples, sometimes claiming to be descended from the sun, and possessing a sun or sky cult, who introduced a form of social organisation consisting of sacred chiefs, a hereditary governing and warrior aristocracy, commoners, and slaves, who also caused a special prestige to be attached to the practice of warfare.[38]

If these statements are true, it will follow that warfare is not a natural thing among mankind. Before the arrival of the "children of the sun" savage peoples would be at the stage of the Punan, Bushmen, Tikopians, Eskimo, and others—peaceful, without hereditary chiefs or warriors, nobles or slaves.

The conclusion suggested by the facts is that a people will be warlike or peaceful, according as they have or have not a hereditary warrior aristocracy; if a warlike community loses its military aristocracy, it will become peaceful, and if a peaceful community acquires a warrior aristocracy, it will become warlike.

38. It does not follow that the same people took the culture all over the earth. Doubtless different races acquired it and then in their turn influenced others. One of the tasks of the future will be to follow up these secondary movements.

The contrast between the Japanese and the Chinese illustrates this. The Japanese are warlike, while the Chinese are pacific. The social constitution of the Japanese has already been described. The Chinese have for centuries been governed by successive dynasties; but these dynasties have never established themselves, and in the course of time China has become a republic. China has no hereditary nobility; all the high offices of the State are reached by competitive examination. The difference in social constitution is accompanied by an entirely different attitude towards warfare; what is an honourable thing in Japan is despised in China. The Chinese look down upon warfare and those who practise it, and their army was formed of Manchu Tartars, who are of a typical warrior race.[39] Therefore the contrast between the two countries is still further emphasised; the "children of the sun" have gained complete control in Japan, and have infused a warlike spirit into the nation; in China the "children of the sun" have not formed an aristocracy, and the people have remained peaceful, the fighting being done by the "children of the sun."

India for centuries was ravaged by wars. Mr. McDougall says that, "the mass of the people have been subjected for long ages to the rule of the dominant castes. . . . The bulk of the people are deficient in the pugnacious instinct."[40] They may never have been warlike, and the pacific nature of the country may be due to the fact that "the warrior caste of Kshattriyas is conspicuous by its absence."[41] Kings of solar descent still exist in the warlike states, Nepal and so forth,[42] and the Rajputs have succeeded to the Kshattriyas as a military caste. The Todas and other tribes of the Nilgiri Hills are peaceful. The Todas possess weapons, which are now only used ceremonially, but there is evidence that they were once used for fighting. The culture of the Todas shows that they have been influenced by the "children of the sun," but the latter have not imposed a hereditary chieftainship or warrior caste, so the Todas have once again become peaceful.[43]

An example from Europe will show the effect of the presence of a warrior aristocracy upon a community. After the break-up of the Roman Empire, Northern Italy was overrun by successive waves of barbarians; Lombards, Germans, Goths and Franks. Many of the noble Italian families became extinct, and cities such as Florence, Genoa, Pisa, Venice, freed from the incubus of a class whose sole profession was warfare, grew and prospered. These cities banded themselves together for protection against "the brigandage of the barbarian armies, which invaded their countries and treated them as enemies,"

39. Letourneau, "Sociology," p. 200; Oldham, "The Sun and the Serpent," London, 1905, p. 202.
40. *Op. cit.*, 291.
41. R. Sewell, "Imp. Gaz. India," II., 1908, p. 323.
42. Oldham, *op. cit.*, p. 109.
43. W. H. R. Rivers, "The Todas," pp. 586, 716.

and also against the "robberies of the other barbarians who called themselves their masters."[44] The old Italian nobility which remained soon discovered that these cities were determined to be left alone to develop their resources in peace. Nobles managed in time to gain a footing in some towns, but their turbulence caused the peaceful citizens to eject them. Sometimes they established themselves, and the contrast between the towns which were purely republican and those which were governed by nobles is striking.

Florence was republican and democratic at a time when Venice was governed by an aristocracy. Sismondi describes the difference between the two places. "Florence was the Athens of Italy. The genius displayed by some of its citizens—the talent and intelligence in business to be found in the men of the people—the generosity which seemed the national character, wherever it was necessary to protect the oppressed or defend the cause of liberty—raised the city above every other." The Florentines "pursued for themselves the noble policy of opposing all usurpation or conquest by any who pretended to domination in Italy."[45] Sismondi then describes the effect of the superposition of an aristocracy, of whom he says that "war was their sole occupation."[46]

"The virtue and elevation of soul, which had done such honour to the Italian nation became obscured, even in the republics of Genoa, Lucca, Pisa, Sienna, Perugia, and Bologna. These republics, in the course of the fourteenth century, had all more than once fallen under the power of some tyrant; accordingly, the examples of cruelty, perfidy, and the success of these usurpers to whom they had been forced to submit, had had a corresponding effect upon their citizens. Neither had Venice presented the true Italian virtue; its citizens often gave proofs of an unbounded submission to its most severe ordinances, but it was a narrow-minded and jealous aristocracy, which, according to the spirit of that government, substituted national selfishness for patriotism. The Venetians took not into the least consideration any other people; they fancied they gave proofs of heroism, when the advantage of their republic was in question, in suppressing every human sentiment, in silencing every moral duty. Venice was governed by secret councils, where the voice of the people was never heard; its foreign policy was administered by the Council of Ten, which in its mysterious meetings took interest only for a guide."[47]

If the warlike temper of a people depends upon the presence or absence of a class which follows war as a profession, it is reasonable to suppose that warfare forms part of a *system;*

44. Sismondi, "Italian Republics," London, p. 27.
45. *Op. cit.*, p. 130.
46. *Ibid.*, p. 25.
47. Sismondi, *op. cit.*, p. 185. The description of Venice under an aristocracy is strikingly similar to that of Germany at the present day.

that it must perform some useful function. Why is war useful to certain forms of social organisation, and not to others?

The social organisation of warrior peoples is such that one class—the nobility—is parasitic. It demands work from the lower classes, and commoners and slaves will supply the different forms of labour needed. How did the Pharoahs of Egypt build their pyramids? By slave labour. Whole populations were enslaved by Egypt, Babylon, Assyria, in order to toil for their rulers, and the gigantic works of antiquity were only made possible by the fact that the Egyptians and others could wage war upon peoples and enslave them. If the savages of early times were pacific, it is easy to understand how the Egyptians and other peoples could have enslaved them.

Does not this need of labour and wealth explain the utility of warfare to a governing class? It is a means of ensuring their own luxury and ease. Much of the warfare of Africa and other continents has been of the nature of slave-raiding, and whole tribes have been made slaves by warrior peoples such as the Masai, so that such warrior peoples might be saved the trouble or working.

Warfare formerly supplied another need. We have seen how constantly slaves were sacrificed by warrior peoples. Human victims were needed for the sun-cult, and for other purposes, and the existence of human sacrifices among warrior peoples is in keeping with the frequent presence among these peoples of the sun-cult. Head-hunting is therefore explicable on the hypothesis that it is a search for victims for the chiefs of the warrior peoples, and for their cults; that, in fact, it is a modification of human sacrifice. Head-hunting can indeed exist along with human sacrifice, as among the Kayan of Borneo.

Slaves are only found among peoples who practise warfare. Unwarlike peoples have no hereditary chiefs, no slavery, and no human sacrifices; on the other hand, slavery and human sacrifices are associated with a hereditary warrior aristocracy.

The hypothesis that warfare originated among a sun-worshipping aristocracy is therefore in accordance with the facts. The enslavement of humanity has not proceeded from any innately cruel motive, but from that powerful stimulant which, once at work, will drive men to extremes—greed. It can be shown that the motive which led the "children of the sun" to the ends of the earth, was that of the exploitation of wealth,[48] and examples could be quoted of the manner in which they enslaved whole populations to work in their mines.

The history of slavery is one of the saddest, and the motives at the back of the practice are still powerful to-day. The exploitation of human labour still continues, and only

48. "The Relationship between the Geographical Distribution of Megalithic Monuments and Ancient Mines," *Proceedings of the Manchester Literary and Philosophical Society*, Manchester, 1915.

the gathering strength of the people is ameliorating the lot of industrial slaves. Human beings are never so cruel as when they are bitten with the desire for wealth and ease, and possibly this desire has been the driving-force at the back of the movement towards civilisation. Man has not emerged from a state of savagery to civilisation and dropped his pugnacious habits; his pugnacious habits are rather the result of civilisation, of the exploitation of man by man, of the desire for wealth and luxury. The motives which gave rise to the wars of the Egyptians, Assyrians, and other nations of antiquity are still as powerful and active to-day as they were thousands of years ago; perhaps they are more active. The desire to exploit humanity has not decreased with advancing civilisation.

What is the bearing of all this upon the problem which now confronts Christendom? The Prussian military aristocracy is waging war. This aristocracy supplies practically all the chief officers in the German army, and holds the principal offices in the State. At the head of the State is a king, who, if not sacred, claims to rule by Divine right. What is the history of this organisation, which is similar to that of the typical warrior state? Have the "children of the sun" also taught the Germans to fight, to seek for a "place in the sun"?

The old Teutons were sun-worshippers, and they had a social organisation consisting of a priest-king, supported by a military aristocracy. Slaves were kept and sacrificed. As among many other warrior peoples, warriors were specially honoured; they only went to Walhalla; "to the old Norsemen, to die the straw death of sickness or old age was to go down into the dismal loathy house of Hela, the Death-Goddess; if the warrior fate on the field of battle were denied him, and death came to fetch him from a peaceful couch, yet at least he could have the scratch of the spear, Odin's mark, and so contrive to go with a blood-stained soul to the glorious Walhalla."[49] Captives of war were thrown into the graves of chiefs.

The evidence quoted goes to show that the source of the social organisation of the old Germanic peoples was similar to that of the other warrior peoples; the German culture displays many of the typical traits: sun-cult, priest-kings, warrior nobility, slavery, human sacrifices, and a special home of the dead for warriors; and it is possible that this organisation has been introduced. The Prussian warrior aristocracy, in regarding war as a splendid thing, as a means of obtaining wealth and power, are simply furnishing another example of a typical warrior state; and their Kaiser in claiming Divine Right is completing the picture. The warlike organisation of

49. Tylor, *op. cit.*, II., 88. The introduction of warfare into the north of Europe is a matter of conjecture at present. Nilsson states that the cult of Odin and Walhalla was introduced among the Teutons of Scandinavia by the Asar, a princely priest-caste. "The Primitive Inhabitants of Scandinavia," London, 1868, p. 237.

the Prussians is deeply rooted in the past, and they are the latest, and one would like to hope the last, and most formidable representatives of the warrior-state system. The Prussians may well claim that they are the bearers of a Kultur, but they are wrong in supposing that their Kultur represents an advance upon that of the rest of Europe. If the thesis of this article be correct, the truculence, perfidy, and other qualities which we ascribe to modern Germany are the direct outcome of the growing power of the Prussian military aristocracy. Just as the nobility caused a degeneration in the character of the Venetian state, so the Prussian military and governing aristocracy has transformed the Germans. The military successes of the last century have enhanced the prestige and multiplied the power of the military aristocracy, and the present war is the outcome of the desire of that class for domination. This war is to be ascribed to the working of social processes, the roots of which lie in the past. But fortunately mankind is not faced with a situation that has been produced by a process of evolution, by the struggle for existence between various societies, the effects of which have been to produce "specifically social qualities." The evidence brought forward here goes to show that warfare has nothing whatever to do with the development of the higher social qualities. It was in the beginning a means whereby one group of human beings exploited another, and far from producing good qualities, it has created mental appetites and ways of thinking and acting which have led to the death of millions. Fortunately other social forces have been at work. Countries such as France and England, once under the yoke of a warrior aristocracy, have freed themselves, and now direct their own destinies more and more for the profit, not of a class, but of the people. Great democracies are growing up in all parts of the world—America, Africa, Australia—and these democracies, freed from the incubus of a sabre-rattling, war-desiring aristocracy, are devoting their entire energies to peaceful advancement. These democracies are peaceful; they lack the presence of a class whose interest is warfare.[50]

The leaven of the "children of the sun" is working itself out. This war, let us hope, represents the last struggle of a system which has held mankind in its clutches for centuries. Once this system is shattered, once the leaven is dead, mankind will settle down to a new phase of development. Warfare as we know it will perhaps be absent, but the motives which gave rise to it will be present. Greed will always press men to exploit their fellow-creatures, and it is only possible to hope that mankind will learn the lesson of the past: that the exploitation of a community for the sake of one class is fraught with grave and continual dangers.

50. Their behaviour in warfare is well exemplified in the case of the United States, who beat Great Britain, but neither made this a pretext of aggression; a contrast to the Prussian method.

VII. Observations on the Nesting Habits of the Palm Swift, *Tachornis parva* (Licht.), made by Mr. Arthur Loveridge in German East Africa.

By T. A. Coward, F.Z.S., F.E.S.

(*Received and read April 24th, 1917.*)

A skin and nest of the Palm Swift, *Tachornis parva*, were recently sent to the Manchester Museum by Mr. A. Loveridge, who is serving with the forces in the country which a short time ago was German East Africa. A letter, telling me about the specimens, contained some interesting notes on the nesting habits of the bird, as observed at Morogoro, in January, 1917. Certain details observed by Mr. Loveridge are, I believe, new facts, whilst others confirm points in the extraordinary habits of the species, which have apparently been doubted by some writers on African birds.

The Palm Swift has a wide range in Africa, occurring from Nubia and Madagascar to the Gold Coast, and southward to the Cape. It has long been known to nest in the leaves of the palms, but apparently, as the bird is numerous wherever it founds a colony, it has been sufficient for most people either to take for granted statements copied from book to book, or to omit any mention of habits which appeared to differ from those of other birds.

The following are Mr. Loveridge's notes.

"*Nest and Eggs.*—When out collecting this morning I came across a small colony of Swifts nesting in the banana palms which line the sides of the road. The lowest nests were 12 to 15 feet from the ground, and were attached to the frond of the leaf just below its union with the mid-rib of the leaf. The inner side of the leaf being concave, a few downy feathers are gummed to its surface over an area of 4½ inches in length and 2 inches in width, which is the width of the frond. At the lower end of the patch the shallowest of cups is formed, and the two white eggs rest upon this and are gummed to the back of the nest. These eggs will not fall out though the nest be turned completely topsy-turvy, and the branch that bears it be roughly shaken. The eggs in the first nest could be seen whilst standing directly underneath.

Incubation—The incubating parent grasps the back feathers of the nest with its claws, and presses itself against the eggs;

May 17th, 1917.

of seven nests examined to-day, in three cases it was the male incubating the eggs, and in the remaining four, females. There is always more or less of a breeze here, and frequently a strong wind, rising to a gale after sunset. As may be imagined, the fronds are swaying up and down nearly all the time, and the back of the brooding bird is often underneath.

Young.—When hatched, the young cling tenaciously to the feathery wall, and on my disturbing two, they actually lowered themselves down, and as far as possible into, their old egg-shells, which, of course, continued to occupy the cup-part of the nest. The latter swarmed with bird-lice and several other species of minute parasites. Two youngsters, which were in the downy stage, could scarcely be distinguished from the feathers which comprised the nest.

Contents of Nest—

1. Single egg, highly incubated.
2. Two eggs, one incubated or bad, the other almost fresh.
3. Two eggs, both highly incubated.
4. One egg broken and bad, and one newly fledged bird.
5. Two young birds only a couple of days old.
6. Two downy young.
7. Empty except for crushed eggshells, the young having flown.

Though the palms bearing these nests were just outside the hut occupied by my boy, on having them pointed out to him he insisted they were the work of insects, and would not believe them to be the work of birds till he saw the eggs. Certainly at a little distance they appeared as a cobwebby mass.

The bird, though of much the same colour as the English swift (*Cypselus apus*), is considerably smaller, measuring 6 inches over all, about half of which is due to the long tail.

Morogoro, 13/1/1917.

Arthur Loveridge."

Palm Swifts of the genus *Tachornis*, occurring in Africa, Southern Asia, and the West Indies, differ from the other Swifts —*Micropus*, *Aeronautes*, and *Panyphilia*—in having their toes in pairs, "the outer and middle toe directed to the right, and the inner and hind toe to the left." Hartert. ("*Catal. of the Picariæ in the Coll. of the Brit. Mus.*" Birds, XVI., 1892, 462) says: "No doubt this has some relation to their habits, and probably to the manner in which they cling to the leaves of palm trees, or to grass roofs of the Naga houses in Cacha and Assam." It appears to me that it is more closely related to the clinging to the nests when affixed to an unstable foundation, such as the wind-swayed palm leaves referred to by Mr. Loveridge.

The great interest of Mr. Loveridge's observations lie in the statement that the two eggs are glued or cemented to the nesting material—"gummed to the back of the nest," he says. I would call special attention to the words "back of the nest."

Stark, "*The Birds of South Africa*"—cont. by W. L. Sclater, Vol. III., 29, 1913) says: "Heuglin (*Orn. Nordost-Afrika's*, 1869, 145) gives a good account of the habits of this bird in the Upper Nile Valley; he states that they build their nests in the leaf sheaths, or against the folds of the downward hanging leaves of the 'Dom' palms (*Hyphene thebaica*) . . . . . They are untidy-looking objects, and sway about in the wind; the cup of the nest is not very deep, and it is difficult to understand how the eggs are prevented from tumbling out. Brehm suggests that they are glued by the secretion to the nest."

Stark's (or Sclater's) account seems to be taken entirely from Heuglin, but it is an error to say that Brehm "suggests"—Brehm (*Jour. f. Orn.*, 1853. Extra. 95—not 1854, as in Sharpe's B.M. Catalogue), makes quite a definite statement.

"They" (the eggs) "stood on the point, and were likewise glued. In some nests young were found, and these also were cemented with the mucilage" (slime or mucus). "Truly the wind, which shakes the whole leaf to and fro, cannot shake them out of the nest. Whether the rest" (the attachment of the young to the nest) "only happens so long as the young carry the down feathers, or usually so long as they are incapable of clinging firmly, and how they later come loose I know not."*

Comparing Mr. Loveridge's account with this, apparently the first and only accurate description of the nesting economy, and with the illustration Brehm gives of the shape of the nest, which he likens to a spoon, and the position within it of the two eggs—we see that his "stood on the point," and Mr. Loveridge's "gummed to the back of the nest" mean one and the same thing. The eggs are not lying in the shallow cup, but stand on end in it, and are fastened to the upright "back" of the long ladle-shaped nest.

Brehm found young similarly fixed to the sticky nesting material, but Mr. Loveridge noticed them clinging to the feathers attached to the wall. Brehm's observations may have been of younger birds than those seen by Mr. Loveridge; he may have been mistaken, or the habit may vary. In any case it is most interesting to learn that these unattached young, when disturbed, actually made use of the fragile cup of eggshell which still remained in one of the nests Mr. Loveridge found.

*My thanks are due to Miss Wigglesworth for this translation as literal as possible.

VIII. On the Atomic Weight of Tellurium in Relation to the Multiple Proportions of the Atomic Weights of other Simple Bodies.[1]

By HENRY WILDE, D.Sc., D.C.L., F.R.S.

(Received May 22nd, 1917.)

The recent determination of the atomic weight of tellurium by M. R. Metzner (Comptes Rendus, 13th June, 1898) affords me the opportunity of again directing the attention of savants to the present anomalous condition of theoretical chemistry, and to the obstacles that stand in the way of its future progress.

The experiments made by M. Metzner show for tellurium an atomic weight equal to 127.9 as the mean of one series, and 128.01 for the second series. These results indicate a nearer approach to the theoretical number 128, adopted by Dumas and other chemists, than any previously recorded.

The classical memoir of Dumas[2] upon the equivalents of simple bodies embodied all our real knowledge of the numerical relations among the atomic weights until the publication of my own memoir on the origin of elementary substances,[3] wherein the triads and other multiple relations of the atomic weights revealed by the illustrious Dumas were greatly extended. I also found that the common numerical difference between the atomic weights of the oxygen series and the alkaline-earth metals observed by Dumas was exactly paralleled by a common difference in the atomic weights of the halogens and alkaline metals of half the amount shown in the series of oxygen and alkaline-earth metals. This new relation only became manifest after the work of Dumas by the discovery of rubidium and cæsium, and by the adoption of the atomic weights of Cannizzaro.

The absolute parallelism of the positive and negative series of elements Hn and H2n, as seen in my table (Comptes Rendus, 8th November, 1897), in their numerical, chemical and physical relations, leaves no doubt that, for these four natural and best known series, the multiple proportions of their atomic weights represent the truth of nature. The small differences observable between the experimental and a few of the theoretical atomic weights, when distributed among the twenty-four numbers com-

1. Comptes Rendus De L'Academie Des Sciences, 1898, tome 2.

2. Comptes Rendus, tome XLV., p. 709, XLVI., p. 951, XLVII., p. 1,026.

3. Manchester Memoirs, 1878, 1886, 1894.

posing the four series, only amount to 0.0046 of the actual determinations.

The atomic weights are also in much closer agreement with experimental results than is the fundamental law of atomic heats formulated by Dulong and Petit for these same series. No one doubts the general accuracy of this law, because it does not hold good for carbon, boron and silicon, or to fractional quantities throughout the whole number of the elements. Dalton's law of chemical combination in definite and multiple proportions was founded on approximations differing for the principal elements more than thirty per cent. from later determinations.[4] and through the adoption of the atomic weights of Cannizzaro, these differences are largely increased.

I would also emphasise the fact, hitherto ignored by chemists, that as the atomic weights of the two positive series of elements, Hn and H2n, are the products of the large multiple numbers, 16, 23 and 24 respectively, correlated also by the common differences 4 and 8 with the large multiple numbers 46 and 48 of the two negative series of elements, the exact multiple proportions subsisting among these higher atomic weights have an immensely greater validity in determining the question of their being whole numbers of hydrogen, than when all the equivalents were compared directly with the unit or half-unit of hydrogen by Stas and the older chemists.

I have now the honour to bring before the Académie a new argument in favour of the exact multiple proportions of the atomic weights, which, while helpful to earnest students of the natural sciences, will be a permanent check to the pretensions of those chemists who set up their laboured approximations of the atomic weights as the absolute truth of nature and the measure of the power of future investigators.

In the memoir referred to, Dumas formulated the proposition that "in three simple bodies of the same natural family, the equivalent of the intermediate body, is always half the sum of the equivalents of the two extreme bodies." This proposition, as will be evident, is the rigorous expression of the definite and exact multiple proportions of the atomic weights.

The first example of this law given by Dumas is the triad of sulphur, selenium and tellurium, with the old equivalents, 16, 40, 64, equal to 32, 80, 128 of the atomic weights of Cannizzaro. Now, in the geometry of solids, we have a triad of numerical proportions similar to those found in the atomic weights, since a cone, sphere and cylinder, of equal diameter and altitude, have the ratios of 1, 2, 3, respectively, and the intermediate body is half the sum of the two extreme bodies, as in the triad of sulphur, selenium and tellurium. The mental attitude of those chemists who make their determinations of the atomic weights the absolute truth of nature, would therefore be strictly

4. Dalton's New System of Chemical Philosophy, Vol. II. p. 352 (1827).

paralleled by that of an ingenious artist who should endeavour to prove, by mechanical means, the ratios of the cone, sphere, and cylinder, but, finding that after the expenditure of much time and labour the exact ratios, by weight and measure, could not be obtained, owing to the unequal density of the material operated upon and other causes, should set the results of his labours above the demonstrations of the geometer, and declare, in the hyperbolic language used by Stas respecting the multiple proportions of the atomic weights as modified by Dumas, that the exact ratios of the cone, sphere and cylinder are " a mere illusion, a pure hypothesis, absolutely contradicted by experience."[5]

Applying the foregoing reasonings to the determinations of the atomic weight of tellurium by M. Metzner, and accepting the theoretical value of 128 as correct, it will be seen that M. Metzner, by taking the mean of the results of his first series of experiments with the sulphate, and making the final atomic weight 127.9, has hardly done himself justice, as the second series with telluric acid shows a mean atomic weight of 128.01. Moreover, three of the seven determinations made by M. Metzner show the actual theoretical atomic weight 128, which is the criterion of the experimental results.

5. Bull. Acad. Sci. Belgique, X., p. 212, 1860.

IX. Recent Work on Overvoltage.

By Dr. E. NEWBERY.

(*Communicated by Professor A. Lapworth, D.Sc., F.R.S., F.I.C.*)

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Since the author's last communication to this journal,[1] a considerable amount of further work has been carried out on the same subject, and certain facts have come to light which necessitate some modification of the theory then proposed.

This work has been done along three lines—

1. Measurement of cathodic overvoltages of metals and alloys in dilute acid and in alkali, under varying conditions of time and current density, hydrogen being liberated in all cases.

2. Measurement of anodic overvoltages under similar conditions, oxygen being liberated.

3. Measurement of "metal" overvoltages during electrolytic deposition or dissolution of a metal in a solution containing a salt of that metal.

Altogether about 12,000 measurements have been made partly with the object of supplying a broad basis on which to found a theory of overvoltage, and partly to supply data which will be generally useful in electrolytic work.

In the following tables current densities in milliamperes per sq. cm. are given in the first column. Columns headed A. show the first sets of readings obtained with the given electrodes immediately after immersion in the electrolyte, whilst those headed B. show the averages of at least four sets taken subsequently. By comparing the two columns, the combined effect of time and subjection to a high current density may be observed, whilst further information as to the effect of time alone may be obtained from the later tables.

The test electrode was in all cases a rod or strip of metal having an exposed surface of 1 sq. cm., and the secondary electrode was a sheet of platinum, 10 sq. cms. area, except when measuring metal overvoltages, when a similar sheet of the metal under examination was used.

[1] Vol. 60 (1916), No. 11.

The standard electrodes used were—

Hg. HgO. *N*. NaOH for alkali solutions.

Hg. Hg_2SO_4. *N*. H_2SO_4 for acid or sulphate solutions.

Hg. Hg_2Cl_2. *N*. KCl for chloride or nitrate solutions.

Cathodic (hydrogen) overvoltages are calculated on the basis of the hydrogen electrode as zero; anodic (oxygen) overvoltages, with the oxygen electrode as zero, the difference between the two being taken as 1.13 volt.

Metal overvoltages (during metal deposition) are all calculated from the single potential of the metal itself, taken as zero in the given electrolyte.

For comparison of results the following values were taken:—

Hg. HgO. *N*. NaOH.	...	*N*. NaOH. H_2 ...	0.93 volt.
Hg. Hg_2SO_4. *N*. H_2SO_4	...	*N*. H_2SO_4. H_2 ...	0.70 ,,
Hg. Hg_2Cl_2. *N*. KCl.	...	Absolute ...	0.56 ,,
H_2. *N*. H_2SO_4 ...	...	Absolute ...	0.27 ,,

CATHODIC OVERVOLTAGES IN NORMAL SULPHURIC ACID.

Current density.	*A.* Cu.	*B.* Cu.	*A.* Ag.	*B.* Ag.	*A.* Au.	*B.* Au.	*A.* Zn.	*B.* Zn.	*A.* Cd.	*B.* Cd.	*A.* Hg.	*B.* Hg.
2	0.37	0.34	0.27	0.33	0.31	0.38	0.68	0.70	0.50	0.50	0.21	0.61
4	0.38	0.35	0.28	0.33	0.32	0.39	0.69	0.70	0.52	0.50	0.21	0.63
6	0.38	0.35	0.28	0.33	0.32	0.38	0.69	0.71	0.54	0.50	0.21	0.65
10	0.39	0.36	0.27	0.32	0.32	0.38	0.69	0.71	0.55	0.50	0.21	0.66
20	0.40	0.35	0.25	0.31	0.31	0.36	0.70	0.72	0.56	0.50	0.21	0.66
50	0.39	0.34	0.24	0.30	0.31	0.36	0.71	0 74	0.55	0.50	0.21	0.66
100	0.38	0.33	0.23	0.29	0.30	0.36	0.71	0.75	0.54	0.50	0.36	0.53
200	0.37	0.33	0.23	0.28	0.29	0.36	0.71	0.75	0.54	0.50	0.38	0.46
400	0.35	0.32	0.23	0.25	0.28	0.34	0.72	0.75	0.53	0.50	0.30	0.37
1000	0.32	0.30	0.22	0.16	0.26	0.30	0.72	0.76	0.50	0.49	0.22	0.29
2000	0.30	0.28	0.11	0.10	0.24	0.24	0.72	0.75	0.48	0.48	0.19	0.26

Current density.	*A.* Al.	*B.* Al.	*A.* Tl.	*B.* Tl.	*A.* C1.	*B.* C1.	*A.* C2.	*B.* C2.	*A.* Sn.	*B.* Sn.	*A.* Pb.	*B.* Pb.
2	0.44	0.18	0.53	0.55	0.38	0.33	0.44	0.32	0.62	0.44	0.74	0.45
4	0.48	0.14	0.53	0.55	0.42	0.37	0.44	0.34	0.66	0.45	0.75	0.46
6	0.49	0.13	0.53	0.55	0.45	0.44	0.44	0.36	0.67	0.46	0.73	0.46
10	0.50	0.11	0.53	0.55	0.48	0.49	0.43	0.35	0.66	0.47	0.71	0.47
20	0.49	0.12	0.53	0.55	0.54	0.56	0.42	0.35	0.66	0.48	0.67	0.46
50	0.49	0.15	0.53	0.55	0.60	0.62	0.40	0.35	0.65	0.49	0.64	0.44
100	0.48	0.19	0.54	0.55	0.67	0.67	0.39	0.35	0.63	0.49	0.59	0.42
200	0.47	0.22	0.54	0.55	0.71	0.71	0.38	0.37	0.60	0.48	0.58	0.39
400	0.40	0.20	0.54	0.54	0.75	0.76	0.38	0.40	0.54	0.41	0.54	0.35
1000	0.16	0.14	0.54	0.54	0.77	0.80	0.38	0.39	0.34	0.33	0.53	0.30
2000	0.11	0.08	0.53	0.53	0.76	0.78	0.38	0.39	0.30	0.29	0.50	0.28

C1 gas carbon.

C2 artificial graphite.

CATHODIC OVERVOLTAGES IN NORMAL SULPHURIC ACID—*Continued.*

Current density.	*A.* Sb.	*B.* Sb.	*A.* Ta.	*B.* Ta.	*A.* Bi.	*B.* Bi.	*A.* Cr.	*B.* Cr.	*A.* Mo.	*B.* Mo.	*A.* W.	*B.* W.
2	0.44	0.38	0.50	0.39	0.49	0.41	0.41	0.41	0.28	0.25	0.32	0.28
4	0.45	0.41	0.50	0.40	0.51	0.42	0.42	0.41	0.31	0.27	0.32	0.28
6	0.45	0.42	0.49	0.40	0.52	0.43	0.42	0.41	0.32	0.28	0.32	0.29
10	0.45	0.42	0.49	.0.40	0.53	0.44	0.42	0.41	0.33	0.29	0.32	0.29
20	0.44	0.42	0.48	0.40	0.54	0.44	0.42	0.41	0.33	0.30	0.32	0.28
50	0.44	0.42	0.46	0.41	0.53	0.43	0.42	0.41	0.33	0.30	0.31	0.28
100	0.43	0.43	0.45	0.42	0.52	0.42	0.43	0.41	0.32	0.30	0.31	0.27
200	0.42	0.42	0.45	042	0.51	0.37	0.43	0.42	0.32	0.30	0.31	0.26
400	0.41	0.41	0.44	0.42	0.49	0.32	0.43	0.42	0.31	0.29	0.30	0.26
1000	0.40	0 40	0.43	0·41	0.36	0.19	0.44	0.43	0.29	0.29	0.26	0.22
2000	0.38	0.37	0.42	0.41	0.12	0.08	0.44	0.43	0.28	0.28	0.20	0.19

Current density.	*A.* Mn.	*B.* Mn.	*A.* Fe.	*B.* Fe.	*A.* Ni.	*B.* Ni.	*A.* Co.	*B.* Co.	*A.* Rh.	*B.* Rh.	*A.* Pd.	*B.* Pd.
2	0.60	0.58	0.27	0.24	0.16	0.29	0.27	0.23	0.03	0.01	—0.09	0.00
4	0.60	0.58	0.27	0.25	0.17	0.30	0.27	0.24	0.04	0.01	—0.07	0.02
6	0.61	0.58	0.27	0.26	0.17	0.31	0.28	0.24	0.04	0 01	—0.06	0.03
10	0.61	0.58	0.27	0.26	0.18	0.30	0.28	0.24	0.04	0 01	—0.05	0.04
20	0.59	0.58	0.28	0.27	0.18	0.29	0.27	0.25	0.03	0.02	—0.04	0.05
50	0.58	0.58	0.29	0.27	0.18	0.26	0.27	0.25	0.03	0.02	-0.02	0.06
100	0.58	0.57	0.30	0.27	0.19	0.24	0.26	0.26	0.03	0.02	0.00	0.07
200	0.58	0.56	0.30	0.27	0.19	0.21	0.26	0.26	0.03	0.02	+0.01	0.08
400	0.57	0.55	0.31	0.28	0.18	0.18	0.25	0.25	0.03	0.02	0.08	0.08
1000	0.55	0.54	0.29	0.27	0.17	0.11	0.25	0.24	0.03	0.01	0.08	0.05
2000	0.53	0.52	0.27	0.26	0.15	0.06	0.23	0.20	0.01	0.00	0.02	0.02

Current density.	*A.* Ir.	*B.* Ir.	*A.* Pt.	*B.* Pt.
2	0.01	0.18	0.05	0.20
4	0.02	0 19	0.06	0.19
6	0.02	0.19	0.06	0.18
10	0.03	0.18	0.06	0.16
20	0.03	0.18	0.06	0.15
50	0.04	0.18	0.07	0.13
100	0.05	0.17	0.07	0.12
200	0.05	0.17	0.08	0.11
400	0.05	0.16	0.09	0.07
1000	0.05	0.14	0.08	—0.01
2000	0.08	0.12	0.01	- 0.02

CATHODIC OVERVOLTAGES IN NORMAL SULPHURIC ACID.
TIME EXPERIMENTS.

Copper.

Time in Minutes.

Current density.	1	2	3	4	5	10	15	20	25	30
1	0.31	0.32	0.32	0.31	0.30	0.30	0.30	0.29	0.29	0.29
10	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.27	0.27	0.27
100	0.28	0.28	0.28	0.27	0.27	0.27	0.27	0.27	0.26	0.26
1000	0.17	0.16	0.15	0.15	0.15	0.14	0.13	0.13	0.13	0.14

Silver.

Time in Minutes.

Current density.	1	2	3	4	5	10	15	20	25	30
1	0.28	0.29	0.29	0.29	0.29	0.31	0.31	0.31	0.32	0.32
10	0.29	0.29	0.29	0.30	0.30	0.31	0.31	0.32	0.32	0.33
100	0.27	0.26	0.25	0.24	0.23	0.22	0.23	0.23	0.23	0.22
1000	0.15	0.14	0.14	0.15	0.15	0.17	0.16	0.17	0.17	0.16

CATHODIC OVERVOLTAGES IN NORMAL SULPHURIC ACID.
TIME EXPERIMENTS—*Continued.*

Amalgamated Zinc.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.82	0.83	0.84	0.85	0.86	0.86	0.87	0.88	0.88	0.88
10	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
100	0.88	0.88	0.88	0.88	0.87	0.87	0.86	0.86	0.86	0.86
1000	0.82	0.82	0.83	0.83	0.83	0.84	0.84	0.84	0.84	0.84
	First series repeated 3 days later with same electrode.									
1	0.78	0.80	0.80	0.80	0.80	0.82	0.83	0.84	0.83	0.83

Mercury.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.51	0.64	0.60	0.58	0.58	0.59	0.55	0.56	0.54	0.56
10	0.39	0.30	0.30	0.29	0.32	0.40	0.45	0.49	0.49	0.50
100	0.45	0.48	0.54	0.48	0.49	0.52	0.48	0.46	0.44	0.45*
1000	—0.02	0.00	0.04	0.01	0.04	0.06	0.12	0.12	0.17	0.19

* Fell to 0.08 after further 30 minutes.

Graphite.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	—0.01	+0.02	0.05	0.07	0.10	0.15	0.18	0.20	0.22	0.23
10	0.42	0.48	0.49	0.48	0.49	0.48	0.47	0.47	0.46	0.46
100	0.44	0.45	0.44	0.44	0.44	0.43	0.43	0.42	0.42	0.43
1000	0.41	0.45	0.47	0.49	0.50	0.60	0.61	0.62	0.62	0·61

Lead.

Current density	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.72	0.78	0.80	0.82	0.84	0.76	0.75	0.74	0.72	0.71
10	0.72	0.73	0.72	0.71	0.70	0.69	0.69	0.69	0.69	0.68
100	0.64	0.64	0.64	0.62	0.61	0.58	0.56	0.55	0.55	0.52
1000	0.38	0.36	0.35	0.35	0.35	0.34	0.34	0.35	0.36	0.36
	First series repeated after the last, without cleaning electrode.									
1	0.36	0.45	0.49	0.52	0.52	0.55	0.54	0.52	0.52	0.54

Tin.

Current density	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.25	0.54	0.56	0.59	0.60	0.60	0.61	0.61	0.61	0.61
10	0.50	0.57	0.59	0.59	0.60	0.60	0.60	0.60	0.61	0.62
100	0.55	0.57	0.55	0.54	0.51	0.45	0.41	0.39	0.40	0.39
1000	0.35	0.33	0.32	0.31	0.31	0.30	0.30	0.30	0.31	0.31

Platinum.

Current density	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.01	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.04
10	0.02	0.03	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.07
100	0.02	0.03	0.03	0 03	0.04	0.06	0.07	0.08	0.08	0.09
1000	0.02	0.03	0.03	0.04	0.04	0.05	0.04	0.04	0.03	0.02

CATHODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE.

Current density.	*A.* Cu.	*B.* Cu.	*A.* Ag.	*B.* Ag.	*A.* Au.	*B.* Au.	*A.* Mg.	*B.* Mg.	*A.* Zn.	*B.* Zn.
2	0.50	0.43	0.43	0.35	0.44	0.38	0.56	0.57	0.59	0.56
4	0.52	0.46	0.44	0.37	0.46	0.39	0.57	0.58	0.60	0.58
6	0.53	0.47	0.45	0.38	0.46	0.40	0.58	0.58	0.60	0.69
10	0.53	0.49	0.45	0.39	0.47	0.40	0.59	0.59	0.60	0.59
20	0.52	0.50	0.45	0.39	0.48	0.41	0.61	0.59	0.60	0.60
50	0.51	0.50	0.44	0.39	0.48	0.41	0.64	0.59	0.59	0.60
100	0.51	0.51	0.43	0.40	0.48	0.42	0.67	0.60	0.59	0.60
200	0.50	0.51	0.43	0.40	0.48	0.42	0.67	0.59	0.58	0.60
400	0.49	0.51	0.42	0.40	0.47	0.41	0.68	0.58	0.57	0.59
1000	0.49	0.50	0.41	0.39	0.47	0.41	0.67	0.58	0.56	0.58
1200	0.48	0.50	0.40	0.38	0.45	0.40	0.66	0.57	0.56	0.57

Current density.	*A.* Cd.	*B.* Cd.	*A.* Hg.	*B.* Hg.
2	0.51	0.55	0.92	0.67
4	0.53	0.60	0.96	0.67
6	0.54	0.62	0.97	0.68
10	0.54	0.64	0.98	0.69
20	0.53	0.65	0.99	0.69
50	0.52	0.66	1.02	0.69
100	0.52	0.66	1.05	0.70
200	0.51	0.67	1.02	0.71
400	0.52	0.67	1.01	0.79
1000	0.56	0.66	0.99	0.88
1200	0.61	0.65	0.95	0.95

Current density	*A.* Al.	*B.* Al.	*A.* Tl.	*B.* Tl.	*A.* C1.	*B.* C1.	*A.* C2.	*B.* C2.	*A.* Sn.	*B.* Sn.	*A.* Pb.	*B.* Pb.
2	0.52	0.48	0.43	0.42	−0.17	0.37	−0.31	0.42	0.57	0.57	0.57	0.58
4	0.52	0.49	0.45	0.44	−0.15	0.41	−0.28	0.47	0.57	0.60	0.57	0.64
6	0.52	0.49	0.46	0.45	−0.12	0.46	−0.24	0.49	0.57	0.62	0.57	0.65
10	0.52	0.49	0.48	0.47	−0.02	0.53	−0.17	0.54	0.57	0.63	0.57	0.67
20	0.52	0.49	0.50	0.49	+0.19	0.62	−0.04	0.56	0.57	0.64	0.57	0.68
50	0.52	0.50	0.54	0.52	0.42	0.66	+0.64	0.60	0.58	0.65	0.60	0.69
100	0.52	0.50	0.56	0.53	0.65	0.70	0.67	0.64	0.59	0.65	0.61	0.69
200	0.51	0.50	0.56	0.54	0.74	0.72	0.69	0.67	0.59	0.63	0.63	0.69
400	0.51	0.50	0.55	0.55	0.79	0.73	0.70	0.69	0.60	0.63	0.64	0.68
1000	0.51	0.49	0.54	0.56	0.78	0.77	0.71	0.71	0.61	0.63	0.64	0.67
1200	0.51	0.49	0.54	0.55	0.77	0.77	0.71	0.71	0.61	0.62	0.65	0.67

C1 gas carbon.
C2 graphite.

Current density.	*A.* Sb.	*B.* Sb.	*A.* Bi.	*B.* Bi.	*A.* Cr.	*B.* Cr.	*A.* W.	*B.* W.	*A.* Mn.	*B.* Mn.	*A.* Fe.	*B.* Fe.
2	0.59	0.62	0.59	0.59	0.46	0.37	0.31	0.27	0.29	0.27	0.27	0.28
4	0.63	0.64	0.66	0.65	0.46	0.37	0.21	0.37	0.31	0.29	0.30	0.31
6	0.64	0.65	0.70	0.68	0.46	0.38	0.31	0.27	0.31	0.29	0.31	0.32
10	0.65	0.66	0.73	0.71	0.45	0.38	0.31	0.27	0.32	0.30	0.32	0.33
20	0.65	0.67	0.75	0.74	0.45	0.39	0.30	0.28	0.33	0.31	0.33	0.34
50	0.65	0.67	0.77	0.75	0.44	0.39	0.29	0.28	0.34	0.32	0.34	0.34
100	0.65	0.67	0.77	0.76	0.42	0.39	0.28	0.28	0.35	0.33	0.34	0.35
200	0.64	0.66	0.77	0.76	0.42	0.39	0.28	0.29	0.37	0.34	0.34	0.35
400	0.63	0.65	0.77	0.76	0.41	0.39	0.28	0.29	0.39	0.35	0.34	0.35
1000	0.61	0.63	0.77	0.74	0.40	0.39	0.28	0.29	0.42	0.37	0.33	0.34
1200	0.60	0.61	0.76	0.73	0.39	0.39	0.28	0.28	0.45	0.37	0.33	0.34

CATHODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE—*Continued.*

Current density.	*A.* Ni.	*B.* Ni.	*A.* Co.	*B.* Co.	*A.* Rh.	*B.* Rh.	*A.* Pd.	*B.* Pd.	*A.* Ir.	*B.* Ir.	*A.* Pt.	*B.* Pt.
2	0.18	0.23	0.25	0.48	0.02	0.04	0.25	0.38	0.43	0.46	0.16	0.21
4	0.20	0.23	0.27	0.53	0.03	0.05	0.27	0.43	0.43	0.54	0.17	0.22
6	0.20	0.24	0.28	0.56	0.03	0.05	0.28	0.45	0.43	0.59	0.19	0.24
10	0.20	0.24	0.28	0.61	0.04	0.06	0.31	0.47	0.44	0.62	0.20	0.25
20	0.20	0.24	0.29	0.67	0.04	0.06	0.32	0.49	0.44	0.64	0.21	0.26
50	0.21	0.24	0.29	0.69	0.04	0.07	0.34	0.53	0.44	0.65	0.22	0.28
100	0.21	0.24	0.29	0.69	0.05	0.08	0.36	0.58	0.45	0.65	0.22	0.28
200	0.21	0.25	0.30	0.69	0.06	0.09	0.36	0.57	0.62	0.65	0.22	0.28
400	0.22	0.24	0.30	0.68	0.07	0.08	0.36	0.58	0.64	0.64	0·21	0·28
1000	0.21	0.24	0.29	0 65	0.08	0.08	0·37	0.58	0.64	0.64	0.20	0.27
1200	0.21	0.23	0.29	0.64	0.08	0.07	0.39	0.57	0.63	0.63	0.19	0.27

CATHODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE.
TIME EXPERIMENTS.

Amalgamated Lead.

Time in Minutes.

Current density	1	2	3	4	5	10	15	20	25	30
1	0.89	0.89	0.88	0.87	0.86	0.85	0.79	0.76	0.74	0.73
10	1.09	1.08	1.05	1.00	0.96	0.87	0.79	0.76	0.74	0.72
100	1.10	1.06	1.00	0.95	0.91	0.76	0.72	0.70	0.71	0.72
1000	1.16	1.11	1.08	1.06	1.05	0.95	0.88	0.85	0.81	0.76

Lead.

Time in Minutes.

Current density	1	2	3	4	5	10	15	20	25	30
1	0.48	0.47	0.47	0.46	0.46	0.44	0.44	0.43	0.43	0.42
10	0.49	0.50	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51
100	0.53	0.55	0.58	0.61	0.63	0.67	0.70	0.72	0.73	0.73
1000	0.65	0.69	0.70	0.70	0.71	0.72	0.71	0.71	0.71	0.71

Nickel.

Time in Minutes.

Current density	1	2	3	4	5	10	15	20	25	30
1	0.15	0.15	0.15	0.15	0.15	0.16	0.16	0.16	0.16	0.16
10	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17
100	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
1000	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.20	0.20	0.20

ANODIC OVERVOLTAGE IN NORMAL SULPHURIC ACID.

Current density.	*A.* Ag.	*B.* Ag.	*A.* Au.	*B.* Au.	*A.* C1.	*B.* C1.	*A.* C2.	*B.* C2.
2	—	—	0.86	0.87	0.25	0.45	0.75	0.67
4	—	—	0.87	0.87	0.32	0.53	0.84	0.69
6	—	—	0.86	0.88	0.37	0.57	0.88	0.71
10	—	—	0.85	0.87	0.43	0.61	0.91	0.75
20	—	—	0.84	0.86	0.52	0.66	0.94	0.81
50	0.75	0.73	0.81	0.84	0.71	0.77	1.00	0.88
100	0.75	0.74	0.80	0.82	0.85	0.83	1.05	0.92
200	0.76	0.74	0.79	0.81	0.90	0.87	1.08	0.96
400	0.76	0.74	0.77	0.80	0.91	0.91	1.12	1.01
1000	0.76	0.74	0.75	0.77	0.89	0.90	1.14	1.08
2000	0.76	0.73	0.74	0.75	0.88	0.88	1.14	1.10

C1 gas carbon.
C2 artificial graphite.

ANODIC OVERVOLTAGE IN NORMAL SULPHURIC ACID—*Continued.*

Current density.	*A.* Pb.	*B.* Pb.	*A.* Fe.	*B.* Fe.	*A.* Ni.	*B.* Ni.	*A.* Pt.	*B.* Pt.
2	0.80	0.91	0.73	0.75	—	—	0.81	0.85
4	0.83	0.94	0.74	0.75	—	—	0.83	0.85
6	0.85	0.96	0.74	0.76	—	—	0.84	0.86
10	0.88	0.98	0.75	0.75	—	—	0.85	0.86
20	0.91	0.99	0.74	0.75	—	—	0.85	0.86
50	0.95	1.04	0.74	0.74	—	—	0.86	0.86
100	0.98	1.05	0.73	0.73	0.62	0.62	0.86	0.86
200	1.00	1.06	0.72	0.73	0.65	0.65	0.86	0.86
400	1.01	1.06	0.71	0.70	0.67	0.67	0.86	0.86
1000	1.00	1.05	0.68	0.67	0.68	0.68	0.85	0.86
2000	0.98	1.04	0.63	0.63	0.68	0.68	0.85	0.85

ANODIC OVERVOLTAGE IN NORMAL SULPHURIC ACID.
TIME EXPERIMENTS.

Graphite.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.31	0.34	0.41	0.45	0.46	0.56	0.61	0.65	0.67	0.68
10	0.79	0.84	0.86	0.87	0.88	0.87	0.86	0.84	0.83	0.83
100	0.95	0.94	0.93	0.93	0.92	0.91	0.90	0.89	0.89	0.89
1000	1.02	1.01	1.00	0.99	0.98	0.97	0.96	0.96	0.96	0.96

Lead.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	−0.09	+0.44	0.59	0.62	0.62	0.61	0.61	0.61	0.61	0.61
10	0.93	0.93	0.94	0.95	0.96	0.99	0.99	0.99	0.99	0.99
100	1.02	1.04	1.06	1.07	1.07	1.07	1.07	1.07	1.06	1.06
1000	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07	1.07

Iron.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.21	0.20	0.20	0.20	0.21	0.20	0.21	0.21	0.26	0.28
10	0.69	0.70	0.70	0.70	0.70	0.71	0.72	0.72	0.72	0.72
100	0.66	0.67	0.68	0.68	0.69	0.69	0.69	0.70	0.70	0.69
1000	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.67	0.67	0.67

ANODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE.

Current density.	*A.* Cu.	*B.* Cu.	*A.* Ag.	*B.* Ag.	*A.* Au.	*B.* Au.	*A.* Zn.	*B.* Zn.
2	0.53	0.57	—	—	0.71	0.96	—	—
4	0.57	0.61	0.10	0.60	0.76	0.96	—	—
6	0.59	0.62	0.35	0.69	0.87	0.96	—	—
10	0.61	0.63	0.36	0.70	0.91	0.96	—	—
20	0.62	0.63	0.58	0.71	0.92	0.96	0.83	0.87
50	0.62	0.62	0.60	0.72	0.93	0.96	0.85	0.97
100	0.62	0.61	0.63	0.72	0.94	1.01	0.91	1.00
200	0.61	0.60	0.65	0.73	0.94	1.16	0.94	1.00
400	0.60	0.59	0.70	0.72	0.93	1.20	0.93	0.96
1000	0.58	0.58	0.70	0.71	0.93	1.17	0.76	0.78
1200	0.58	0.57	0.69	0.69	0.93	1.16	—	—

ANODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE—*Continued.*

Current density.	*A.* C1.	*B.* C1.	*A.* C2.	*B.* C2.	*A.* Sn.	*B.* Sn.	*A.* Pb.	*B.* Pb.
2	0.05	0.26	0.53	0.52	1.17	1.22	0.60	0.86
4	0.11	0.34	0.56	0.54	1.27	1.27	0.64	0.93
6	0.16	0.38	0.56	0.56	1.34	1.31	0.66	0.94
10	0.24	0.47	0.60	0.58	1.34	1.35	0.69	0.95
20	0.32	0.54	0.62	0.60	1.35	1.37	0.82	0.96
50	0.48	0.70	0.65	0.71	1.35	1.33	0.83	0.96
100	0.65	0.79	0.69	0.89	1.34	1.33	0.84	0.95
200	0.74	0.83	0.71	0.96	1.34	1.32	0.84	0.94
400	0.88	0.90	0.83	1.00	1.29	1.30	0.86	0.93
1000	0.90	0.88	0.96	0.97	1.25	—	0.84	0.92
1200	0.85	0.86	0.94	0.94	—	—	0.83	0.90

C1 gas carbon.
C2 artificial graphite.

Current density.	*A.* Fe.	*B.* Fe.	*A.* Ni.	*B.* Ni.	*A.* Co.	*B.* Co.	*A.* Pt.	*B.* Pt.
2	0.44	0.44	0.45	0.49	0.58	0.54	0.56	0.85
4	0.46	0.46	0.48	0.53	0.60	0.55	0.57	0.86
6	0.48	0.48	0.49	0.54	0.60	0.56	0.59	0.87
10	0.49	0.49	0.51	0.57	0.59	0.57	0.62	0.87
20	0.49	0.49	0.53	0.60	0.58	0.57	0.72	0.88
50	0.50	0.51	0.54	0.64	0.58	0.57	0.75	0.99
100	0.51	0.51	0.55	0.65	0.57	0.56	0.80	0.98
200	0.51	0.52	0.56	0.66	0.57	0.56	0.82	0.97
400	0.51	0.52	0.57	0.66	0.56	0.56	0.85	0.94
1000	0.51	0.52	0.57	0.65	0.54	0.55	0.86	0.90
1200	0.50	0.51	0.57	0.64	0.54	0.54	0.85	0.88

ANODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE. TIME EXPERIMENTS.

Graphite.

Time in Minutes.

Current density.	1	2	3	4	5	10	15	20	25	30
1	0.55	0.57	0.58	0.58	0.58	0.59	0.59	0.60	0.60	0.60
10	0.93	0.95	0.96	0.96	0.95	0.95	0.96	0.97	0.98	0.98
100	0.92	0.92	0.93	0.93	0.93	0.93	0.94	0.94	0.94	0.95
1000	0.82	0.84	0.84	0.84	0.84	0.84	0.83	0.83	0.83	0.82

Lead.

Time in Minutes.

Current density.	1	2	3	4	5	10	15	20	25	30
1	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
10	0.65	0.66	0.68	0.70	0.70	0.75	0.84	0.90	0.92	0.94
100	0.75	0.92	0.93	0.94	0.94	0.97	1.01	1.02	1.02	1.03
1000	0.93	0.95	0.97	0.98	0.99	1.00	1.00	1.00	0.99	0.99

Iron.

Time in Minutes.

Current density.	1	2	3	4	5	10	15	20	25	30
1	0.51	0.51	0.52	0.52	0.52	0.5	0.53	0.53	0.53	0.53
10	0.54	0.54	0.54	0.54	0.54	0.55	0.55	0.55	0.55	0.55
100	0.55	0.55	0.55	0.55	0.55	0.56	0.56	0.56	0.56	0.56
1000	0.57	0.56	0.56	0.55	0.55	0.56	0.56	0.56	0.56	0.56

ANODIC OVERVOLTAGE IN NORMAL SODIUM HYDROXIDE.

TIME EXPERIMENTS—*Continued.*

Nickel.

Current density.	Time in Minutes. 1	2	3	4	5	10	15	20	25	30
1	0.40	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
10	0.51	0.51	0.51	0.52	0.52	0.53	0.54	0.54	0.55	0.55
100	0.61	0.62	0.63	0.63	0.64	0.66	0.67	0.68	0.69	0.69
1000	0.67	0.68	0.69	0.69	0.69	0.70	0.71	0.72	0.72	0.72

CATHODIC METAL OVERVOLTAGES IN SOLUTIONS OF METALLIC SULPHATES.

Current density	Copper. *A.*	Copper. *B.*	Zinc. *A.*	Zinc. *B.*	Cadmium. *A.*	Cadmium. *B.*	Thallium. *A.*	Thallium. *B.*
2	0.04	0.02	0.04	0.02	0.01	0.01	0.00	0.00
4	0.04	0.02	0.04	0.02	0.01	0.01	0.00	0.00
6	0.03	0.02	0.03	0.02	0.01	0.01	0.00	0.00
10	0.03	0.02	0.03	0.02	0.01	0.01	0.00	0.00
20	0.03	0.03	0.02	0.02	0.01	0.01	+ 0.01	—0.02
50	0.02	0.02	0.02	0.02	0.02	0.01	+ 0.02	—0.01
100	0.02	0.02	0.02	0.02	0.02	0.01	—0.02	0.00
200	0.12	0.03	0.04	0.03	0.02	0.01	—0.03	0.00
400	0.12	0.04	0.06	0.04	0.03	0.02	0.00	0.00

Current density.	Iron. *A.*	Iron. *B.*	Nickel. *A.*	Nickel. *B.*	Nickel.* *A.*	Nickel.* *B.*	Cobalt. *A.*	Cobalt. *B.*
2	0.30	0.23	0.58	0.77	0.45	0.45	0.50	0.34
4	0.30	0.24	0.62	0.80	0.63	0.55	0.49	0.35
6	0.30	0.25	0.63	0.81	0.68	0.62	0.48	0.35
10	0.30	0.26	0.65	0.83	0.72	0.66	0.48	0.36
20	0.31	0.28	0.76	0.83	0.74	0.72	0.48	0.37
50	0.32	0.29	0.79	0.82	0.77	0.77	0.50	0.40
100	0.34	0.30	0.80	0.82	0.78	0.79	0.51	0.46
200	0.34	0.30	0.80	0.81	0.77	0.78	0.51	0.54
400	0.33	0.32	0.80	0.81	0.75	0.75	0.49	0.52

* In nickel ammonium sulphate solution.

CATHODIC METAL OVERVOLTAGES IN SOLUTIONS OF METALLIC NITRATES.

Current density.	Copper. *A.*	Copper. *B.*	Silver. *A.*	Silver. *B.*	Zinc. *A.*	Zinc. *B.*	Lead. *A.*	Lead. *B.*	Nickel. *A.*	Nickel. *B.*	Cobalt. *A.*	Cobalt. *B.*
2	0.02	0.01	0.00	0.00	0.02	0.11	0.00	0.00	0.40	0.47	0.26	0.31
4	0.02	0.01	0.00	0.00	0.03	0.15	0.00	0.00	0.41	0.52	0.35	0.36
6	0.01	0.01	0.00	0.00	0.03	0.26	0.00	0.00	0.44	0.55	0.38	0.41
10	0.01	0.02	0.00	0.00	0.01	0.32	0.00	0.00	0.47	0.60	0.45	0.46
20	0.02	0.03	0.00	0.00	0.27	0.35	0.00	0.00	0.52	0.66	0.57	0.49
50	0.02	0.05	0.00	0.00	0.28	0.35	0.00	0.00	0.70	0.78	0.73	0.83
100	0.02	0.07	0.00	0.00	0.28	0.33	0.01	0.00	0.91	0.86	0.72	0.80
200	0.06	0.21	0.00	0.00	0.30	0.32	0.01	0.00	0.94	0.86	0.69	0.74
400	0.60	0.59	0.01	0.01	0.30	0.29	0.01	0.01	0.88	0.85	0.64	0.67

CATHODIC METAL OVERVOLTAGES IN SOLUTIONS OF METALLIC CHLORIDES.

Current density.	Copper. A.	Copper. B.	Zinc. A.	Zinc. B.	Tin. A.	Tin. B.	Iron. A.	Iron. B.	Nickel. A.	Nickel. B.	Cobalt. A.	Cobalt. B.
2	0.01	0.04	0.01	0.03	0.00	0.00	0.35	0.25	0.71	0.80	0.31	0.23
4	0.06	0.05	0.02	0.03	0.00	0.00	0.35	0.27	0.72	0.84	0.31	0.24
6	0.07	0.05	0.03	0.04	0.00	0.00	0.34	0.28	0.74	0.87	0.30	0.25
10	0.07	0.06	0.04	0.04	0.01	0.00	0.34	0.29	0.75	0.90	0.31	0.26
20	0.08	0.07	0.04	0.04	0.01	0.01	0.34	0.31	0.77	0.92	0.32	0.27
50	0.09	0.09	0.05	0.05	0.03	0.01	0.34	0.33	0.81	0.94	0.35	0.28
100	0.10	0.10	0.05	0.05	0.03	0.01	0.36	0.35	0.87	0.96	0.38	0.29
200	0.11	0.10	0.05	0.05	0.04	0.02	0.40	0.36	0.95	0.96	0.44	0.32
400	0.14	0.14	0.05	0.05	0.04	0.03	0.41	0.40	0.96	0.96	0.53	0.47

ANODIC METAL OVERVOLTAGES IN SOLUTIONS OF METALLIC SULPHATES.

Current density.	Copper. A.	Copper. B.	Zinc. A.	Zinc. B.	Cadmium. A.	Cadmium. B.	Thallium. A.	Thallium. B.
2	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.30
4	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.43
6	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.65
10	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.70
20	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.72
50	0.00	0.02	0.01	0.01	0.00	0.01	0.01	1.06
100	0.01	0.02	0.01	0.01	0.01	0.01	0.02	1.68
200	0.01	0.02	0.01	0.02	0.01	0.02	1.78*	1.78
400	0.02	0.03	0.02	0.02	0.03	0.03	—	—

Current density.	Iron. A.	Iron. B	Nickel. A.	Nickel. B.	Nickel.† A.	Nickel.† B.	Cobalt. A.	Cobalt. B.
2	0.02	1.66	0.15	1.60	0.04	1.56	0.02	0.02
4	0.05	1.71	1.61*	1.63	0.08	1.59	0.02	0.02
6	0.06	1.74	1.64	1.65	0.09	1.61	0.03	0.02
10	0.06	1.79	1.67	1.68	0.13	1.62	0.03	0.02
20	0.07	1.84	1.69	1.69	0.16	1.64	0.04	0.03
50	0.08	1.90	1.72	1.72	0.22	1.67	0.05	0.04
100	0.09	1.88	1.73	1.72	1.65*	1.68	0.06	0.05
200	0.12	1.87	1.74	1.73	1.68	1.69	0.06	0.05
400	1.85*	1.85	1.73	1.72	1.69	1.70	0.08	0.07

* Metal became passive.
† In nickel ammonium sulphate solution.

ANODIC METAL OVERVOLTAGES IN SOLUTIONS OF METALLIC NITRATES.

Current density.	Copper. A.	Copper. B.	Silver. A.	Silver. B.	Zinc. A.	Zinc. B.	Lead. A.	Lead. B.	Nickel. A.	Nickel. B.	Cobalt. A.	Cobalt. B.
2	0.00	0.01	0.00	0.01	0.06	0.04	0.00	0.00	0.12	1.57	0.11	0.07
4	0.00	0.01	0.00	0.01	0.05	0.03	0.00	0.00	0.13	1.59	0.12	0.07
6	0.00	0.02	0.00	0.01	0.05	0.03	0.00	0.00	0.15	1.61	0.11	0.04
10	0.00	0.02	0.00	0.01	0.05	0.04	0.00	0.00	1.60*	1.62	0.09	0.03
20	0.00	0.02	0.00	0.01	0.05	0.06	0.00	0.00	1.64	1.64	0.06	0.03
50	0.01	0.02	0.00	0.01	0.05	0.06	0.00	0.00	1.67	1.66	0.00	0.00
100	0.01	0.02	0.01	0.01	0.04	0.05	0.00	0.01	1.68	1.68	0.00	0.00
200	0.02	0.03	0.01	0.01	0.04	0.04	0.01	0.01	1.69	1.69	0.02	0.03
400	0.04	0.04	0.02	0.02	0.13	0.06	0.01	0.01	1.71	1.70	0.02	0.04

* Metal became passive.

Anodic Metal Overvoltages in Solutions of Metallic Chlorides.

Current density.	Copper. A.	Copper. B.	Zinc. A.	Zinc. B.	Tin. A.	Tin. B.	Iron. A.	Iron. B.	Nickel. A.	Nickel. B.	Cobalt. A.	Cobalt. B.
2	0.02	0.03	0.00	0.00	0.00	0.00	0.05	0.00	0.07	0.07	0.03	0.06
4	0.03	0.04	0.00	0.00	0.00	0.00	0.07	0.02	0.09	0.08	0.02	0.07
6	0.03	0.04	0.00	0.00	0.00	0.00	0.07	0.03	0.09	0.08	0.00	0.07
10	0.03	0.04	0.00	0.00	0.00	0.00	0.08	0.04	0.09	0.09	0.00	0.06
20	0.04	0.04	0.00	0.00	0.00	0.00	0.09	0.06	0.08	0.09	−0.02	0.06
50	0.05	0.03	0.01	0.01	0.01	0.01	0.10	0.08	0.08	0.10	—0.03	0.05
100	0.02		0.02	0.02	0.02	0.02	0.10	0.09	0.08	0.10	—0.02	0.05
200	—	—	0.03	0.03	0.03	0.03	0.10	0.10	0.09	0.10	+ 0.03	0.07
400	—	—	0.04	0.04	0.04	0.05	0.11	0.11	0.10	0.10	0.07	0.09

Cathodic (hydrogen) overvoltage.

It was previously suggested that overvoltage is due to four factors:—

1. Supersaturation of the electrode surface with non-electrified gas under high pressures.

2. Formation of a series of alloys or solid solutions of the discharged ion, or a product of the discharged ion, with the electrode surface.

3. Deficiency or excess of non-hydrated ions in the immediate neighbourhood of the electrodes.

4. Inductive action of the escaping ionised gas on the electrode.

A study of the tables given will soon show that the above theory is inadequate to explain all the observed phenomena.

An amalgamated zinc cathode shows the remarkably high and constant value of 0.88 volt. If factor (1) above, were the true cause of overvoltage, we should have to assume pressures greater than 10^{30} atmospheres, in the soft surface of this alloy. Such pressures are incredible, and hence this factor cannot be the main cause of overvoltage. The remarkable constancy of the values for certain electrodes, notably thallium and rhodium, shows that factor (3) can only exert an inappreciable effect upon the total, since the effect, if any, must be proportional to the current density. Factor (3) may therefore be safely omitted from the general theory.

The very small fall of overvoltage observed in most cases at the highest current densities also shows that factor (4) cannot in general reduce the values by more than 20 or 30 millivolts, and therefore, although the effect is real, it is of little importance, specially as these very high current densities are seldom or never used in practical work.

We are left, therefore, with factor (2), or some modification of it, to account for all of the main facts of overvoltage.

On examining the tables more closely, it is evident that in spite of the variations due to time and current density, certain metals show one, and only one, definite value in a given electrolyte, with small variations above and below this value. Thallium, chromium and rhodium in acid electrolyte show this property well. Others show two such values with rapid changes from one to the other. Thus, iridium, when first used, shows low values approaching zero, but on subjection to the highest current density employed, a rapid rise to about 0.18 volt occurs, and this value persists throughout the range of current density used, although a small fall is produced at the highest current densities. In alkali, again, this metal shows two very distinct values, with a sudden change from the lower to the higher when the current density is raised from 100 to 200 milliamperes per sq. cm., and a similar sudden fall when the current density again reaches a low value. By maintaining the current density at about 200 milliamperes per sq. cm., the overvoltage rises to 0.7 volt or higher. Thus iridium shows four quite definite values for the hydrogen overvoltage.

By proceeding in this way with all the electrodes used, certain more or less definite average values for the cathodic hydrogen overvoltages may be assigned to all the metals.

When these values are placed with the metals in the periodic table a new law at once becomes evident—*Elements in the same group of the periodic system show the same overvoltage.*

The following table illustrates this law:—

Cathodic Overvoltage in the Periodic System.

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.		
2	—	—	—	Carbon **0.44** 0.70	—	—	—	—	—	—
3	Sodium **0.34?**	Magnesium **0.70**	Aluminium **0.50** <0.10	—	—	—	—	—	—	—
4	—	—	—	—	—	Chromium **0.38** 0.42 0.48	Manganese **0.30** 0.60	Iron **0.18** 0.25 0.33	Nickel **0.18** 0.24 0.30	Cobalt 0.25 0.67
5	Copper **0.34** 0.60	Zinc **0.72**	—	—	—	—	—	—	—	—
6	—	—	—	—	—	Molybdenum 0.32	—	—	Rhodium **0.19** 0.02	Palladium 0.05 0.34 0.65
7	Silver **0.30** 0.06	Cadmium **0.66** 0.50	—	Tin **0.45** 0.66	Antimony **0.42** 0.66	—	—	—	—	—
10	—	—	—	—	Tantalum **0.41** 0.50	Tungsten **0.30**	—	—	Iridium **0.18** 0.04 0.45 0.67	Platinum **0.18** 0.06 0.45 0.65
11	Gold **0.32** 0.50	Mercury **0.70** 0.00	Thallium **0.52**	Lead **0.46** 0.72	Bismuth **0.43** 0.52	—	—	—	—	—

It is evident from the above table that each group has what we may term a "typical overvoltage." Further than this, we may now explain the multiple values shown by most metals as merely due to change of valency. Thus, lead, which readily forms two series of compounds, in which it is divalent and tetravalent respectively, can easily change its overvoltage from 0.72 to 0.46 volt. Almost without exception, all the multiple overvoltages will be found to correspond with definite changes of valency, which are indicated by the existence of compounds, in which the metal in question has the required valency. Since it is difficult, if not impossible, to conceive of valency apart from compounds, we are forced to the conclusion that *overvoltage is due to the presence of compounds of the electrode with the discharged ion, or some product of the discharged ion.*

The values approaching zero observed with many metals are therefore due to the absence of these compounds, and it is noteworthy that the metals which most easily show these low values are the platinum metals. This is undoubtedly due to the well-known reluctance of these metals to form any compounds. The zero value may therefore be considered as typical of group 0, which contains the inert gases.

The following table shows the distribution of the metals in the groups, those which have the overvoltage of a group to which they do not properly belong being placed in brackets:—

Cathodic Overvoltages of the Periodic Groups.

Group 0.—Typical overvoltage, 0.0 volt; (silver), (mercury), (aluminium), (bismuth), (nickel), (rhodium), (palladium), (iridium), (platinum).

Group I.—Typical overvoltage, 0.35 volt; sodium, copper, silver, gold.

Group II.—Typical overvoltage, 0.70 volt; magnesium, zinc, cadmium, mercury, (carbon), (tin), (lead), (antimony). (bismuth), (manganese), (cobalt), (palladium), (iridum), (platinum), (copper).

Group III.—Typical overvoltage, 0.50 volt; aluminium, thallium, (antimony), (tantalum), (bismuth), (gold).

Group IV.—Typical overvoltage, 0.45 volt; carbon, tin, lead, (iridium), (platinum).

Group V.—Typical overvoltage, 0.42 volt; antimony, tantalum, bismuth, (chromium).

Group VI.—Typical overvoltage, 0.32 volt; chromium, molybdenum, tungsten, (iron), (nickel).

Group VII.—Typical overvoltage, 0.25 volt; manganese, (iron), (nickel), (cobalt), (palladium), (platinum).

Group VIII.—Typical overvoltage, 0.18 volt; iron, nickel, rhodium, iridium, platinum.

The only metals in this table which do not appear in their proper groups are cobalt and palladium. Values for cobalt as low as 0.18 volt have not been obtained. Palladium shows values above and below the group value, but in the neighbourhood of the group value the overvoltage is indefinite and changing rapidly.

Reviewing the table as a whole, a rise of overvoltage of two equal steps is observed from Group 0 to Group II., followed by a gradual fall through the rest of the table.

Anodic (oxygen) overvoltage.

The overvoltages so far discussed have all been cathodic hydrogen overvoltages.

Anodic overvoltages do not show so great regularity for two reasons:—

(1) It is impossible to obtain an aqueous electrolyte having only one anion, whilst any dilute acid gives only one cation.

(2) The true potential of the oxygen electrode is still doubtful, and further, it is not clear as to whether this potential should be taken as the standard from which to measure anodic overvoltages, since in any aqueous solution hydroxyl ions are far more plentiful than oxygen ions. Hence, anodic overvoltages calculated from an oxygen electrode as standard are abnormally high, compared with cathodic overvoltages.

Caspari, using an indefinitely low current density, obtained a value for the anodic overvoltage of platinum about 0.3 volt lower than the average of those given in these tables. Under the experimental conditions of Caspari's work, the oxygen ions present were probably sufficient to carry the small current used, whilst in the present work other ions certainly took part.

If the anodic overvoltages are recalculated on the assumption that the potential of the normal standard is 0.3 volt above that of an oxygen electrode, we obtain a series of values which in many cases show a considerable resemblance to cathodic overvoltages of the same metal. The parallelism is, however, very rough, and in many cases an anodic overvoltage measured in alkali only corresponds with a cathodic overvoltage found in acid.

A few of the best examples are given below, where column I. shows the average anodic overvoltage, generally in alkali, and column II. the corresponding cathodic overvoltage.

Metal.	I. Anodic. Volt.	II. Cathodic. Volt.
Copper	0.32	0.34
Silver	0.41	0.43
Zinc	0.63	0.60
Lead	0.64	0.67
Nickel	0.27	0.24
Cobalt	0.27	0.25
Palladium	0.35	0.34
Iridium	0.18	0.18
Platinum	0.60	0.65
Manganese	0.62	0.60

It may be noted here that the anodic overvoltage of lead covered with peroxide corresponds with the cathodic overvoltage of a bivalent metal. According to Liebenou's theory of the lead accumulator, lead peroxide ionises directly, giving a PbO_2'' ion and forming plumbites in which the lead is definitely bivalent.

Overvoltage in different electrolytes.

Generally speaking, anodic overvoltages measured in alkali are more reliable than those measured in acid, since we only have two anions, O'' and OH'' present, while in acid the four anions O'', OH', SO_4'', and HSO_4' may all take part.

Similarly, cathodic overvoltages in acid, where only one cation is present, are more reliable than those in alkali where two exist. How far we are justified in assuming those in alkali to be hydrogen overvoltages is somewhat doubtful, although in view of the fact that in the greater number of cases the values are almost the same in both electrolytes, the assumption is probably correct in most cases. Mercury is certainly exceptional, owing to its affinity for metallic sodium. Hence mercury and amalgamated electrodes may show abnormally high values in alkali, due to the visible formation of sodium amalgam.

Since the cathodic overvoltage of a given metal depends to some extent upon the electrolyte, the table of values given must not be looked upon as complete. There seems to be no reason why any metal should not acquire the typical overvoltage of any group if it is capable of showing the valency characteristic of that group. Further determinations under certain conditions, specially in different electrolytes, will undoubtedly supply new values for many of these metals. Nickel, for example, in nickel sulphate solution, shows a hydrogen overvoltage of 0.7 volt, which is typical of a divalent metal, and it may be noted that the metal actually has this valency in the given compound. Iron, again, in ferrous sulphate solution, shows the high value typical of a divalent metal, while in ferric sulphate solution the value 0.5 volt typical of a trivalent metal is shown.

Metal overvoltages.

Metal overvoltages are remarkable as being generally so low that they might be nearly all put down as approximately zero, compared with gas overvoltages. Iron, nickel, and cobalt are striking exceptions to the above rule, but in all three cases hydrogen is evolved in quantity at the cathodes, specially at high current densities.

With some of the other metals (copper, in copper sulphate solution, for example), if a very high current density is employed, hydrogen is also liberated, owing to the inability of the copper ions to diffuse fast enough to carry all the current. At the same time the overvoltage rises to the high values shown by divalent metals. This effect is increased by further hindering diffusion of copper ions by the addition of glue, gum, etc.

It is evident, therefore, that the high values obtained in such cases are true hydrogen overvoltages, and are due to the formation of metallic hydrides on the electrode surface.

The occlusion of hydrogen in almost all electro-deposited metals is a well-established fact. It is only reasonable, therefore, to conclude that the very small cathodic overvoltages usually observed during metal deposition, are due to the presence of small quantities of hydrides, which form a dilute solid solution in the deposited metal. Similarly the small anodic overvoltages observed are probably due to the formation of traces of higher oxides on the electrodes. The large values obtained when the electrode becomes passive will be referred to later.

The mechanism of electrolysis.

We are now in a position to attempt an explanation of the exact mechanism of electrolysis as far as the electrodes are concerned at least.

When a current is passed between two electrodes in an aqueous electrolyte, the ions carrying electrical charges are attracted towards the electrodes, and move at first with uniform velocity, owing to frictional resistance. When very close to the electrode, however, they must move very rapidly, and probably strike the electrode with considerable force. The continuous rain of ions on the electrode will thus produce great pressure on the surface. Under the influence of this pressure the chemically active discharged ion tends to combine with the electrode material, and the resultant compound dissolves in the solid—more easily in the amorphous cementing material between the crystals of the metal than in the crystals themselves.

On releasing the applied pressure by cutting off the current, these compounds will tend to separate from the metal in two ways:—

(1) By spontaneous decomposition within the electrode, liberating gas which forces its way through the surface and produces the craters, photographs of which have been shown.

(2) By direct ionisation, that is, by taking an electrical charge from the electrode and passing into the solution in exactly the same way as any metal does.

It is the second action which gives rise to overvoltage.

We may therefore state more definitely than before that—(1) *Overvoltage is caused by the high single potential differences of hydrides, higher oxides, etc., formed on or in the electrode surfaces.* (2) *Variations of overvoltage are caused by changes* (a) *in the chemical constitution of the above compounds and* (b) *in the concentration of the solid solutions formed by these compounds in the electrode surfaces.*

By careful search through the data obtained from the 12,000 measurements made, the author has been unable to find any point which is inconsistent with this theory.

Further evidence of the existence of metallic hydrides, etc.

Most of the metallic hydrides formed on the cathodes appear to exist only under the influence of the high pressures prevailing at the time. Their rapid and ready decomposition accounts for their high solution potentials, and the fact that they are good electrical conductors is evidence in favour of the idea that they ionise like a metal.

In all cases where a metallic hydride is capable of independent existence in presence of water, that hydride is formed at a cathode of the given metal in an aqueous electrolyte. Thus the formation of arsine on a zinc cathode containing arsenic has long been utilised in the detection and estimation of arsenic. Similarly, an antimony cathode liberates stibine, and a carbon cathode gives hydrocarbon mixed with the hydrogen in an acid electrolyte. A copper cathode, after use for a few seconds, acquires a difference of potential from an unused plate of the same metal which persists for many hours, and this is certainly due to the formation of copper hydride, which is but slowly decomposed by the acid present. Nickel behaves similarly.

These hydrides also exist at high temperatures, a fact which gives additional support to the suggestion that they are endothermic compounds. Fowler (Trans. Roy. Soc., 1909, *209*, 447) proved the existence of magnesium hydride in an arc of magnesium in hydrogen, and Evans (Phil. Mag., 1916 [VI.] *31*, 55) showed the presence of cadmium hydride in a hydrogen-filled tube containing cadmium heated to 800°—1,000° C.

The higher oxides are frequently produced in quantity on certain anodes; for example, lead dioxide on a lead anode, and chromium trioxide on a chromium anode, and the ionisation of lead dioxide giving the anion PbO_2'' is proved by the existence of plumbites such as Na_2PbO_2. The actual composition of these hydrides, etc., is to some extent a matter of speculation at present, but suggestions have been made having a certain degree of probability (J. Chem. Soc., 1916, *109*, 1363).

Passivity and valve action.

The phenomena of passivity find a ready and complete explanation with the aid of the overvoltage theory. If the higher oxides formed on an anode are good electrical conductors, and are also insoluble, or nearly so, in the electrolyte, the metal itself will be protected from the action of the deposited anions, and passivity will be produced. At the same time the electrode acquires the high positive potential of these higher oxides. Passivity is more readily produced in alkali than in acid, partly owing to the lesser solubility of most oxides in the former, and partly because the presence of the hydroxylion is more favourable to oxide production.

If the surface oxides are insulators, and also insoluble in the electrolyte, valve action is produced. Thus two electrodes of tungsten and platinum respectively in nitric acid will allow no appreciable current to pass if the tungsten is made the anode, although the cell conducts well when the platinum is the anode. No visible change occurs on the tungsten surface, so that the oxide film must be a very good insulator, and may be only of molecular thickness.

Stability of the overvoltage compounds.

The chemical stability of the hydrides formed on cathodes is of great importance in certain types of electro-chemical reduction.

A considerable amount of work is still to be done in this direction, since very little is known on the subject, although for some reductions it is more important to use a cathode which gives a stable hydride than one which has a high overvoltage.

Up to the present, it appears that copper, nickel, and possibly cobalt from hydrides of exceptional stability, and since electrolytic reduction consists in most cases merely of reduction by these hydrides, it is evident that greatly increased current efficiency, etc., may be obtained by the use of these electrodes in many cases.

Thus oleic acid is easily reduced by a copper cathode to a saturated acid under certain conditions, while a lead or zinc cathode has little or no effect. This is evidently due to the fact that the slowly reacting oleic acid requires a definite time for reduction to take place, which is afforded by the slowly decomposing copper hydride, whilst the more active lead or zinc hydrides are decomposed before they can effect any appreciable reduction.

The reduction of nitrates to ammonia by copper, and to hydroxylamine by amalgamated lead is probably due to similar causes.

Metal overvoltage and ion hydration.

We have still to explain why the cathodic metal overvoltages of iron, nickel, and cobalt are so markedly different from those of the other metals given.

Lapworth (Trans. Chem. Soc., 1915, *107*, 857) has shown that the hydrogen ion is probably strongly hydrated, that is, combined with the solvent in aqueous or alcoholic solution, while other ions, $Na^{\cdot}$, $NH^{\cdot}_4$, $K^{\cdot}$, $Ag^{\cdot}$, NO_3', Cl', etc., are either non-hydrated or their affinity for the solvent is of a quite different order from that of hydrion.

If iron, nickel and cobalt ions are hydrated in the same way as hydrion, their high overvoltages are readily understood. Since the process of hydration takes place automatically, work must be done in the dehydration of these ions. Hence a resisting force will be produced tending to prevent the separation of these ions, which will increase with increasing current density. If a non-hydrated ion such as zinc ion be present in an acid solution, this ion will not be subject to the resisting force, and at high current densities will separate in much greater quantity than the hydrogen ion, in spite of the lower potential necessary to separate the latter.

If, however, a hydrated ion such as ferrous-ion be present, this will be subject to a similar resisting force to that opposing the hydrion, with the result that both will deposit together in an ideal condition for hydride formation.

If an acid solution containing zinc and iron sulphates is subjected to a high current density, zinc will deposit readily. Iron and hydrogen will deposit in much smaller quantity, and some of these will re-enter the solution in the form of iron-hydride-ion, which having a high solution potential will readily reduce zinc out of the solution. As a result nearly pure zinc may be deposited from a very impure electrolyte, and this process is being worked on the large scale in South Africa with considerable success. It is evident that the method may also be applied in the separation of many other metals from iron, nickel and cobalt.

The single potentials of these three metals in contact with solutions containing the same ions are greatly altered by stirring the liquid or moving the metal in the electrolyte. When the metal is first placed in the liquid, hydrated ions deposit on the metal, discharge and lose their water of hydration. At the same time, non-hydrated ions will be thrown off, and will hydrate before returning. The speed of the returning ions is therefore much less than that of the outgoing ions, and when equilibrium is established, the potential of the electrode will be greatly lowered by this action. On rapidly moving the electrode, the speed of the incoming ions is increased, while that of the outgoing ions is almost unaltered, with the result that in some cases the potential rises by over 0.1 volt.

A copper plate treated in the same way shows a barely detectable rise of 0.002 volt.

This behaviour again supports the proposition that the ions of iron, nickel and cobalt are hydrated.

Further, it has been found that colloids are carried into the electrode surfaces only by hydrated ions. In this way it has been shown that the hydroxyl ion is also hydrated.

Summary.

1.—The overvoltages, anodic and cathodic, of a number of electrodes have been measured in acid, in alkali, and in certain solutions of metallic salts under varying conditions of time and current density.

2.—Elements in the same group of the periodic system show the same cathodic (hydrogen) overvoltages.

3.—Overvoltage is due to the high solution potentials of compounds of the electrode material with the discharged ion, or with a product of the discharged ion. These compounds (hydrides, higher oxides, etc.), form solid solutions in the electrode substance, and are usually stable only under the influence of high pressures or high temperatures.

4.—Metal overvoltages are due to the presence of the same compounds which produce gas overvoltages, and are in most cases very low, compared with gas overvoltages. Iron, nickel, and cobalt are exceptions to this rule.

5.—Changes of overvoltage are produced (*a*) by changes of constitution of the above compounds, and (*b*) by changes of concentration of the solid solutions formed.

6.—Passivity is due to the insolubility and good electrical conductivity of certain of the above compounds, which form a protective coating over the attackable metal surface.

7.—The chemical stability of the hydrides or higher oxides formed on the electrode surfaces is of great importance when dealing with substances which are only reduced or oxidised with a low velocity.

8.—The ions $H^{\cdot}$, OH', $Fe^{\cdot\cdot}$, $Ni^{\cdot\cdot}$, $Co^{\cdot\cdot}$ are hydrated (combined with the solvent) in aqueous solution.

9.—The ions $Na^{\cdot}$, $NH_4^{\cdot}$, $K^{\cdot}$, $Cu^{\cdot\cdot}$, $Ag^{\cdot}$, $Zn^{\cdot\cdot}$, $Cd^{\cdot\cdot}$, $Hg^{\cdot\cdot}$, $Tl^{\cdot}$, $Sn^{\cdot\cdot}$, $Pb^{\cdot\cdot}$, Cl', NO_3', and SO_4'' are either non-hydrated, or have an affinity for the solvent of a quite different order from that of $H^{\cdot}$, OH', etc.

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Ordinary Meeting, October 3rd, 1916.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Mr. C. L. BARNES, M.A., drew attention to the recent accessions to the Society's Library, and a vote of thanks was accorded the donors of the books upon the table. The following were amongst the recent accessions to the Society's Library:—"*Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Cheltenham, Maryland, 1913 and 1914*," by D. L. Hazard (Serial No. 19) (4to., Washington, D.C., 1915), presented by the United States Coast and Geodetic Survey, Washington; "*La Science Française (Exposition Universelle et Internationale de San Francisco)*," Tomes 1 and 2 (8vo., Paris, 1915), presented by the Ministère français de l'Instruction publique, Paris; "*An Introduction to the Grammar of the Tibetan Language . . . .*," by S. C. Das (4to., Darjeeling, 1915), presented by the author; "*Echoes from East and; West . . . .*," by Roby Datta (8vo., Cambridge, 1909), presented by the author; "*Réponse au Livre blanc Allemand du 10 Mai, 1915, 'Die völkerrechtswidrige Führung des Belgischen Volkskriegs'*" (fol., Paris, 1916), presented by the Belgian Foreign Office; "*Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Honolulu, Hawaii, 1913 and 1914*," by D. L. Hazard (Serial No. 21.), (4to., Washington, D.C., 1916), and "*Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory near Tucson, Arizona, 1913 and 1914*," by D. L. Hazard (Serial No. 23), (4to., Washington, D.C., 1916), presented by the United States Coast and Geodetic Survey, Washington; "*Check-List of Books and Pamphlets relating to the History of the Pacific Northwest*," by Charles W. Smith (8vo., Olympia, Washington, 1909), presented by the Washington State Commission, Alaska-Yukon-Pacific Exposition; "*Geologic Atlas of the United States,*" Folios Nos. 195-198 (fol., Washington, D.C., 1915), presented by the United States Geological Survey, Washington; "*The Physical Anthropology of the Lenape or Delawares...,*" by Aleš Hrdlička (Bulletin 62.) (8vo., Washington, 1916), presented by the Bureau of American Ethnology, Washington; "*Results of Rainfall Observations in Java,*" with Atlas, by W. van Bemmelen. (Fol., Batavia, 1914 and 1915), and "*Results of Registering Balloon Ascents at Batavia,*" by W. van Bemmelen. (Verhandelingen No. 4.) (8vo., Batavia, 1916), presented by the Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia, Batavia; "*The Medieval Popular Ballard,*" by E. G. Cox (University of Washington Publications in English. Vol. III.) (8vo., Boston, etc., 1914), presented by the University of Washington, Seattle; "*Results of Observations made at the United States Coast and Geodetic Survey Magnetic Observatory at Sitka, Alaska, 1913 and 1914,*" by D. L. Hazard (Serial No. 27) (4to., Washington, D.C., 1916), and "*Determination of the Difference in Longitude between each Two of the Stations Washington, Cambridge, and Far Rockaway,*" by F. Morse and O. B. French. (Special publication, No. 35.) (8vo., Washington, D.C., 1916), presented by the United States Coast and Geodetic Survey; and a set of the Works of Linnaeus, comprising twenty-five volumes, presented by Dr. William Carruthers, F.R.S., F.L.S., Honorary Member of the Society.

The PRESIDENT referred to the death of Mr. John Angell, F.C.S., F.I.C., on September 9th, 1916, who was a member of the Society for over forty-five years. He also drew attention to the death, on July 15th, 1916, of Professor Elie Metschnikoff, and to the death, on July 23rd, 1916, of Sir William Ramsay, K.C.B., Sc.D., F.R.S., both Honorary Members of the Society.

"**The Discussions at the Newcastle Meeting of the British Association,**" were dealt with by Professor F. E. WEISS, D.Sc., F.L.S., Professor SIR ERNEST RUTHERFORD, M.A., D.Sc., F.R.S., Mr. WILLIAM THOMSON, F.R.S.E., F.I.C., and Dr. GEORGE HICKLING, F.G.S.

Professor WEISS confined his remarks to two of the communications made to the Botanical Section. In the first place, he dealt with the address of Professor F. O. Bower, on "Leaf-architecture," in which Prof. Bower showed within the group of Ferns that the pinnate leaves were to be considered as an advanced type which could be derived from a bifurcating condition, in which one of the lobes became arrested while the other underwent further bifurcation. The conclusion was based upon evidence afforded by early stages in the development of the ferns in question and as confirmatory evidence numerous instances of bifurcations of pinnate fronds might be cited.

Dr. Willis' paper on the Distribution of Plants in New Zealand dealt with the question of endemic forms, which the author was inclined to consider as largely forms of comparatively recent origin. His view that the range of distribution of endemics varies directly as the age of these plants, he considered to be confirmed by the evidence obtainable from the distribution of plants in New Zealand.

Sir ERNEST RUTHERFORD gave a brief account of the proceedings of Section A, and of the discussion on Gravitation. Attention was drawn to the important theoretical deductions of Einstein and of the possible experimental methods of testing his theories.

Mr. WILLIAM THOMSON dealt with the proceedings of Section B (Chemistry), and pointed out that the subject of economy of coal was discussed at considerable length. He was afraid we could not hope for much from these discussions. The problem for both steam raising and household purposes is so complicated that it is unlikely that anything of a final nature can be reached in the near future.

The question of Air Pollution by smoke is occupying attention at present. An organised attempt has been made to determine the relative degrees of impurity of the atmosphere in different towns throughout the kingdom, by collecting rain water in large glazed open vessels and analysing the water collected therein, each month. This attempt was commenced by a Smoke Prevention League and it has received general acceptance by a number of eminent scientific men, who evidently acquiesced in the decision of the members of the League and tried to help them. The results obtained however are ridiculous and the time and money expended on it wasted.

A discussion took place on the Aniline Dye Industry. One reader of a paper tried to show that the present English Industry in dyes is not far behind that of Germany. This might be so in certain common colours, but Mr. Thomson thought it must be admitted that the Germans are far ahead of us in the manufacture of fast delicate colours.

Dr. GEORGE HICKLING, referring to the proceedings of Section C (Geology), stated that by far the most important subject dealt with in that section was the proper investigation and utilisation of our coal resources, which formed the principal theme of the presidential address, and was the matter of a joint discussion with Section B (Chemistry). Various speakers dealt with the importance of systematic enquiry, of the investigation of the potentialities of different coals as sources of by-products, of the study of the origin and distribution of the ash-content, of the questions of chemical constitution, of the structure as revealed in microscopic section, and of the study of the variation of seams vertically and horizontally. All speakers agreed as to the necessity for close co-operation among various researchers and as to the vital importance to the nation of the questions involved, the adequate solution of which was a matter for immediate government action.

Ordinary Meeting, October 17th, 1916.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Professor WILLIAM H. LANG, M.B., D.Sc., F.R.S., gave a **demonstration of a series of lantern slides illustrating the mode of preservation and the structure of *Rhynia Gwynne-Vaughani*, from the Old Red Sandstone of Rhynie, Aberdeenshire.**

The chert in which the plant occurs was discovered by Dr. Mackie, of Elgin, and the plant-remains are being studied by Dr. R. Kidston, F.R.S., and Professor Lang, the results being published by the Royal Society of Edinburgh.

The slides showed the underground rhizomes attached to the peaty soil by rhizoids, the branched cylindrical aerial stems which were leafless, and the large cylindrical sporangia. The internal structure is well preserved, so that our knowledge of this ancient land plant is pretty complete.

Rhynia differs so much from other Vascular Cryptogams that a new class, the Psilophytales, has been founded to contain it.

General Meeting, October 31st, 1916.

Professor W. W. HALDANE GEE, B.Sc., M.Sc.Tech., Vice-President, in the Chair.

Mrs. M. BADGER CRAVEN, M.Sc., Demonstrator in Chemistry, The Municipal School of Technology, *10, Birch Grove, Rusholme, Manchester;* and Mr. WILFRID ROBINSON, M.Sc. (Manc.), B.Sc. (Lond.), Lecturer in Economic Botany in the Victoria University of Manchester, *The University, Manchester*, were elected Ordinary Members of the Society.

Ordinary Meeting, October 31st, 1916.

Professor W. W. HALDANE GEE, B.Sc., M.Sc.Tech., Vice-President, in the Chair.

Mr. C. E. STROMEYER, M.Inst.C.E., M.Inst.M.E., made a short communication on a method of extracting square roots by means of division with whole numbers. Let a^2 be the number to be dealt with and $a+b=n$ a whole number. Obtain m by dividing n into a^2. Then

$$b = \frac{n-m}{2} + \frac{1}{4} \cdot \frac{(n-m)^2}{(n+m)} + \frac{1}{4} \cdot \frac{1}{n^2(n+m)},$$

on squaring b, subtracting from a^2 and again dividing by the whole number n and the approximate root is half the sum of the divisor and the dividend.

Mr. E. L. RHEAD, M.Sc.Tech., F.I.C., called the attention of the meeting to an extremely bright meteor which he observed in the Northern sky on October 20th, at 10-38 p.m. Its path was eastward from a point immediately under the Great Bear. The period of visibility was approximately 4 seconds, the brightness increasing to a maximum and then fading. Its motion was somewhat slow. About the middle of the flight an explosion took place and some five fragments were detached and fell almost vertically, the main body proceeding in the original direction.

The appearance was a more or less conical sheet of flame with jagged edges, and the direction in which it was observed was a little E. of magnetic North.

Professor G. ELLIOT SMITH, M.A., M.D., F.R.S., gave some "**Observations on Recently Discovered Fossil Human Skulls.**"

The announcements made in '*Nature*' last year of the discovery of fossil human skulls in Australia (Talgai) and South Africa (Boskop) suggest certain observations concerning the problems relating to early mankind. For not only do they add to the number of the distinct types of early humanity with which we are acquainted, but also they force upon us the further consideration of the question of early migrations, of the reality of which the widespread distribution of certain definite types of stone implements already afforded convincing testimony for all who were willing to accept the plain significance of positive evidence.

There are reasons for believing that when *Homo sapiens* first became differentiated from other human species many human strains other than those which made their way into Western Europe in the Upper Palaeolithic (or as I prefer to call it the Early Neoanthropic) Age were also budded off from the original parent stock. Some of these diversely specialised strains were the ancestors of the Australians, others of Negroes, others again of the Mongolian race, and yet others of the brachycephalic types of humanity, none of which were represented in Europe, excepting possibly the last of the groups mentioned, which began to filter into Eastern Europe in Solutrean times, but did not become at all common in the West until the closing phases of the Neolithic. Some of these various strains wandered far from their area of characterisation; and when brought into contact with other stocks were able to transmit their culture. Thus it is possible to explain how, even in the remote period usually called palaeolithic, identical methods of chipping stone implements in widely separated localities can be regarded as certain evidence of the derivation of the technique from a common source, though the actual makers of the weapons may be of different races.

Further, a particular culture-complex may have been built up of practices and customs derived from varied sources; and the particular set of them which became intermingled in one area, and the type of culture which develops as the result of the blending of these ingredients is peculiar to and distinctive of that area. For example, the well-defined culture complex which is commonly called neolithic, is characteristic of Europe and the immediate neighbourhood: nor in fact was it synchronous or of similar composition in different parts of Europe. But when one passes to the East or the South, although all the ingredients out of which the European neolithic was compounded may be found, there is no phase of culture which can justly be labelled neolithic in the same sense that the term is applied in Europe.

Mr. MAURICE COPISAROW, M.Sc., read a paper entitled "**Trinitrotoluene.**"

The paper, dealing with Trinitrotoluene, comprised the study of:—

1. Its chemistry, with special reference to its physical and chemical properties and use as an explosive.

2. Its manufacture and formation of intermediate and by-products.

3. Purification methods.

4. Peculiarities of acidity-determinations.

5. Recovery and utilisation of residues as explosives and dyes.

6. The action of alkalis on trinitrotoluene and the formation of addition, substitution, and condensation products.

This paper will be printed in the *Memoirs* after the war.

Ordinary Meeting, November 14th, 1916.

Mr. T. A. COWARD, F.Z.S., F.E.S., Vice-President, in the Chair.

Mr. WILLIAM THOMSON, F.R.S.E., F.I.C., exhibited and described parts of a German bomb.

Mr. JONATHAN BARNES, F.G.S., made a short communication on the amounts of sugar and starch in bananas. The fruit of *Musa paradisiaca* (banana) when in green or unripe condition contains only a small amount of glucose, but has an abundance of starch. The fruit in the green state has an unpleasant bitter taste, and is hard. During the process of ripening, which goes on after the fruit has been removed from the trees, the starch becomes changed into sugar. The analyses given below show the changes which took place during six weeks. On the 3rd of August, 1916, six pieces of fruit in a very green state were obtained, an estimation of the amount of sugar was made, this estimation was repeated at intervals of a week. At the end of the sixth week the fruit was completely ripe, the whole of the starch having changed into glucose.

Aug.	3rd,	0.72%	glucose,	17.315%	starch.
,,	10th,	1.76%	,,	10.463%	,,
,,	17th,	2.18%	,,	6.811%	,,
,,	24th,	7.60%	,,	1.445%	,,
,,	31st,	11.29%	,,	1.029%	,,
Sept.	7th,	18.21%	,,	absent	

The unripe fruit is very acid, whilst the fully ripened is only slightly acid.

Mr. BARNES also exhibited some specimens illustrating the results of pressure on peat.

A short communication was made by Dr. WILLIAM CRAMP, on the breaking of glass tubes.

It has been frequently noticed by engineers that a boiler gauge glass which has been in use, and is then cleaned by pushing waste through it on the end of a wire is very liable to break on being put to work again. Further experience seems to show that this is only the case if the wire has in the cleaning process touched the glass; and that if the waste be drawn through by means of a string subsequent breakage seldom occurs. The breakage which takes place is very marked, the tube often being shattered; and it does not seem to matter whether steel or copper wire is used. Scratching of the glass by the wire seems insufficient to account for the effect, and no adequate explanation has as yet been put forward.

Dr. F. E. BRADLEY, M.A., F.R.S.E., communicated a note on the presence of arsenic in various forms of food.

Dr. J. STUART THOMSON, M.Sc., F.R.S.E., read a paper entitled **"The Gorgonacea of the Cape of Good Hope."**
This paper is printed in the *Memoirs.*

Professor F. E. WEISS, D.Sc., F.L.S., read a paper entitled **"The Manufacture of Manure from Peat."**

Professor WEISS brought to the notice of the members a pamphlet published in Edinburgh in 1815, entitled "Directions for Preparing Manure from Peat." The anonymous author of this pamphlet, a Scottish landowner, conducted a series of experiments with considerable insight, and succeeded in utilising with great benefit for agricultural purposes a mass of peat moss which had been dug out in the making of an artificial lake. The method consisted in spreading alternate layers, about 6 inches deep, of peat and fairly fresh dung, until a heap of about four or five feet was constructed. The whole was then covered with peat and left for some months. After a short time the heap got into heat, and when this had passed off the peat had been transformed into a perfect compost as effective weight for weight as farmyard manure.

Peat made up in the same way with seaweed became similarly heated and underwent decomposition. It was found that it was unnecessary to add lime in the preparation of this manure. In all probability, in the method recommended by the author, the acidity of the peat becomes neutralised by the ammonia contained in the dung, while decay-producing bacteria may percolate into the peat in addition to those normally contained in it, but whose activity is inhibited by the presence of humic acid.

Professor Weiss then referred to more recent experiments made in America, with a view to determining in how far bog-water retards or stimulates the growth of plants. In these experiments Dachowski has shown that while untreated bog-water inhibits the normal growth of plants, neutralised bog-water stimulates more particularly the development of roots, and hence increases the absorptive capacity of the plant.

The method of preparation of "bacterised peat" (humogen) was also explained, and various experiments which have been made to test the value of this manure, were discussed.

General Meeting, November 28th, 1916.

Mr. T. A. COWARD, F.Z.S., F.E.S., Vice-President, in the Chair.

Mr. FREDERICK MAURICE ROWE, M.Sc., Research Chemist in Dyestuffs, The Municipal School of Technology, Manchester, 5, *Woodbine Terrace, Latchford*, was elected an Ordinary Member of the Society.

Ordinary Meeting, November 28th, 1916.

Mr. T. A. COWARD, F.Z.S., F.E.S., Vice-President, in the Chair.

A vote of thanks was accorded the donors of the books upon the table. Among these were: "*Science as Enemy and Ally*," by E. Crocker (8vo., Birmingham, 1915), presented by the Birmingham and Midland Institute; and "*The Weather Map*," by N. Shaw (16mo., London, 1916), presented by the Meteorological Office, London.

Mr. J. WILFRID JACKSON, F.G.S., exhibited a number of faceted pebbles from Pendleton. He stated that almost 200 of these had been collected within the last six months from near the top of a section of current-bedded and faulted Glacial sand and gravel, at an altitude of about 200 feet O.D.

The specimens occur *in situ* some two or three feet below the capping of darker subsoil, which contains cores and flakes of flint, including pigmies. They are composed of slate, granites (Eskdale and Shap), Ennerdale granophyre, Borrowdale volcanic tuffs, porphyries, quartzites, millstone grit, sandstones, chalk flints, carboniferous chert, and other rocks.

The facets are mostly concave, grooved, or fluted. Some stones have but one facet; others, two or more. One, with a flat top, exhibits five incipient facets. The dimensions of the largest faceted pebble are $11\frac{1}{2}$ by $8\frac{1}{4}$ inches by 7 inches high; and the smallest is but half an inch in diameter.

Differentiation, according to varying hardness and composition, is well displayed.

The pebbles are of Glacial origin. Some occurred in the sand completely inverted. Of those orientated *in situ*, the facets faced north-westwards, westwards, and south-westwards, i.e., the directions of the present prevailing winds.

Dr. F. E. BRADLEY, M.A., M.Com., F.R.S.E., made a further communication as to the presence of arsenic in baking powder. In some cases the amount of arsenic detected was about 25 times the amount permitted by the authorities, but was nevertheless practically negligible, because of the small proportion of the powder which passed into the ultimate food product. Dr. Bradley's investigations showed that the arsenic present in samples of baking powder recently sold was contained only in the acid phosphate of lime lately used in these powders in place of the tartaric acid or cream of tartar more generally employed, and only in those cases where the phosphoric acid used in the preparation of the acid phosphate had been made by means of pyrites-prepared sulphuric acid. He suggested that only brimstone-prepared sulphuric acid should be permitted to be used in the preparation of any phosphoric acid which entered into the manufacture of foodstuffs.

The Secretary communicated the following note from Mr. W. HENRY TODD.

In a communication to this Society on the 30th April, 1915, Mr. T. A. Coward records the behaviour of a blackbird in repeatedly fighting its own reflection in a pane of glass. This conduct, Mr. Coward suggests, is due to sexual excitement, which induces the bird to drive away any rival from what he regards as his "sphere of influence."

A case of a blackbird fighting his own reflection has recently occurred at my house at Flixton. On the 24th October, 1916, my wife heard a repeating noise in the cellar, and found it was occasioned by a blackbird attacking a window in the cellar, the upper part of which is about 12 inches above the level of the ground.

On the 10th November the blackbird again visited the window and repeated the performance.

On the 11th, about 3 o'clock in the afternoon, on going into the cellar, I found the blackbird fighting its reflection in the same window. My wife observed the bird at about the same time of day on the previous occasion.

The window faces due west, and, being near the ground, gets splashed with dirt. On each occasion when the bird was observed by my wife, the window had been cleaned in the morning, making the reflection clearer. It is possible that there may have been other window visits, and contests, with the phantom enemy.

The fact of these incidents having occurred in October and November appears to contradict Mr. Coward's theory that the pugnacity of the bird is due to sexual excitement. On the other hand, as the temperature on the 10th and 11th November was very high for the time of the year, and the character of the weather remarkably spring-like, it may be contended that the climatic conditions had stimulated sexual excitement.

Mr. Coward, in reply, pointed out that in many species the period of sexual excitement, and in some cases of actual pairing, begins in autumn, and that male blackbirds are, this year, already displaying. Probably the weather influences the time at which displays begin. The female birds appear to be less excited than the male.

Miss Laura Start confirmed the fact that display had begun; she recently watched two males displaying before one female.

Mr. HERBERT BOLTON, M.Sc., F.R.S.E., read a paper entitled **"The Mark Stirrup Collection of Fossil Insects from Commentry, Central France."**

This paper is printed in the *Memoirs*.

Ordinary Meeting, December 12th, 1916.

Professor W. W. HALDANE GEE, B.Sc., M.Sc. Tech., Vice-President, in the Chair.

Mr. W. G. PEMBERTON made a short communication on **"A direct reading Specific Gravity Balance for Solid Bodies heavier than water."**

If a pendulum be furnished with a circular head, and be swung on a pivot passing through the centre of the circular headpiece, it may be used, with a suitable scale, as a direct reading Specific Gravity Balance.

The body under examination is hung on a thread which passes round a groove in the circular head, and a sliding weight is adjusted along the pendulum arm until equilibrium is obtained with the latter horizontal. (*Fig. 1.*)

A vessel of water is then introduced around the sample, and the pendulum falls back through a certain angle to a position of rest.

Now from *Fig. 1.*

Where M is the mass of the sample.

And R is the radius of the circular head.

Where W is the mass of the pendulum and sliding weight.

And L is the distance from the pivot at which it may be assumed to act.

$$MR = WL \qquad \therefore M = \frac{WL}{R}.$$

And from *Fig. 2.*

Where M_1 is the weight of the sample in water.

$$M_1 R = WL\cos\theta \qquad M_1 = \frac{WL}{R}\cos\theta.$$

Now the specific gravity of any body

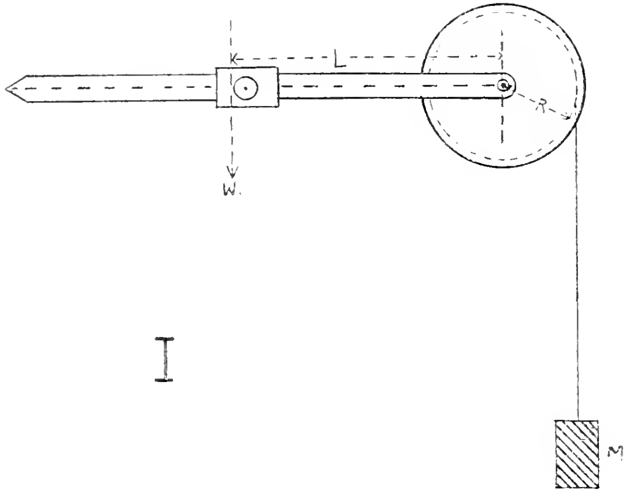
$$= \frac{\textit{weight in air}}{\text{weight in air} - \text{weight in water}}.$$

$$= \frac{M}{M - M_1} = \frac{\frac{WL}{R}}{\frac{WL}{R} - \frac{WL\cos\theta}{R}} = \frac{1}{1 - \cos\theta}$$

Therefore the specific gravity varies only as the angle θ and the mass or position of the sliding weight will cause no difference in reading, if a scale be constructed from the equation.

$$\text{S.G.} = \frac{1 - \cos\theta}{1}$$

giving direct readings of the S. G. from the angle θ.



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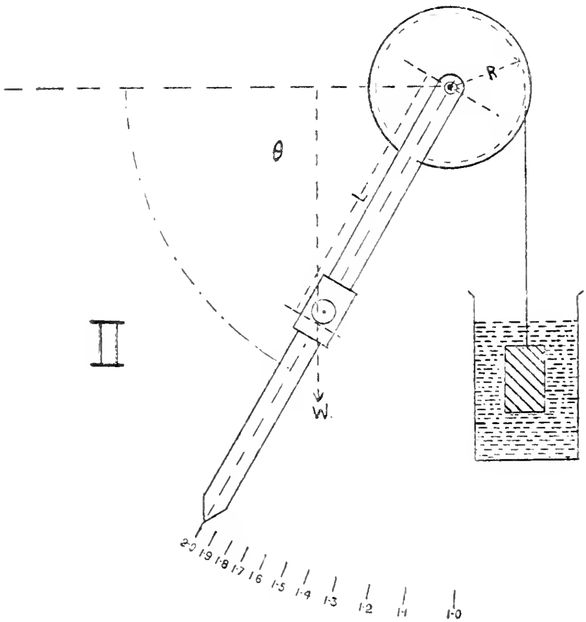

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It will be found that the readings of Specific Gravity from 1.0 to 2.0 occupy 30° of the scale, and the graduations between 1.0 and about 3.0 are conveniently large and open, giving accurate results.

Above about 5.0, however, the graduations become much closed up, and the balance is of no practical use. It is, however, particularly suitable for the determination of the Specific Gravity of samples of rubber, which rarely rises above 2.5.

It may be shown, also, that exact counterpoise to the horizontal in the first adjustment is by no means necessary, since an error of 5° or 10° from the horizontal hardly affects the subsequent reading. This is very convenient where an economy of time is important. In fact, the chief advantage of such an appliance is the speed with which a large number of determinations can be made.

Professor W. W. HALDANE GEE, B.Sc., M.Sc., Tech., made a short communication on a simple method for converting degrees Fahrenheit into degrees Centigrade, and back again from C. to F.

Professor HORACE LAMB, M.A., LL.D., Sc.D., F.R.S., read a paper entitled **"The Deflection of the Vertical by Tidal Loading of the Earth's Surface."**

The paper gave an account of some investigations in the theory of elasticity bearing on the above subject. The observations of Hecker, Orloff, and Michelson on lunar deflection of gravity exhibit an inconsistency between the results for the E.-W. and N.-S directions respectively. This has been attributed to the attraction of the tides, which have the same periodicity as the direct lunar influence, and to the tilting which their varying pressure produces in the solid earth. Some calculations illustrative of the effect which the tides might produce in this way have recently been made, but various modifying influences have been left out of account. The author had attempted to make an estimate of these corrections. Though of slight amount in many cases, they may under certain conditions attain considerable relative importance. Their general effect is to diminish the deflections as calculated on previous theories.

Professor Haldane Gee, Mr. W. G. Pemberton, Mr. W. D. Evans and other members took part in the discussion which followed this paper.

Ordinary Meeting, January 9th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

A vote of thanks was accorded the donors of the books upon the table.

Mr. FRANCIS JONES, M.Sc., F.R.S.E., read a paper entitled "**Note on the action of Hydrogen on Sulphuric Acid.**"

This paper is printed in the *Memoirs*.

Mr. T. A. COWARD, F.Z.S., F.E.S., read a paper entitled "**An Undescribed Habit of the Field Vole.**"

Mr. Coward stated that at the end of December, 1916, he found three Field Voles occupying nests at an elevation above the ground varying from three to six feet. The first was in a round ball-like nest of grass, apparently entirely constructed by the mouse, similar in shape and size to the summer nest of a dormouse. It was placed at a height of about five to six feet, in the branches of a willow, in an osier-bed at the edge of Rostherne Mere, Cheshire. The other two mice were in nests made in the hollows of the old nests of birds, and a third nest of this character was found without occupant. These three nests were in the hedge bordering the osier-bed. All three voles were dead, and the first one found—on December 26th—had died so recently that the fleas had not left its body.

The Field Vole is far more terrestrial in its habits than its relative, the Bank Vole, *Evotomys glareolus*, which constantly climbs to secure hedge fruits or to bark tender twigs. Barrett-Hamilton says of Field Voles that "although not incapable of climbing, they never under normal circumstances leave the ground." The nests, collections of dry grass, are placed in a hollow on the surface of the ground, or, especially in winter, in chambers in their long subterranean runs or burrows. No writer on British mammals records other situations for nests. The Bank Vole usually nests in the same manner, but Collett mentions as an exception a nest which he found in Norway within that of a Fieldfare, six feet above the ground in a spruce. One of the nests (exhibited at the meeting), is similar in character to this nest of the Bank Vole described by Collett—domed, and with an entrance hole at the side. This nest is built over the old nest of some passerine bird, probably a greenfinch.

Barrett-Hamilton and Hinton say that Field Voles "are very hardy, and never hibernate, although they may be comparatively inactive in cold, damp weather," but Lydekker states that "during the hardest weather they fall into uninterrupted hibernation," rousing at the return of milder condition. Which of these contradictory statements is correct Mr. Coward could not say, but he has frequently seen and captured voles in snow and during severe frosts, and has never, until this winter, come across anything suggestive of hibernation.

The osier-bed in which the first nest was found is frequently flooded, and underground burrows would be death-traps for the voles, but it is only occasionally that the water rises so high as to flood the base of the boundary hedge.

Towards the end of December, 1916, the weather was severe, but changeable, and the snow, thawing and freezing again, would have made the ground unsafe for a burrowing mammal. This probably explains why the voles had constructed nests as retreats in elevated positions, but whether this above-ground nesting habit is usual in similar situations remains to be proved. The cause of death of the three voles is difficult to explain, for the weather was not more severe than obtained when the mice have been met with abroad. Possibly in dryer situations they would be protected in underground nests, but the elevated nests were too much exposed, and the mice had not had time or chance to gather sufficient material in which to protect themselves.

The matter requires further investigation, and Mr. Coward hopes to make further observations under varying weather conditions.

Ordinary Meeting, January 23rd, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Professor G. ELLIOT SMITH, M.A., M.D., F.R.S., read a paper entitled "**The Endocranial Cast of the Boskop Skull.**"

Professor Elliot Smith stated that Dr. Péringuey, Director of the South African Museum, has submitted for examination and report an endocranial cast obtained from the fossil human skull found near Boskop, in the Transvaal, in 1913. Apart from the right temporal bone, the base of the skull is missing; but sufficient of the calvaria has been recovered to show that the capacity of the cranial cavity must have been well above 1800 c.c., perhaps even as much as 1900 c.c.—greater than that of the philosopher Kant's skull, and almost as large as Bismarck's.

Unfortunately it reveals only the slightest indications of the positions of the cerebral sulci; but a very definite idea is afforded of the general form and relative proportions of those parts of the brain that were covered by the frontal and parietal bones respectively. The flatness of the cast and certain of its features suggest affinities of the Boskop man with the Neanderthal race. But the larger size, and especially the form, of the prefrontal bulging indicates an even closer kinship with the peoples found in Europe in Aurignacian and later times.

But it would be incorrect to regard the Boskop man as a member of either the Neanderthal or Cro-Magnon races. For he represents a variety of mankind that never intruded into Europe—probably a divergent branch of the species *sapiens*, which sprang from the parent stock soon after its separation from the so-called species *neanderthalensis*. In confirmation of this suggestion is the fact that, though the prefrontal area is larger than that of Neanderthal man, and has assumed the form distinctive of the modern type of man, it is smaller, both actually and relatively, than that of the Cro-Magnon race.

The great size of the Boskop cast is due mainly to the exceptional dimensions, and especially the great lateral expansion, of the parietal area.

The conclusion that seems to emerge from a comparison of the cranial casts of these extinct varieties of mankind is that the chief factor which above all others determines brain superiority is not so much mere bulk as the size of the prefrontal area.

It is perhaps not without some significance that the Strandloopers, hitherto regarded as the most primitive and the least negroid race of South Africa, were distinguished by an exceptionally large cranial capacity, a remarkable prominence of the parietal eminencies, and a full forehead (Shrubsall). It is possible that these early cave-dwellers may represent the descendants of the Boskop race, modified both by development and admixture.

Dr. G. HICKLING, F.G.S., read a paper entitled "**The Skull of a Permian Shark.**"

A preliminary statement was made concerning the results of a re-examination of certain remains of the skull of *Diacranodus texensis*, Cope, sp., now in the Manchester Museum. The material is sufficient for a practically complete restoration of the cranium and jaws, while there is some indication of the character of the branchial apparatus, not hitherto described. Cope's original description appears to be on the whole more accurate than some of the later accounts, though his reference to distinct "frontal" and "parietal," etc., elements cannot be maintained. The comparison, also, with *Chlamydoselache* appears to be much less close than that with *Heptanchus*.

Ordinary Meeting, February 6th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Mr. C. L. BARNES, M.A., made a short communication on "**Galvanit,**" a preparation brought out some years ago for depositing silver, nickel, or cadmium on a surface of copper or brass. The active ingredients were powdered magnesium and a salt of the metal to be deposited, but the method soon fell into disuse, through the layer not proving sufficiently adherent. A tin of the silver mixture was placed in the Society's keeping.

Professor BOYD DAWKINS conveyed to the Society his deep regret that owing to illness, he was unable to be present to read his paper on "**The Place of the Manchester Museum in the General Scheme of Education.**"

Mr. T. A. COWARD, F.Z.S., F.E.S., then took the chair, and the President made a communication on "**Polytrema and allied foraminifera,**" and exhibited some specimens and a series of lantern slides to show their structure.

Ordinary Meeting, February 20th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Dr. HICKLING referred to the very large group of sun-spots which has recently been visible, and some discussion took place on this subject.

Dr. W. MAKOWER, M.A., then read a paper on "**The Photographic action of α Rays.**"

Dr. Makower stated that although the discovery of the radio-activity of uranium was made by the photographic action of uranium salts as long ago as 1896, the nature of this effect was not studied in detail for many years. The first important investigation of the photographic action of α particles was made in 1910 by Kinoshita, who succeeded in showing that whenever an α particle strikes a grain of silver halide in a photographic plate, that grain is subsequently capable of photographic development; moreover, this was true throughout the range of the α particle. Later it was shown by Reinganum and others that when α particles are projected tangentially to a photographic plate after development the film shows definite trails of grains of silver halide, which can readily be distinguished under the microscope. These trails are produced by the impact of the

α particles on the halide grains as they pass through the film, and their length represents the range of the α particles in the film of gelatine. It is evident, therefore, that we are dealing with an extremely delicate method of detecting and studying the emission of α rays, for each single α particle produces a record of its passage through the photographic film, and the path taken by each particle can be studied in detail.

Microphotographs showing the paths of α particles through photographic films were first published by Walmsley and Makower, and soon afterwards by Kinoshita and Ikeuti. The method adopted by the latter was to activate the tip of a sewing needle by gently rubbing it on a surface coated with the active deposit of radium or some other source of α radiation. In this way a trace of active matter was transferred to the point of the needle, which was then placed for a short time in contact with a photographic film. The grains affected by the α particles can be clearly seen radiating out in straight lines from centres representing the points at which the needle had been brought into contact with the films.

A defect of the method when applied to quantitative measurements is the difficulty of obtaining photographic plates capable of development without showing under the microscope a number of blackened grains, even when the plate has not been exposed to light or any radio-active source. For some reason most photographic plates, if developed without exposure to light or other stimulus, though showing no visible fogging to the naked eye, are found on examination under the microscope to be covered with blackened silver grains. It is, therefore, important to use a plate which, when suitably developed, is free from this defect. After a careful search it was found by Sahni that this condition is well satisfied by Wratten and Wainwright's lantern plates. Later experiments have shown that Schumann plates are even more suitable, and by this means the photographic method has been used to attack a number of problems such as the determination of the ranges of α particles, and the variation in the number of particles near the end of their range.

Ordinary Meeting, March 6th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Mr. G. P. Varley, M.Sc., and Mr. W. C. Jenkins, F.R.A.S., were nominated Auditors of the Society's Accounts for the Session 1916-17.

The following resolution was passed unanimously: "That the best thanks of the Society be accorded to Dr. A. E. Barclay, and to Mr. Noton, for their generous and valuable gift of a microscope which formerly belonged to John Dalton.

Professor G. ELLIOT SMITH, M.A., M.D., F.R.S., made a short communication on the discovery of the remains of a second representative of *Eoanthropus Dawsoni*, which was made by the late Mr. Charles Dawson. By the courtesy of Dr. Smith Woodward, F.R.S., he was permitted to exhibit models of the newly-found fragments.

Dr. HENRY WILDE, F.R.S., conveyed to the Society his regret that owing to the state of his health he was unable to be present to read his paper on **"An Egyptian Meteorite."**

The paper which was read by the Honorary Secretary is printed in the *Memoirs*.

Dr. A. D. IMMS, M.A., F.L.S., then read a paper entitled **"Remarks on 'castration-parasitaire' in Insects with special reference to Termites."**

Dr. A. D. Imms referred to the occurrence among diverse groups of animals of the phenomenon known as "castration parasitaire." This designation was applied by the French biologist Giard to a particular phase of parasitism, in which the parasite suppresses, or inhibits the reproductive function of its host. In a series of some twenty papers, published between 1869 and 1902, Giard elucidated a variety of cases selected from both the animal and vegetable kingdoms. One of the best known is the infestation of Decapod Crustacea with cirriped and bopyrid parasites pertaining to such genera as *Sacculina Peltogaster*, *Bopyrus*, etc. In addition to destroying the gonads of its host, *Sacculina*, for example, profoundly affects the secondary sexual characters. In the case of infested males of *Inachus mauritanicus* this parasitism induces them to assume the characters of the female as regards the form of the abdomen, the pleopods, and the chelæ. Among insects several remarkable cases were dealt with: (1) The infestation of bees of the genus *Andrena*, and the wasp *Polistes*, through the agency of the aberrant parasite *Stylops* and its allies; (2) The effects of the parasitism of bumble bees through the agency of the Nematode worm, *Sphærularia bombi*; (3) Wheeler's discovery of the remarkable individuals found among *Pheidole*, and other ants, and termed by him mermithagates—individuals which lose their reproductive function, and possess an enormously enlarged abdomen, harbouring a Nematode of the genus *Mermis*; (4) Kunckel d'Herculais' discovery of the effects of the larva of the Dipteron *Sarcophaga* upon the grasshopper *Stauronotus*, which they parasitise. By devouring the fact-body, and absorbing the oxygen of the blood-plesma, atrophy of the gonads results; (5) The effects of the larvæ of the dryinid hymenopteron *Aphelopus*, and those of the pipunculid fly *Chalarus*, upon leaf-hoppers of the genus *Typhlocyba*; (6) The supposed occurrence of "castration-parasitaire" among Termites. Grassi and Sandias (1893) pointed out that, in certain Italian Termitidæ, the soldiers and workers harbour vast numbers of Protozoa in the specially enlarged hind intestine. In Termites infected with these Protozoa the gonads are very greatly reduced and the sexual function lost. In the very young larvæ, and the sexual forms, which are fed on saliva, the Protozoa are absent. These zoologists regard the development of the sterile soldier and worker castes are being correlated with infection by parasitic Protozoa. Brunelli (1905) regards this as a case of "castration-parasitaire," and says that in certain queen Termites which he examined Protozoa were present, and the ovaries of their hosts were degenerating. This conclusion has been disputed recently by Feytaud, who states that the appearances of the ovaries, which Brunelli interprets as being indicative of degeneration, are in reality only artifacts resulting from the reagents employed. Dr. Imms then dealt with his own researches which were conducted on the Himalayan Termite *Archotermopsis*. In this primitive form, the gonads in the so-called sterile castes, are as well developed as in the sexual forms, nevertheless Protozoa are extremely abundant in the hind intestine in every instance. They were also found in the gut of the sexual forms on several occasions, and were, furthermore, present in great quantities in an egg-laying worker-like individual. Dr. Imms pointed out that the evidence was in favour of the Protozoa not being parasites at all, and that very possibly they were symbiotic in their relations with their host. It is a significant fact that, so far, they are only known to occur in the intestine of wood-feeding Termites, and there is good reason to believe that these minute organisms act upon the lignin in their digestive processes, and render it capable of ready assimilation by the host Termites. The Protozoa appear to have no influence at all upon caste production, as soldiers and workers are present in numerous Termites which do not harbour these organisms. Similarly they exert no apparent influence on the gonads, as can be readily seen in *Archotermopsis*, *Eutermes*, and other forms. In the first-named genus the gonads are highly developed, and Protozoa occur in prodigious numbers, while in certain species of *Eutermes* Protozoa are totally wanting, nevertheless the gonads are so degenerate as to be almost absent. In conclusion, Dr. Imms referred briefly to the presence of Infusoria in the digestive system of the Ruminantia and Equidæ, and to their possible symbiotic rôle as agents, which render the cellulose of the food capable of being digested by these animals.

Ordinary Meeting, March 20th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Professor WEISS presented a paper "**On the contents of a herbarium of British and foreign plants for presentation to the Victoria University of Manchester.**" By Mr. CHARLES BAILEY, M.Sc., F.L.S.

Professor Weiss exhibited some sample sheets, showing the method of arrangement observed by Mr. Bailey in his herbarium, and emphasised the great value which so well ordered and extensive a collection would be to all students of botany in the district.

This paper is printed in full in the *Memoirs*.

General Meeting, April 3rd, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Mr. HERBERT EDWARD SOPER, M.A., Electrical Engineer, of 81, Moston Lane, Failsworth, was elected an ordinary member of the Society.

Ordinary Meeting, April 3rd, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

Mr. R. B. FISHENDEN, M.Sc.Tech., read a paper entitled "**Illustration Processes used in Scientific Publications.**"

Mr. Fishenden stated that although type is almost invariably used for printing the letterpress portion of a book or paper, there exist other essentially different printing processes—lithography and intaglio printing—which are occasionally used for printing type characters. Illustrations are commonly printed by all three processes, according to the nature of the result desired, but if both type and illustration are printed in one operation, the cost is less than if either of the other two processes is used for "supplement" illustrations.

Suitable printing surfaces may be prepared from the original drawings or photographs by trained craftsmen, who engrave the subjects, or, in the case of lithographic work, re-draw them. These processes are relatively slow and costly and have been largely superseded by photographic processes of reproduction; the latter, however, demand that the original drawings shall be so prepared as to be suitable for reproduction without the need of any further work by a draughtsman. In special cases line-work is re-drawn, but the majority of scientific writers prefer a direct reproduction of their own drawings.

In the case of diagrams and other drawings in pure line, the most satisfactory results are obtained by the use of a waterproof Indian or Chinese ink upon a smooth, hard-surfaced paper, or Bristol board. All the lines must be equally black and firm; if they are broken, or have serrated edges, the defects generally become more pronounced in the reproduction. Unless it is impracticable for other reasons, the original drawings should be made to be reproduced to half or two-thirds their lineal dimensions. Lines, dots, or irregular stipples may be applied to the printing block by the engraver if indications are given in blue pencil on the corresponding portions of the original drawing.

Photographs may conveniently be converted into line drawings by drawing over the outlines with waterproof ink and then bleaching out the original print.

For rapid effects the use of "scraper-boards" is sometimes convenient. These boards have a chalk coating and are obtainable in a variety of forms; they are covered with printed and embossed lines. The shadows of the drawing are made with a carbon pencil, the high lights being scraped away with a knife.

Photographs for reproduction by collotype or by the half-tone process are preferably black, glossy "bromide" prints, or "gelatino-chloride" prints of a purple-brown tone. If a number of separate prints are to be reproduced together as a page, they should, as far as possible, be similar in strength and colour.

Sepia wash drawings are more satisfactory for photographic reproduction than those made in pure black and gray. The quality of the reproduction of a suitable drawing by the collotype process, or by the half-tone process under satisfactory conditions is indubitable; and it is questionable whether the expense of preparing a chalk lithograph can be justified.

The correct translation of coloured objects or drawings into monochrome reproductions by photography is not possible by means of the ordinary silver bromide dry plate, for the sensitiveness of the latter includes only the violet and blue regions of the visible spectrum. The applications of photography to scientific purposes and to reproduction work have been greatly increased by the commercial production of panchromatic dry plates, which are sensitive to the entire visible spectrum. By the use of these plates, in conjunction with suitable colour light filters, which transmit only light of the required spectral regions, it is possible to obtain photographs of coloured objects which reproduce their true colour values or secure maximum contrast.

Colour sensitive plates are used in the various modifications of the three-colour process, including the semi-automatic colour processes in six or more colours, which are printed in collotype or lithography. It is probable that such processes will largely replace existing processes of chromo-lithography.

Annual General Meeting, April 24th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

The Annual Report of the Council and the Statement of Accounts were presented, and it was resolved:—"That the Annual Report, together with the Statement of Accounts, be adopted, and that they be printed in the Society's *Proceedings*."

Mr. MELLAND and Dr. L. BALLS were appointed Scrutineers of the balloting papers.

The following members were elected Officers of the Society and Members of the Council for the ensuing year:—

President: WILLIAM THOMSON, F.R.S.E., F.I.C., F.C.S.

Vice-Presidents: G. ELLIOT SMITH, M.A., M.D., F.R.S.; T. A. COWARD, F.Z.S., F.E.S.; W. W. HALDANE GEE, B.Sc., M.Sc.Tech., A.M.I.E.E.; SYDNEY J. HICKSON, M.A., D.Sc., F.R.S.

Secretaries: R. L. TAYLOR, F.C.S., F.I.C.; GEORGE HICKLING, D.Sc., F.G.S.

Treasurer: W. HENRY TODD.

Librarian: C. L. BARNES, M.A.

Other Members of the Council: FRANCIS JONES, M.Sc., F.R.S.E., F.C.S.; MARY MCNICOL, M.Sc.; D. THODAY, M.A.; FRANCIS NICHOLSON, F.Z.S.; H. R. HASSE, M.A., D.Sc.; E. L. RHEAD, M.Sc.Tech., F.I.C.

Ordinary Meeting, April 24th, 1917.

The President, Professor SYDNEY J. HICKSON, M.A., D.Sc., F.R.S., in the Chair.

A vote of thanks was accorded the donors of the books upon the table.

A Paper by Mr. J. W. PERRY, B.A., entitled **"An Ethnological Study of Warfare,"** was then read by Professor G. ELLIOT SMITH, M.A., M.D., F.R.S.

This paper is printed in full in the *Memoirs*.

Mr. T. A. COWARD, F.Z.S., F.E.S., then read the short notes of Mr. A. Loveridge, on **"The Nesting Habits of the Palm Swift,** *Tachornis parva* (Licht)," from observations he made on a colony of this species at Morogoro, German East Africa.

These notes are printed in the *Memoirs*.

Ordinary Meeting, May 8th, 1917.

The President, Mr. WILLIAM THOMSON, F.R.S.E., F.I.C., F.C.S., in the Chair.

A vote of thanks was accorded the donor of the book upon the table.

Mr. R. F. GWYTHER read a paper entitled **"The Specification of Stress."** Part V. **"The formal Solution of the Statical Stress Equations, and a Theory of Displacement as consequent on Stress."**

This paper will be printed in the *Memoirs*.

A paper was afterwards read by Dr. E. NEWBERY, entitled **"Recent Work on Overvoltage."**

This paper is also printed in full in the *Memoirs*.

MANCHESTER
LITERARY AND PHILOSOPHICAL SOCIETY,

Annual Report of the Council, April 1917.

The Society had at the beginning of the Session an ordinary membership of 138. Since then four new members have joined the Society, and three members have resigned. There are, therefore, at the end of the Session 139 ordinary members of the Society.

The Society has lost, by death, three honorary members, viz., Dr. Elie Metschnikoff, For.Mem.R.S.; Sir William Ramsey, K.C.B., Ph.D., Sc.D., M.D., F.R.S.; Sir Edward Burnett Tylor, D.C.L., LL.D., F.R.S. Memorial notices of Dr. Metschnikoff and Sir William Ramsay appear with this Report.

Twenty-six papers have been read at the meetings during the year; fifteen shorter communications have also been made.

The Society commenced the session with a balance in hand, from all sources, of £329 8s. 4d., made up as follows:—

At credit of General Fund	....	£27	19	1
,, ,, Wilde Endowment Fund	......	224	12	0
,, ,, Joule Memorial Fund	....	76	17	3
Balance 31st March, 1916	....	£329	8	4

The balance in hand at the close of the Session amounted to £232 8s. 0d., the amounts standing at credit of the various accounts on the 31st March, 1917, being:—

At credit of General Fund	....	£69	4	3
,, ,, Wilde Endowment Fund	......	81	6	9
,, ,, Joule Memorial Fund	....	81	17	0
Balance 31st March, 1917	....	£232	8	0

The Wilde Endowment Fund, kept as a separate banking account, shows a balance due to the Fund of £81 6s. 9d. in its favour, as against a balance in hand of £224 12s. 0d. at the end of the last financial year. The receipts for the year 1916-17 show a slight decrease as compared with those for the previous year.

£142 10s. 0d. of the Wilde Endowment Fund has been invested in the purchase of £150 of the new 5 per cent. War Loan Stock; and the £200 (£195 16s. 0d.) of the 4½ per cent. War Loan Stock purchased last year has been converted into £200 of the new 5 per cent. War Loan Stock.

The Librarian reports that during the Session 348 volumes have been stamped, catalogued and pressmarked; 314 of these were serials, and 34 were separate works. 79 catalogue cards were written: 25 for serials, and 54 for separate works. The total number of volumes catalogued to date is 37,387, for which 13,935 cards have been written.

The library continues to be satisfactorily used for reference purposes. 284 volumes have been borrowed from the library during the past year. The number of books borrowed during the previous year was 184, and during 1913-14, 201.

During the year 132 volumes have been bound in 130 covers. In the previous Session the corresponding numbers were 220 volumes in 163 covers.

The additions to the library for the Session amounted to 580 volumes: 523 serials, and 57 separate works. The donations (exclusive of the usual exchanges) were 103 volumes; 2 volumes were purchased in addition to those regularly subscribed for.

The donations to the Society's Library during the Session include gifts of books by the Trustees of the British Museum (Natural History), the Meteorological Office, London, Mr. Edward Melland, and Dr. William Carruthers.

The publication of the Society's *Memoirs and Proceedings* has been continued under the supervision of the Editorial Committee.

The Society is indebted to Dr. A. E. Barclay and Mr. John Noton for the gift of a microscope which formerly belonged to John Dalton.

The Assistant Secretary (Mr. R. F. Hinson) was called away from Manchester for military service on January 2nd, 1917, since which date his duties have been undertaken by Miss A. McK. Crabtree.

The Committees appointed by the Council during the year were as follows:—

House and Finance.

The PRESIDENT
Mr. C. L. BARNES.
Mr. FRANCIS JONES.
Mr. R. L. TAYLOR.
Mr. FRANCIS NICHOLSON.
Mr. W. H. TODD.
Dr. H. G. A. HICKLING.

Editorial.

The PRESIDENT.
Mr. R. F. GWYTHER.
Dr. H. G. A. HICKLING.
Mr. FRANCIS NICHOLSON.
Mr. R. L. TAYLOR.
The ASSISTANT SECRETARY.

Wilde Endowment.

The PRESIDENT.
Mr. FRANCIS JONES.
Dr. H. G. A. HICKLING.
Mr. W. H. TODD.
Mr. R. L. TAYLOR.

Special Library Committee.

The PRESIDENT.
Mr. C. L. BARNES.
Prof. W. W. HALDANE GEE.
Mr. R. L. TAYLOR.
Mr. FRANCIS NICHOLSON.
Mr. R. F. GWYTHER.
Mr. FRANCIS JONES.
Dr. H. G. A. HICKLING.
The ASSISTANT SECRETARY.

Publications Committee.

The PRESIDENT.
Dr. W. M. TATTERSALL.
Mr. C. L. BARNES.
Dr. H. G. A. HICKLING.

Sir William Ramsay, K.C.B.—By the death of Sir William Ramsay, which occurred on July 22nd, 1916, the Society has lost one of its most distinguished honorary members. He was born in Glasgow on October 2nd, 1852, the son of William Ramsay, C.E., and nephew of Sir Andrew Crombie Ramsay, F.R.S., the well-known geologist. He was educated, up to his eighteenth year, in Glasgow, first at the Academy, and then at the University, proceeding afterwards to Germany, where he studied under Bunsen at Heidelberg, and under Professor Fittig at Tübingen. Returning to Glasgow in 1872, he became Tutorial Assistant in the University. In 1880 he was appointed Professor of Chemistry in University College, Bristol, where a year afterwards he became Principal of the College. In 1887 he succeeded the veteran chemist, Williamson, in the Chair of Chemistry at University College, London.

Ramsay has been described by Tilden as a "born physical chemist," nearly the whole of his published work belonging to the physical side of chemistry He first came prominently before the chemical world when he joined Lord Rayleigh in the endeavour to discover the explanation of the remarkable fact, first noticed by Rayleigh, that nitrogen obtained from air was sensibly heavier than the same element isolated from various chemical compounds containing it. The result was the discovery of a new constituent of the atmosphere, the element argon, with its strange properties. Almost immediately after the discovery of the new element had been announced, Ramsay discovered terrestrial helium, the hitherto hypothetical solar element, distinguished by the characteristic line D_3 in the solar spectrum, in the gases from the mineral clèveite. Subsequently Ramsay isolated three other elements, companions of argon, from the atmosphere, namely, neon, krypton, and xenon, all belonging, like argon, to the zero group in the periodic scheme. As Tilden has remarked, "to have added an entire group of new elements to the periodic scheme is an achievement both unexpected and unparalleled."

Shortly after the discovery of radium by Madame Curie in 1902, Ramsay and Soddy added a fact of fundamental importance when they identified the gaseous product of the disintegration of radium as helium. Later, Ramsay placed the radium emanation, which he called *niton*, in the list of inactive gases, and, in conjunction with Dr. Whyttlaw Gray, actually determined its density, and hence its molecular and atomic weight, working with a volume of the gas which only measured one-fifteenth of a cubic millimetre!

Ramsay was a most distinguished and successful investigator and a wonderful manipulator. He had a remarkable command of foreign languages. He gave lectures to large audiences in German in Berlin, and in French in Paris, and at the opening meeting of the International Congress of Applied Chemistry in London in 1909 the readiness with which he addressed the audience in the four official languages successively, English, French, German, and Italian, attracted great interest and admiration.

Naturally, Ramsay was the recipient of many honours and distinctions. He was elected a member of most of the scientific societies in the world, and many universities conferred honorary degrees on him. He received the Davy Medal from the Royal Society in 1895, the Longstaffe Medal from the Chemical Society in 1897, and in 1904 he was awarded the Nobel Prize for Chemistry. He was elected President of the Society of Chemical Industry in 1903, and of the Chemical Society in 1907. On March 28th, 1899, Ramsay gave the Wilde Lecture for that year before our Society, on "The newly-discovered Elements and their relation to the Kinetic Theory of Gases." This was not long after the announcement of the discovery of the new elements, and many of the present members of the Society will remember the great interest which was taken in that lecture. The lecturer was elected an Honorary Member of the Society in April of the same year.

R. L. T.

Dr. Elie Metschnikoff.—Sixteen years ago the members of the Manchester Literary and Philosophical Society had the privilege of hearing the Wilde lecture delivered by Dr. Metschnikoff entitled, "Sur la Flore du Corps Humain."

In this lecture the distinguished Russian biologist gave us a most interesting summary of our knowledge of the microbes that are found under normal conditions in the human skin and alimentary canal. He expounded in a masterly manner the reasons for believing that many of these organisms are definitely the cause of disease and are responsible for the infirmities of old age that ultimately end in death.

This lecture gives us a clear insight into the thesis that occupied the mind and absorbed the indefatigable labours of the last period of his distinguished career.

A follower of the great Pasteur, and for many years the most distinguished investigator in the famous Pasteur Institute in Paris, he believed that the method of the study of micro-organisms that are associated with the animal body is the method which will yield the most valuable results not only in the cure and prevention of disease but also in the prolongation of the normal human life. But although a follower of Pasteur and for six years his colleague in the Pasteur Institute he must not be regarded as a pupil of Pasteur, for he came to Paris in 1888 with a reputation already well established by his writings on Phagocytosis and his ideas and lines of research, although ultimately concerned with micro-organisms and their relation to disease, were the result of his own independent investigations.

He was born in 1845 at Ivanaka near Kharkoff, his father being an officer in the Russian Imperial Guard. He took his degree examination in 1864 and after a brief visit to Heligoland went to Leuckart's laboratory in Giessen in order to extend his knowledge of the Biological Sciences. Before going to Germany he had already shown his ability in zoological research work by two short papers on the stalk of Vorticella and on the nematode worm Diplogaster, but in Leuckart's laboratory he made his first great discovery which was published in a paper, that has become famous in the literature of Zoology, on the life history of the Ascaris nigrovenosa, parasitic in the Frog. From this time (1866) onwards he continued to make investigations on a variety of subjects in Zoological Science, and the number of papers he published in rapid succession showed his extraordinary faculty for investigation and untiring industry.

In 1870 he was appointed Professor Ordinarius of Zoology in the University of Odessa, and during the twelve years that he occupied that chair he published several important memoirs on the embryology of Chelifer, of Myriapods and of the Annelid worms.

In 1882 he resigned his chair in Odessa, owing to political disturbances, and migrated to Messina where he devoted his time to researches on the marine fauna of the straits. It was from Messina that he published a remarkable series of papers on the process which he called "Sporogony" in the development of certain jelly-fishes, and the curious kind of parasitism of the larva of one kind of jelly-fish (Cunina) on the swimming-bell of another (Carmarina).

The remarkable wandering habits of the microscopic sporogenetic broods of the Cunina specially attracted his attention and interest as he was at the same period beginning his important investigations on the wandering amoeboid corpuscles found in the blood and tissues of the higher Invertebrates and the phenomena of intra-cellular digestion which they exhibited. As a result of the interest excited in these researches on the marine fauna at Messina he came to devote himself almost entirely to the functions of the wandering cells of the animal organism and more particularly to their powers of ingestion and destruction of the poisonous microbes that so frequently cause disease and death. To him we are indebted for the introduction of the term "Phagocytes" which he applied to these scavenger cells that, as he was the first to demonstrate, play such an important part in the maintenance of health.

In 1888 he went to Paris, and being heartily welcomed by Pasteur who gave him every facility for continuing his investigations on his own lines, he plunged at once into the problems of animal health and disease that arose from his work and theory of phagocytosis, and in 1901, the year that he came over to deliver the Wilde lecture in Manchester, he published his important book entitled, "L'Immunité contre les malades infectieuses." The importance of Metschnikoff's researches on the problems of disease and on inflammation received recognition by the reward of medals and foreign membership of many of the learned Societies of Europe, and in 1908 he received the Nobel Prize for his medical discoveries.

Metschnikoff was twice married. His second wife, Olga Belocoyitoff, who was married to him in 1875, was herself a trained zoologist. She was his constant companion in his travels abroad and many of our members will remember her visit to Manchester in 1901, when she accompanied her husband on the occasion of his Wilde lecture. She was able to assist him in the laboratory, and herself published some contributions to scientific knowledge. During his visits to England she frequently acted as his interpreter as she was an excellent linguist and he was not fluent in the English language.

The end of his long and valuable career came in the residence attached to the Pasteur Institute on July 15th, 1916.

S. J. H.

NOTE.—The Treasurer's Accounts of the Session 1916-1917 have been endorsed as follows:

April 12th, 1917. Audited and found correct.

We have also seen, at this date, the Certificates of the following Stocks held in the name of the Society :—£1,225 Great Western Railway Company 5% Consolidated Preference Stock, Nos. 12,293, 12,294, and 12,323 ; £7,500 Gas Light and Coke Company Ordinary Stock (No. 8/1960) ; £100 East India Railway Company's 4% Annuity Stock (No. 4032) ; and the deeds of the Natural History Fund, of the Wilde Endowment Fund, those conveying the land on which the Society's premises stand, and the Declarations of Trust.

Leases and Conveyances dated as follows :—

22nd Sept., 1797.
23rd Sept., 1797.
25th Dec., 1799.
25th Dec., 1799.
22nd Dec., 1820.
23rd Dec., 1820.

Declarations of Trust :—

24th June, 1801.
23rd Dec., 1820.
8th Jan., 1878.

Appointment of New Trustees :—

30th April, 1851.

We have also seen Bankers' acknowledgment of the investment of £400 in the $4\frac{1}{2}$% War Loan :—1 Bond for £200, No. 1964 ; and 2 Bonds for £100 each, Nos. 6594/5 ; and £150 from the Wilde Endowment Fund in the 5% War Loan.

We have also verified the balances of the various accounts with the bankers' pass books.

(*Signed*) { WILLIAM C. JENKINS.
GEORGE P. VARLEY.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

Dr. *W. Henry Todd, Treasurer, in Account with the Society, from 1st April, 1916, to 31st March, 1917.* **Cr.**

	£ s. d.	£ s. d.
To Balance, 1st April, 1916		104 16 4
To Member's Subscriptions:—		
Half Subscriptions, 1915-16, 4 at £1 1s. 0d.	4 4 0	
,, 1916-17, 10 ,, ,,	10 10 0	
Subscriptions:— 1913-14, 3 at £2 2s. 0d.	6 6 0	
,, 1914-15, 5 ,, ,,	10 10 0	
,, 1915-16, 10 ,, ,,	21 0 0	
,, 1916-17, 86 ,, ,,	180 12 0	
		233 2 0
To Transfers from Wilde Endowment Fund:—		
Rent of Rooms	50 0 0	
Entrance Fees	12 12 0	
Half Subscriptions	19 19 0	
		82 11 0
To Sale of Publications		5 11 4
To Sale of Catalogues		0 2 6
To Dividends:		
Natural History Fund	47 9 4	
Joule Memorial Fund	4 19 9	
Wilde Endowment Fund	13 10 0	
		65 19 1
To National Health Insurance Act deductions		2 6 7
		£494 8 10

	£ s. d.	£ s. d.
By Charges on Property:—		
Chief Rent	10 0 11	
Income Tax and Inhabited House Duty... ...	3 4 6	
Insurance against Fire	11 0 0	
Insurance against Air Raids	8 12 6	
		32 17 11
By House Expenditure:—		
Coals, Gas, Electric Light, Water, etc.	30 18 10	
Tea, Coffee, etc., at Meetings	11 16 11	
Cleaning, etc.	2 18 0	
Replacement of Mantles, Dusters, Crockery, etc.	4 14 11	
Repairs, etc.	12 4 8	
		62 13 4
By Administrative Charges:—		
Housekeeper	57 10 0	
Postages, Carriage of Parcels and "Memoirs"	18 11 10	
Stationery, Cheques, Receipts, Engrossing, etc.	8 9 4	
Printing Circulars, Reports, etc.	9 11 6	
Extra attendance at Meetings	1 7 8	
Insurance against Liability	0 12 0	
National Health Insurance Stamps...	4 4 7	
Miscellaneous Expenses	1 18 11	
		102 5 10
By Case for Dalton's Diagrams		2 15 0
By Publishing:—		
Printing "Memoirs and Proceedings"	96 8 6	
Illustrations for "Memoirs"	9 8 1	
		105 16 7
By Library:—		
Books and Periodicals (except those charged to Natural History Fund)		13 17 5
By Agreements		0 13 6
By Natural History Fund:—		
(Items shown in the Balance Sheet of this Fund)		15 13 0
By Wilde Endowment Fund (Dividend Refunded)		6 15 0
By Balance at Williams Deacon's Bank, 1st April, 1917	141 1 3	
By Balance in Treasurer's hands	10 0 0	
		151 1 3
		£494 8 10

NATURAL HISTORY FUND, 1916-17. (Included in the General Account, above.)

	£	s.	d.		£	s.	d.	£	s.	d.
To Balance, 1st April, 1916	19	5	1	By Natural History Periodicals				11	9	0
To Dividends on £1,225 Great Western Railway Company's Stock...	47	9	4	By Subscriptions:—						
				Lancashire and Cheshire Fauna Committee, 1916-17...	1	1	0			
				Ray Society, 1916-17	2	2	0			
				Entomological Society, 1916	1	1	0			
								4	4	0
				By Balance, 1st April, 1917				51	1	5
	£66	14	5					£66	14	5

JOULE MEMORIAL FUND, 1916-1917. (Included in the General Account, above.)

	£	s.	d.		£	s.	d.
To Balance, 1st April, 1916	76	17	3	By Balance, 1st April, 1917	81	17	0
To Dividends on £100 East India Railway Company's 4% Annuity Stock	4	19	9				
	£81	17	0		£81	17	0

WILDE ENDOWMENT FUND, 1916-1917.

	£	s.	d.		£	s.	d.	£	s.	d.
To Balance, 1st April, 1916	224	12	0	By Assistant Secretary's Salary				150	0	0
To Dividends on £7,500 Gas Light and Coke Company's Ordinary Stock	244	2	6	By Maintenance of Society's Library:— Binding Books				23	13	10
To Interest on £200 War Loan	6	15	0	By £150 War Loan Stock				142	10	0
To Bank Interest...	4	14	7	By Cheque Book				0	2	6
				By Transfer to Society's Funds:—						
				Rent of Rooms	50	0	0			
				Entrance Fees	12	12	0			
				Half Subscriptions...	19	19	0			
								82	11	0
				By Balance at District Bank, April 1st, 1917				81	6	9
	£480	4	1					£480	4	1

THE COUNCIL AND MEMBERS
OF THE
MANCHESTER
LITERARY AND PHILOSOPHICAL SOCIETY.

Corrected to October 20th, 1917.

The Council met 10 times.

President.
SYDNEY J. HICKSON, M.A., D.Sc., F.R.S.

Vice-Presidents.
FRANCIS NICHOLSON, F.Z.S.
G. ELLIOT SMITH, M.A., M.D., F.R.S.
T. A. COWARD, F.Z.S., F.E.S.
W. W. HALDANE GEE, B.Sc., M.Sc.Tech., A.M.I.E.E.

Secretaries.
R. L. TAYLOR, F.C.S., F.I.C.
GEORGE HICKLING, D.Sc., F.G.S.

Treasurer.
W. HENRY TODD.

Librarian.
C. L. BARNES, M.A.

Other Members of the Council.
R. F. GWYTHER, M.A.
W. M. TATTERSALL, D.Sc.
FRANCIS JONES, M.Sc., F.R.S.E., F.C.S.
WILLIAM THOMSON, F.R.S.E., F.C.S., F.I.C.
MARY McNICOL, M.Sc.
D. THODAY, M.A.

Assistant Secretary and Librarian.
R. F. HINSON.

Acting Assistant Secretary and Librarian.
A. McK. CRABTREE.

ORDINARY MEMBERS.

Date of Election

1911, April 4. Adamson, Arthur, M.Sc.Tech., A.R.C.S., Lecturer in Physics in the Municipal School of Technology, Manchester. *The Municipal School of Technology, Sackville Street, Manchester.*

1901, Dec. 10. Adamson, Harold. *Oaklands College, Godley, near Manchester.*

1912, Oct. 15. Adamson, R. Stephen, M.A., B.Sc., Lecturer in Botany in the Victoria University of Manchester. *The University, Manchester.*

1914, Dec. 1. Atack, F.W., M.Sc. Tech. (Manc.), B.Sc. (Lond.), F.I.C., Demonstrator in Chemistry, The Municipal School of Technology, Manchester. 88, *Claude Road, Chorltonville, Manchester.*

1865, Nov. 14. Bailey, Charles, M.Sc., F.L.S., *Haymesgarth, Cleeve Hill, S.O., Gloucestershire.*

1916, Feb. 2. Balls, W. Lawrence, Sc.D., Research Botanist to the Fine Cotton Spinners' Association, St. James's Square, Manchester. *Bramhall, Cheshire.*

1895, Jan. 8. Barnes, Charles L., M.A., 151, *Plymouth Grove, Manchester.*

1903, Oct. 20. Barnes, Jonathan, F.G.S., *South Cliff House*, 301, *Great Clowes Street, Higher Broughton, Manchester.*

1917, Oct. 16. Barwick, Fred Wilkinson, Manager of the Manchester Chamber of Commerce Testing House, Royal Exchange, Manchester. *Parkfield, Woodville Road, Bowdon.*

1910, Oct. 18. Beattie, Robert, D.Sc., M.I.E.E., Professor of Electrotechnics in the Victoria University of Manchester. *The University, Manchester.*

1895, Mar. 5. Behrens, Gustav. *Holly Royde, Withington, Manchester.*

1868, Dec. 15. Bickham, Spencer H., F.L.S. *Underdown, Ledbury.*

1914, Nov. 17. Bohr, Neils, Ph.D. (Copenhagen), Reader in Mathematical Physics, in the Victoria University of Manchester. *The University, Manchester.*

1914, Dec. 1. Bowman, Frank, B A. (Camb.), M.Sc.Tech. (Manc.), Assistant Lecturer in Mathematics, The Municipal School of Technology, Manchester. 21, *Whalley Road, Whalley Range, Manchester.*

1914, Feb 10. Boyd, A. W., M.A., F.E.S. *The Alton, Altrincham, Cheshire.*

1875, Nov. 16. Boyd, John, *Barton House*, 11, *Didsbury Park, Didsbury, Manchester.*

1915, Oct. 19. Bradley, F. E., M.A., M.Com., LL.D., F.R.S.E., Barrister-at-Law, *Stormarn, Wilbraham Road, Chorlton-cum-Hardy, Manchester*, and *Bank of England Chambers, Manchester.*

1886, April 6. Brown, Alfred, M.A., M.D. *Beech Hill, Hale, Cheshire.*

1913, Dec. 2. Brown, T. Graham, M.D., D.Sc., Lecturer in Experimental Physiology in the Victoria University of Manchester, *The University, Manchester.*

1889, Oct. 15. Budenberg, C. F., M.Sc., M.I.Mech.E. *Bowdon Lane, Marple, Cheshire.*

Date of Election

1911, Jan. 10. Burt, Frank Playfair, B.Sc. (Lond.), D.Sc. (Bristol), Senior Lecturer in Chemistry in the Victoria University of Manchester. 15, *Oak Road, Withington, Manchester.*

1906, Feb. 27. Burton, Joseph, A.R.C.S., Dublin. *Tile Works, Clifton Junction, near Manchester.*

1894, Nov. 13. Burton, William, M.A., F.C.S. *Carisbrook, Victoria Park, Manchester.*

1911, Oct. 31. Butterworth, Charles F. *Waterloo, Poynton, Cheshire.*

1904, Oct. 18. Campion, George Goring, L.D.S. 264, *Oxford Street, Manchester.*

1899, Feb. 7. Chapman, D. L., M.A., F.R.S., Fellow and Tutor of Jesus College, Oxford. *Jesus College, Oxford.*

1901, Nov. 26. Chevalier, Reginald C., M.A., Mathematical Master at the Manchester Grammar School. 3, *Fort Road, Sedgley Park, Prestwich, Manchester.*

1907, Nov. 26. Clayton, Robert Henry, B.Sc., Chemist. 1, *Parkfield Road, Didsbury, Manchester.*

1906, Oct. 30. Coward, H. F., D.Sc., Chief Lecturer in Chemistry in the Municipal School of Technology, Manchester. 15, *Great George Street, Westminster, London, S.W.*1.

1906, Nov. 27. Coward, Thomas Alfred, F.Z.S., F.E.S. *Brentwood, Bowdon, Cheshire.*

1908, Nov. 3. Cramp, William, D.Sc., M.I.E.E., Consulting Engineer, 33, *Brazennose Street, Manchester.*

1916, Oct. 31. Craven, Mrs. M., M.Sc., Demonstrator in Chemistry, in the Municipal School of Technology, Manchester. 10, *Birch Grove, Rusholme, Manchester.*

1915, Nov. 16. Cutler, Donald Ward, M.A. (Cantab.), Scholar of Queen's College, Cambridge; Assistant Lecturer and Demonstrator in Zoology, in the Victoria University of Manchester. 69, *Mauldeth Road, Withington, Manchester.*

1895, April 9. Dawkins, W. Boyd, M.A., D.Sc., F.R.S., Honorary Professor of Geology in the Victoria University of Manchester. *Fallowfield House, Fallowfield, Manchester.*

1894, Mar. 6. Delépine, A. Sheridan, M.B., B.Sc., Professor of Pathology in the Victoria University of Manchester. *Public Health Laboratory, York Place, Manchester.*

1887, Feb. 8. Dixon, Harold Baily, M.A., Ph.D., M.Sc., F.R.S., F.C.S. Professor of Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1906, Oct. 30. Edgar, E. C., D.Sc., Senior Lecturer in Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1914, Nov. 3. Edwards, C. A., D.Sc., Professor of Metallurgy and Metallography in the Victoria University of Manchester. 26, *Lyndhurst Road, Withington Manchester.*

1910, Oct. 18. Evans, Evan Jenkin, D.Sc. (Lond.), B.Sc. (Wales), A.R.C.Sc., Assistant Lecturer and Demonstrator in Physics in the University of Manchester. *The University Manchester.*

1914, Feb. 24. Evans, William David, M.A., Richardson Lecturer in Mathematics, The Victoria University of Manchester. 22, *Chatham Grove, Withington, Manchester.*

Date of Election	
1912, Oct. 15.	Fairlie, D. M., M.Sc. 232, *Burton Road, West Didsbury, Manchester.*
1914, Oct. 20.	Field, Allan B., M.A., B.Sc., M.I.E.E., Professor of Mechanical Engineering, The Municipal School of Technology, Manchester. *Kingslea, Strines Road, Marple, Cheshire.*
1912, Feb. 6.	Forder, H. G., B.A. *St. Olave's Grammar School, Tower Bridge, London.*
1908, Jan. 28.	Fox, Thomas William, M.Sc.Tech., Professor of Textiles in the School of Technology, Manchester University, *Gledfield,* 15, *Clarendon Crescent, Eccles.*
1912, Oct. 15.	Garnett, J. C. Maxwell, M.A., Principal of the Municipal School of Technology, Manchester. *The Municipal School of Technology, Sackville Street, Manchester,* and *Westfield, Victoria Park, Manchester.*
1909, Mar. 23.	Gee, W. W. Haldane, B.Sc., M.Sc.Tech., A.M.I.E.E., Professor of Pure and Applied Physics in the School of Technology, Manchester. *Oak Lea, Whalley Avenue, Sale.*
1907, Oct. 15.	Gravely, F. H., M.Sc. *Natural History Dept., Indian Museum, Calcutta.*
1907, Oct. 29.	Gwyther, Reginald Felix, M.A., Secretary of the Joint Matriculation Board of the Universities of Manchester, Liverpool, Leeds, Sheffield and Birmingham. 24, *Dover Street, Manchester,* and *Ivy Cottage, Lymm, Cheshire.*
1915, Nov. 2.	Hamlyn, G. A., B.A. (Oxon.), Assistant Lecturer and Demonstrator in the Fermentation Industries, The Municipal School of Technology, Manchester. *The Municipal School of Technology, Sackville Street, Manchester.*
1913, Dec. 16.	Handley, Marion, M.A. (Birm.), Lecturer in the Municipal Day Training College, Manchester. *Himmel, Burnage Garden Village, Manchester.*
1911, Oct. 3.	Hassé, H. R., M.A., D.Sc., Lecturer in Mathematics in the University of Manchester. 22, *Chatham Grove, Withington, Manchester.*
1914, Mar. 10.	Hibbert, Eva, Assoc.M.S.T., Demonstrator in Chemistry, The Municipal School of Technology, Manchester. *The Municipal School of Technology, Manchester.*
1907, Oct. 15.	Hickling, H. George A., D.Sc., F.G.S., Lecturer in Palæontology in the Victoria University of Manchester. *Dalegarth, Romiley, near Stockport.*
1895, Mar. 5.	Hickson, Sydney J., M.A., D.Sc., F.R.S., Professor of Zoology in the Victoria University of Manchester. *The University, Manchester.*
1905, Nov. 14.	Holt, Alfred, M.A., D.Sc. Research Fellow of the University of Manchester. *Dowsefield, Allerton, Liverpool.*
1896, Nov. 3.	Hopkinson, Edward, M.A., D.Sc., M.Inst.C.E. *Ferns, Alderley Edge, Cheshire.*
1909, Feb. 9.	Howles, Frederick, M.Sc., Analytical and Research Chemist. *Glenluce, Waterpark Road, Broughton Park, Manchester.*
1889, Oct. 15.	Hoyle, William Evans, M.A., D.Sc., F.R.S.E., Director of the Welsh National Museum, Cardiff. *City Hall, Cardiff.*
1907, Oct. 15.	Hübner, Julius, M.Sc.Tech., F.I.C., Lecturer in the Faculty of Technology, in the University of Manchester, *Linden, Cheadle Hulme, Cheshire.*

Date of Election	
1913, Oct. 21.	Imms, A. D., M.A., D.Sc., F.L.S., Reader in Agricultural Entomology in the Victoria University of Manchester. *Department of Agricultural Entomology, The University, Manchester.*
1914, Jan. 13.	Jenkins, William Charles, F.R.A.S., Curator of the Godlee Observatory, The Municipal School of Technology, Manchester. *The Municipal School of Technology, Manchester.*
1911, Oct. 3.	Johnstone, Mary A., B.Sc. (Lond.), Headmistress of the Municipal Secondary School for Girls, Whitworth Street, Manchester. 43, *Hill Top Avenue, Cheadle Hulme, Cheshire.*
1878, Nov. 26.	Jones, Francis, M.Sc., F.R.S.E., F.C.S. *Manchester Grammar School*, and 17, *Whalley Road, Whalley Range, Manchester.*
1915, Mar. 9.	Kearns, Henry Ward, B.Sc., J.P. *Boothroyd, Brooklands, near Manchester.*
1917, Oct. 16.	King, Alfred J., *Elleray, Windermere*, and *Clarendon Club, Manchester.*
1903, Feb. 3.	Knecht, Edmund, Ph.D., Professor of Chemistry in the School of Technology, Manchester University. *Beech Mount, Marple, Cheshire.*
1893, Nov. 14.	Lamb, Horace, M.A., LL.D., D.Sc., Sc.D., F.R.S., Professor of Mathematics in the Victoria University of Manchester. 6, *Wilbraham Road, Fallowfield, Manchester.*
1909, Nov. 2.	Lang, William H., M.B., C.M., D.Sc., F.R.S., F.L.S., Barker Professor of Cryptogamic Botany in the University of Manchester. 2, *Heaton Road, Withington, Manchester.*
1902, Jan. 7.	Lange, Ernest F., M.I.Mech.E., A.M.Inst C.E., M.I. & S. Inst., F.C.S. *Westholme, The Firs, Bowdon, Cheshire.*
1911, Jan. 10.	Lankshear, Frederick Russell, B.A. (New Zeal.), M.Sc. (Manc.), Demonstrator in Chemistry in the Victoria University, of Manchester. *The University, Manchester.*
1910, Oct. 18.	Lapworth, Arthur, D.Sc., F.R.S., F.I.C., Professor of Organic Chemistry in the Victoria University of Manchester. 26, *Broadway, Withington, Manchester.*
1917, Oct. 16.	Lee, Kenneth, *of Messrs. Tootal Broadhurst, Lee & Co. Ltd., Oxford Road, Manchester*, and *The Old House, Ashley Heath, Hale, Cheshire.*
1914, April 7.	Lees, S., M.A., Assoc.M.S.T., Reader in Applied Thermodynamics in the Faculty of Technology, The University of Manchester. *The Municipal School of Technology, Manchester*, and *Brierfield, Ashley Road, Hale, Cheshire.*
1907, Oct. 29.	Leigh, Harold Shawcross. *Brentwood, Worsley.*
1912, Nov. 12.	Lindsey, Marjorie, M.Sc., Research Student in the Victoria University of Manchester. 3, *Demesne Road, Whalley Range, Manchester.*
1912, May 7.	Loewenfeld, Kurt, Ph.D. *Fern Bank, Ogden Road, Bramhall, Cheshire.*
1910, Oct. 18.	McDougall, Robert, B.Sc. *City Flour Mills, German Street, Manchester.*
1905, Oct. 31.	McNicol, Mary, M.Sc., 182, *Upper Chorlton Road, Manchester.*
1904, Nov. 1.	Makower, Walter, M.A., D.Sc. (Lond.), Lecturer in Physics in the University of Manchester. 37, *Maresfield Gardens, London, N.W. 3.*

Date of Election

1902, Mar. 4. Mandleberg, Goodman, Charles. *Redclyffe, Victoria Park, Manchester.*

1911, Oct. 31. March, Margaret Colley, M.Sc. *The University, Edinburgh.*

1901, Dec. 10. Massey, Herbert. *Ivy Lea, Burnage, Didsbury, Manchester.*

1864, Nov. 1. Mather, Sir William, P.C., M.Inst., C.E., M.I.Mech.E. *Iron Works, Salford.*

1912, Nov. 26. Melland, Edward. *Kia Ora, Hale, Cheshire.*

1873, Mar. 18. Melvill, James Cosmo, M.A., D.Sc., F.L.S. *Meole Brace Hall, Shrewsbury.*

1915, Nov. 30. Miers, Sir Henry Alexander, M.A., D.Sc., F.R.S., Vice-Chancellor of the Victoria University of Manchester. *Birch Heys, Cromwell Range, Fallowfield, Manchester.*

1894, Feb. 6. Mond, Robert Ludwig, M.A., F.R.S.E., F.C.S. *Winnington Hall, Northwich, Cheshire.*

1915, Oct. 19. Munro, John Clegg. *Clough House, Whaley Bridge.*

1912, Nov. 26. Myers, J. E., M.Sc., Beyer Fellow and Assistant Lecturer in Chemistry in the Victoria University of Manchester. 7, *Station Road, Cheadle Hulme, Cheshire.*

1908, Jan. 28. Myers, William, Lecturer in Textiles, in the School of Technology, Manchester University. 7, *Station Road, Cheadle Hulme, Cheshire.*

1873, Mar. 4. Nicholson, Francis, F.Z.S. *Ravenscroft, Windermere, Westmorland.*

1884, April 15. Okell, Samuel, F.R.A.S. *Overley, Langham Road, Bowdon, Cheshire.*

1915, Oct. 19. Pemberton, William Granville, Technical Chemist, 49, *Acresfield Road, Pendleton.*

1901, Oct. 29. Petavel, J. E., B.A., D.Sc. F.R.S., Professor of Engineering in the Victoria University of Manchester. *The University, Manchester.*

1903, Dec. 15. Prentice, Bertram, Ph.D., D.S., Principal, Royal Technical Institute, Salford. *Isca Mount, Manchester Road, Swinton.*

1901, Dec. 10. Ramsden, Herbert, M.D. (Lond.), M.B., Ch.B. (Vict.). *Sunnyside, Dobcross, near Oldham, Lancashire.*

1913, Jan. 7. Renold, Hans, M.I.Mech.E. *Priestnall Hey, Heaton Mersey, near Manchester.*

1910, Oct. 4. Rhead, E. L., M.Sc.Tech., F.I.C., Lecturer in Metallurgy and Assaying, The Municipal School of Technology, Manchester. *Stonycroft, Polygon Avenue, Levenshulme, Manchester.*

1914, Nov. 3. Richardson, Harry, M.Sc., Demonstrator in Physics, The Municipal School of Technology, Manchester. 98, *Dudley Road, Whalley Range, Manchester.*

1912, Oct. 29. Roberts, A. W. Rymer, M.A. *The Common, Windermere.*

1880, Mar. 23. Roberts, D. Lloyd, M.D., F.R.S.E., F.R.C.P. (Lond.). *Ravenswood, Broughton Park, Manchester.*

1911, Jan. 10. Robinson, Robert, D.Sc. (Vict.), Professor in the University of Liverpool. *The University, Liverpool.*

1916, Oct. 31. Robinson, Wilfrid, M.Sc. (Manc.), B.Sc. (Lond.), Lecturer in Economic Botany in the Victoria University of Manchester. 23, *North Avenue, Garden Village, Levenshulme, Manchester.*

1897, Oct. 19. Rothwell, Alderman William Thomas, J.P., *Heath Brewery, Newton Heath, near Manchester.*

Date of Election

1916, Nov. 28. Rowe, Frederick Maurice, M.Sc., Research Chemist in Dyestuffs, The Municipal School of Technology, Manchester. 5, *Woodbine Terrace, Latchford.*

1907, Oct. 15. Rutherford, Sir Ernest, M.A., D.Sc., F.R.S. Langworthy Professor of Physics in the University of Manchester. 17, *Wilmslow Road, Withington, Manchester.*

1909, Jan. 26. Schmitz, Hermann Emil, M.A., B.Sc., Physics Master at the Manchester Grammar School. 15, *Brighton Grove, Rusholme, Manchester.*

1873, Nov. 18. Schuster, Arthur, Sc.D., Ph.D., Sec.R.S., F.R.A.S., Honorary Professor of Physics in the Victoria University of Manchester. *Yeldhall, Twyford, Berks.*

1898, Jan. 25. Schwabe, Louis. *Hart Hill, Eccles Old Road, Pendleton, Manchester.*

1890, Nov. 4. Sidebotham, Edward John, M.A., M.B., M.R.C.S., *Erlesdene, Bowdon, Cheshire.*

1915, Nov. 28. Simon, Councillor Ernest Darwin. *Moorlands, Fog Lane, Didsbury, Manchester.*

1910, Oct. 4. Smith, Grafton Elliot, M.A., M.D., F.R.S., Professor of Anatomy in the University of Manchester. *The University, Manchester.*

1906, Nov. 27. Smith, Norman, D.Sc. Assistant Lecturer in Chemistry in the Victoria University of Manchester. *The University, Manchester.*

1917, April 3. Soper, Herbert Edward M.A., Electrical Engineer. 81, *Moston Lane, Failsworth.*

1896, Feb 18. Spence, David. *Lowood, Hindhead, Haslemere, R.S.O., Surrey.*

1901, Dec. 10. Spence, Howard. *C/o Messrs. Peter Spence & Sons, Ltd., Manchester Alum Works, Manchester.*

1911, Oct. 17. Start, Laura, Lecturer in Art and Handicraft in the University of Manchester. *Moor View, Mayfield Road, Kersal, Manchester.*

1897, Nov. 30. Stromeyer, C.E., M.Inst.C.E., M.Inst.M.E., M.I.&S.Inst. *Steam Users' Association*, 9, *Mount Street, Albert Square, Manchester*, and *Lancefield, West Didsbury.*

1910, Oct. 18. Tattersall, Walter Medley, D.Sc., Keeper of the Manchester Museum. *The Manchester Museum, The University, Manchester.*

1895, April 9. Tatton, Reginald A., M.Inst.C.E., Engineer to the Mersey and Irwell Joint Committee.

1893, Nov. 14. Taylor, R. L., F.C.S., F.I.C. *Central High School for Boys, Manchester*, and 37, *Mayfield Road, Whalley Range, Manchester.*

1911, Oct. 17. Thoday, D., M.A., Lecturer in Plant Physiology in the University of Manchester. *The University, Manchester.*

1911, Jan. 10. Thomson, J. Stuart. M.Sc. (Manc.), Ph.D.(Bern), F.R.S.E., F.L.S., Senior Demonstrator in Zoology in the Victoria University of Manchester. *The University, Manchester.*

1773, April 15. Thomson, William, F.R.S.E., F.I.C., F.C.S. *Royal Institution, Manchester.*

1896, Jan. 21. Thorburn, William, M.D., B.Sc. 2, *St. Peter's Square, Manchester.*

1899, Oct. 17. Todd, William Henry. *Greenfield, Parsonage Road, Flixton, near Manchester.*

Date of Election.	
1909, Jan. 26.	Varley, George Percy, M.Sc. (Vic.), Central High School for Boys, Manchester. 19, *Mayfield Road, Whalley Range, Manchester.*
1912, Oct. 15.	Walker, Miles, M.A., M.I.E.E., Professor of Electrical Engineering, the Municipal School of Technology, Manchester.
1873, Nov. 18.	Waters, Arthur William, F.L.S., F.G.S. *Alderley, McKinley Road, Bournemouth.*
1906, Nov. 13.	Watson, D.M.S., M.Sc., *Dye House, School of Technology, Manchester.*
1892, Nov. 15.	Weiss, F. Ernest, D.Sc., F.L.S., F.R.S., Professor of Botany in the Victoria University of Manchester. *Easedale, Disley, Cheshire.*
1909, Feb. 9.	Weizmann, Charles, Ph.D., D.Sc., Reader in Bio Chemistry in the Victoria University of Manchester. *The University, Manchester.*
1908, May 12.	Welldon, Rt. Rev. J. E. C., D.D., Dean of Manchester. *The Deanery, Manchester.*
1911, Oct. 17.	West, Tom, B.Sc., Chemist and Metallurgist. 101, *Spring Bank Street, Stalybridge, near Manchester.*
1917, Oct. 16.	Wigglesworth, Grace, M.Sc., Botanical Department of the Manchester Museum. *The University, Manchester.*
1901, Oct. 1.	Wild, Robert B., M.D., M.Sc., F.R.C.P., Professor of Materia Medica and Therapeutics in the Victoria University of Manchester. 96, *Mosley Street, Manchester.*
1859, Jan. 25.	Wilde, Henry, D.Sc., D.C.L., F.R.S. *The Hurst, Alderley Edge, Cheshire.*
1909, Jan. 26.	Wolfenden, John Henry, B.Sc. (Lond.), A.R.S.C. (Lond.), Assistant Master in the Central High School for Boys, Whitworth Street, Manchester. 5, *Ashton Road East, Failsworth.*
1905, Oct. 31.	Woodall, Herbert J., A.R.C.S. 32, *Market Place, Stockport.*
1860, April 17.	Woolley, George Stephen. *Victoria Bridge, Manchester.*
1895, Jan. 8.	Worthington, Wm. Barton, B.Sc., M.Inst.C.E. *Kirkstyles, Duffield, near Derby.*

N.B.—Of the above list the following have compounded for their subscriptions, and are therefore life members.

Bailey, Charles, M.Sc., F.L.S.

Worthington, Wm. Barton, B.Sc., M.Inst.C.E.

HONORARY MEMBERS.

Date of Election	
1892, April 26.	Abney, Sir William de W., K.C.B., D.C.L., D.Sc., F.R.S. *Rathmore Lodge, Bolton Gardens South, South Kensington, London, S.W.*
1894, April 17.	Appell, Paul, Membre de l'Institut, Professor of Theoretical Mechanics. *Faculté des Sciences, Paris.*
1892, April 26.	Baeyer, Adolf von, For. Mem. R.S., Professor of Chemistry in the University of Munich. 1, *Arcisstrasse, Munich.*
1886, Feb. 9.	Baker, John Gilbert, F.R.S., F.L.S. 3, *Cumberland Road, Kew.*
1889, April 30.	Carruthers, William, F.R.S., F.L.S. 44, *Central Hill, Norwood, London, S.E.*
1903, April 28.	Clarke, Frank Wigglesworth, D.Sc. *United States Geological Survey, Washington, D.C., U.S.A.*
1866, Oct. 30.	Clifton, Robert Bellamy, M.A., F.R.S., F.R.A.S., Professor of Experimental Philosophy in the University of Oxford. 3, *Bardwell Road, Banbury Road, Oxford.*
1892, April 26.	Curtius, Theodor, Professor of Chemistry in the University of Kiel. *Universität, Kiel.*
1892, April 26.	Darboux, J. Gaston, Membre de l'Institut, Secrétaire perpétuel de l'Académie des Sciences, Doyen honoraire de la Faculté des Sciences. 3, *Rue Mazarine, Paris.*
1900, April 24.	Dewar, Sir James, M.A., LL.D., D.Sc., F.R.S., V.P.C.S., Fullerian Professor of Chemistry at the Royal Institution. *Royal Institution, Albemarle Street, London, W.*
1892, April 26.	Edison, Thomas Alva. *Orange, N.J., U.S.A.*
1895, April 30.	Elster, Julius, Ph.D. 6, *Lessingstrasse, Wolfenbüttel.*
1900, April 24.	Ewing, Sir J. Alfred, K.C.B., M.A., LL.D., F.R.S., Director of Naval Education to the Admiralty. 16, *Moray Place, Edinburgh.*
1889, April 30.	Farlow, W. G., Professor of Botany at Harvard College. *Harvard College, Cambridge, Mass, U.S.A.*
1900, April 24.	Forsyth, Andrew Russell, M.A., Sc.D., LL.D., F.R.S., Professor of Mathematics at the Imperial College of Science and Technology. *The Imperial College of Science and Technology, S. Kensington, London.*
1892, April 26.	Fürbringer, Max, Professor of Anatomy in the University of Heidelberg. *Universität, Heidelberg.*
1895, April 30.	Geitel, Hans. 6, *Lessingstrasse, Wolfenbüttel.*
1894, April 17.	Glaisher, J. W. L., Sc.D., F.R.S. *Trinity College, Cambridge.*
1894, April 17.	Gouy, A., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Physics in the University of Lyons. *Faculté des Sciences, Lyons.*

Date of Election	
1900, April 24.	Haeckel, Ernst, Ph.D., Professor of Zoology in the University of Jena. *Zoologisches Institut, Jena.*
1894, April 17.	Harcourt, A. G. Vernon, M.A., D.C.L., F.R.S., V.P.C.S. *St. Clare, Ryde, Isle of Wight.*
1894, April 17.	Heaviside, Oliver, Ph.D., F.R.S. *Homefield, Lower Warberry, Torquay.*
1892, April 26.	Hill, G. W. *West Nyack, N.Y., U.S.A.*
1888, April 17.	Hittorf, Johann Wilhelm, Professor of Physics at Münster, *Polytechnicum, Münster.*
1892, April 26.	Klein, Felix, Ph.D., For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Mathematics in the University of Göttingen. 3, *Wilhelm Weber Strasse, Göttingen.*
1894, April 17.	Königsberger, Leo, Professor of Mathematics in the University of Heidelberg. *Universität, Heidelberg.*
1902, May 13.	Larmor, Sir Joseph, M.A., D.Sc., LL.D., F.R.S., F.R.A.S. *St. John's College, Cambridge.*
1892, April 26.	Liebermann, C., Professor of Chemistry in the University of Berlin. 29, *Matthäi-Kirch Strasse, Berlin.*
1887, April 19.	Lockyer, Sir J. Norman, K.C.B., LL.D., Sc.D., F.R.S., Corr. Memb. Inst. Fr. (Acad. Sci.). *Hill Observatory, Salcombe Regis, Sidmouth, Devon.*
1902, May 13.	Lodge, Sir Oliver Joseph, D.Sc., LL.D., F.R.S., Principal of the University of Birmingham *The University, Birmingham.*
1900, April 24.	Lorentz, Henrik, Anton, For. Mem. R.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Professor of Physics in the University of Haarlem. *Zijlweg*, 76, *Haarlem.*
1862, April 26.	Marshall, Alfred, M.A., formerly Professor of Political Economy in the University of Cambridge. *Balliol Croft, Madingley Road, Cambridge.*
1895, April 30.	Mittag-Leffler, Gösta, D.C.L. (Oxon.), For. Mem. R.S., Professor of Mathematics in the University of Stockholm, *Djursholm, Stockholm.*
1910, April 5.	Nernst, Geh. Prof. Dr. Walter, Director of the Physikal-Chemisches Institut in the University of Berlin. *Am Karlsbad* 26a, *Berlin. W.* 35.
1902, May 13.	Osborn, Henry Fairfield, Professor of Vertebrate Palæontology at Columbia College. *American Museum of Natural History, W.* 77 *Street, New York, U.S.A.*
1902, May 13.	Ostwald, W., Professor of Chemistry. *Groszbothen, Kgr. Sachsen.*
1899, April 25.	Palgrave, Sir Robert H. Inglis, F.R.S., F.S.S. *Henstead Hall, Wrentham, Suffolk.*
1894, April 17.	Pfeffer, Wilhelm, For. Mem. R.S., Professor of Botany in the University of Leipsic. *Botanisches Institut, Leipsic.*
1892, April 26.	Quincke, G. H., For. Mem. R.S., Professor of Physics in the University of Heidelberg. *Universität, Heidelberg.*

Date of Election	
1886, Feb. 9.	Rayleigh, Right Hon. John William Strutt, Lord, O.M., M.A., D.C.L. (Oxon.), Sc.D. (Cantab.), LL.D. (Univ. McGill), F.R.S., F.R.A.S., Corr. Memb. Inst. Fr. (Acad. Sci.), Chancellor of the University of Cambridge. *Terling Place, Witham, Essex.*
1900, April 24.	Ridgway, Robert, Curator of the Department of Birds, U.S. National Museum. *Brookland, District of Columbia, U.S.A.*
1902, May 13	Scott, Dukinfield, Henry, M.A., LL.D., Ph.D., F.R.S., F.L.S. *East Oakley House, Oakley, Hants.*
1892, April 26.	Thistleton-Dyer, Sir William T., K.C.M.G., C.I.E., M.A., Sc.D., Ph.D., LL.D., F.R.S. Lately Director Royal Botanic Gardens, Kew. *The Ferns, Witcombe, Gloucester.*
1895, April 30.	Thomson, Sir Joseph John, O.M., M.A., Sc.D., F.R.S., Cavendish Professor of Experimental Physics in the University of Cambridge. *Trinity College, Cambridge.*
1894, April 17.	Thorpe, Sir T. Edward, C.B., Ph.D., D.Sc., LL.D., F.R.S., V.P.C.S. *Whinfield, Salcombe, S. Devon.*
1894, April 17.	Vines, Sidney Howard, M.A., D.Sc., F.R.S., F.L.S., Sherardian Professor of Botany in the University of Oxford. *Headington Hill, Oxford.*
1894, April 17.	Warburg, Emil, Professor of Physics at the Physical Institute, Berlin *Physikalisches Institut, Neue Wilhelmstrasse, Berlin.*

CHANGES OF ADDRESS.

Members are particularly requested to inform the Secretaries of any errors in their addresses or descriptions.

AWARDS OF THE DALTON MEDAL.

1898. EDWARD SCHUNCK, Ph.D., F.R.S.

1900. Sir HENRY E. ROSCOE, F.R.S.

1903. Prof. OSBORNE REYNOLDS, LLD., F.R.S.

THE WILDE LECTURES.

1897. (July 2) "On the Nature of the Röntgen Rays." By Sir G. G. STOKES, Bart, F.R.S. *(28 pp.)*

1898. (Mar. 29.) "On the Physical Basis of Psychical Events." By Sir MICHAEL FOSTER, K.C.B., F.R.S., *(46 pp.)*

1899. (Mar. 28.) "The newly discovered Elements; and their relation to the Kinetic Theory of Gases." By Professor WILLIAM RAMSAY, F.R.S. *(19 pp.)*

1900. (Feb. 13.) "The Mechanical Principles of Flight." By the Rt. Hon. LORD RAYLEIGH, F.R.S. *(20 pp.)*

1901. (April 22.) "Sur la Flore du Corps Humain." By Dr. ELIE METSCHNIKOFF, For.Mem.R.S. *(38 pp.)*

1902. (Feb. 25.) "On the Evolution of the Mental Faculties in relation to some Fundamental Principles of Motion." By Dr. HENRY WILDE, F.R.S. *(34 pp., 3 pls.)*

1903. (May 19.) "The Atomic Theory." By Professor F. W. CLARKE, D.Sc. *(32 pp.)*

1904. (Feb. 23.) "The Evolution of Matter as revealed by the Radio-active Elements." By FREDERICK SODDY, M.A. *(42 pp.)*

1905. (Feb. 28.) "The Early History of Seed-bearing Plants, as recorded in the Carboniferous Flora." By Dr. D. H. SCOTT, F.R.S. *(32 pp., 3 pls)*

1906. (March 20.) "Total Solar Eclipses." By Professor H. H. TURNER, D.Sc., F.R.S. *(32 pp.)*

1907. (February 18.) "The Structure of Metals." By Dr. J. A. EWING, F.R.S., M.Inst.C.E. *(20 pp., 5 pls., 5 text-figs.)*

1908. (March 3.) "On the Physical Aspect of the Atomic Theory." By Professor J. LARMOR, Sec. R.S. *(54 pp.)*

1909. (March 9.) "On the Influence of Moisture on Chemical Change in Gases." By Dr. H. BRERETON BAKER, F.R.S. *(8 pp.)*

1910. (March 22.) "Recent Contributions to Theories regarding the Internal Structure of the Earth." By Sir THOMAS H. HOLLAND, K.C.I.E., D.Sc., F.R.S.

SPECIAL LECTURES.

1913. (March 4.) "The Plant and the Soil." By A. D. HALL, M.A., F.R.S.

1914. (March 18.) "Crystalline Structure as revealed by *X*-rays." By Professor W. H. BRAGG, M.A., F.R.S.

1915. (May 4.) "The Place of Science in History." By Professor JULIUS MACLEOD, D.Sc.

LIST OF PRESIDENTS OF THE SOCIETY.

Date of Election	
1781.	PETER MAINWARING, M.D., JAMES MASSEY.
1782-1786.	JAMES MASSEY, THOMAS PERCIVAL, M.D., F.R.S.
1787-1789.	JAMES MASSEY.
1789-1804.	THOMAS PERCIVAL, M.D., F.R.S.
1805-1806.	Rev. GEORGE WALKER, F.R.S.
1807-1809.	THOMAS HENRY, F.R.S.
1809.	*JOHN HULL, M.D., F.L.S.
1809-1816.	THOMAS HENRY, F.R.S.
1816-1844.	JOHN DALTON, D.C.L., F.R.S.
1844-1847.	EDWARD HOLME, M.D., F.L.S.
1848-1850.	EATON HODGKINSON, F.R.S., F.G.S.
1851-1854.	JOHN MOORE, F.L.S.
1855-1859.	Sir WILLIAM FAIRBAIRN, Bart., LL.D., F.R.S.
1860-1861.	JAMES PRESCOTT JOULE, D.C.L., F.R.S.
1862-1863.	EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
1864-1865.	ROBERT ANGUS SMITH, Ph.D., F.R.S.
1866-1867.	EDWARD SCHUNCK, Ph.D., F.R.S.
1868-1869.	JAMES PRESCOTT JOULE, D.C.L., F.R.S.
1870-1871.	EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
1872-1873.	JAMES PRESCOTT JOULE, D.C.L., F.R.S.
1874-1875.	EDWARD SCHUNCK, Ph.D., F.R.S.
1876-1877.	EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
1878-1879.	JAMES PRESCOTT JOULE, D.C.L., F.R.S.
1880-1881.	EDWARD WILLIAM BINNEY, F.R.S., F.G.S.
1882-1883.	Sir HENRY ENFIELD ROSCOE, D.C.L., F.R.S.
1884-1885.	WILLIAM CRAWFORD WILLIAMSON, LL.D., F.R.S.
1886.	ROBERT DUKINFIELD DARBISHIRE, B.A., F.G.S.
1887.	BALFOUR STEWART, LL.D., F.R.S.
1888-1889.	OSBORNE REYNOLDS, LL.D., F.R.S.
1890-1891.	EDWARD SCHUNCK, Ph.D., F.R.S.
1892.1893.	ARTHUR SCHUSTER Ph.D., F.R.S.
1894-1896.	HENRY WILDE, D.C.L., F.R.S.
1896.	EDWARD SCHUNCK, Ph.D., F.R.S.
1897-1899.	JAMES COSMO MELVILL, M.A., F.L.S.
1899-1901.	HORACE LAMB, M.A., F.R.S.
1901-1903.	CHARLES BAILEY, M.Sc., F.L.S.
1903-1905.	W. BOYD DAWKINS, M.A., D.Sc., F.R.S.
1905-1907.	Sir WILLIAM H. BAILEY, M.I.Mech.E.
1907-1909.	HAROLD BAILY DIXON, M.A., F.R.S.
1909-1911.	FRANCIS JONES, M.Sc., F.R.S.E.
1911-1913.	F. E. WEISS, D.Sc., F.L.S.
1913-1915.	FRANCIS NICHOLSON, F.Z.S.
1915-1917.	SYDNEY J. HICKSON, M.A., D.Sc., F.R.S.
1917.	WILLIAM THOMSON, F.R.S.E., F.C.S., F.I.C.

* Elected April 28th; resigned office May 5th.

Vol. 61 : Part I.

MEMOIRS AND PROCEEDINGS

OF

THE MANCHESTER LITERARY & PHILOSOPHICAL SOCIETY, 1916-1917.

CONTENTS.

MANCHESTER:
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Price Six Shillings and Sixpence.

July 17th, 1917.

RECENT ADDITIONS TO THE LIBRARY.

Presented.

Barnes, C. L. Parallels in Dante and Milton. Manchester, 1917. (*Recd. 3/iv./17*).

Coward, T. A. Notes on the Vertebrate Fauna of Cheshire and S. Lancashire. Darwen, 1916. (*Recd. 26/x./16*).

Crocker, E. Science as Enemy and Ally. Birmingham, 1915. (*Recd. 7/xi./16*).

Garnett, J. Maxwell. Part Time Secondary Education. Manchester, 1917. (*Recd. 22/iii./17*).

London.—British Museum (Natural History). Catalogue of the Cretaceous Flora. By M. C. Stopes. Part II. London, 1915. (*Recd. 22/xii./16*).

——.— ———— Guide to Insects.........Brit. Mus. (Special Guide, No. 7). By W. G. Ridewood. London, 1916. (*Recd. 22/xii./16*).

——.— ———— The Louse and its Relation to Disease. (Economic Ser. No. 2). By B. F. Cumming. London, 1915. (*Recd. 22/xii./16*).

——.—**Meteorological Office.** The Weather Map. By N. Shaw. London, 1916. (*Recd. 27/xi./16*).

Washington.—United States Coast and Geodetic Survey. Result of Observations at Sitka, Alaska, 1913 and 1914. (Serial No. 27). By D. L. Hazard. Washington, 1916. (*Recd. 25/ix./16*).

——.— ———— Determination of the Difference in Longitude between two Stations. (Special Publication No. 35). By F. Morse and O. B. French. Washington, 1916. (*Recd. 25/ix./16*).

And a set of the **Works of Linnaeus,** comprising 25 volumes, presented by Dr. William Carruthers, F.R.S., F.L.S., Honorary Member of the Society.

Purchased.

London.—Ray Society. The Principles of Plant Teratology. Vol. II. By W. C. Worsdell. London, 1916. (*Recd. 16/iii./17*).

——.—**Royal Society.** Catalogue of Scientific Papers (1884-1900). Vol. XV. Cambridge, 1916. (*Recd 17/x./16*).

And the usual Exchanges and Periodicals.

VOL. 61 : PARTS II. AND III.

MEMOIRS AND PROCEEDINGS

OF

THE MANCHESTER LITERARY & PHILOSOPHICAL SOCIETY, 1916-1917.

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MANCHESTER:
36, GEORGE STREET.

Price Six Shillings and Sixpence.

RECENT ADDITIONS TO THE LIBRARY.

Presented.

Barraclough, S. H, E.—The War Australia and the Engineer. Sydney, 1915. (*Recd. 25/ix./17.*)

Bolton, H.—Insects from the British Coal Measures. London, 1917. (*Recd. 28/vi./17.*)

Breinl, Anton.—Report of the Institute of Tropical Medicine, 1910. Sydney, 1911. (*Recd. 25/ix./17.*)

Carslaw, H. S.—Teaching of Mathematics in Australia. Sydney, 1914. (*Recd. 25/ix./17.*)

Dean, B.—A Bibliography of Fishes. Vol. 1. (American Museum of Natural History.) New York, 1916. (*Recd. 18/vii./17.*)

Elliot, D. G.—A Check list of Mammals of the North American Continent, West Indies and neighboring seas. (American Museum of Natural History.) (*Recd. 20/vii./17.*)

London.—Library Association and Athenæum. Athenæum Subject Index to Periodicals. Theology and Philosophy, 1916. London, 1917. (*Recd. 28/vi./17.*)

Manchester.—List of Books on Engineering and Allied Subjects in the Christie Library, Manchester. Manchester, 1917. (*Recd. 27/vi./17.*)

Ripley, H. Ernestine.—Bibliography of the Published writings of H. Fairfield Osborn. 1877-1915. New York, 1916. (*Recd. 18/vii./17.*)

Start, L. E.—Burmese Textiles.—Bankfield Museum Notes. (No. 7) Halifax, 1917. (*Recd. 8/v./17.*)

Purchased.

Moscow.—Bulletin. Société Imperiale des Naturalistes de Moscou. 23 vols., 1840-1861. Moscow, 1840-1861. (*Recd. 8/v./17.*)

And the usual Exchanges and Periodicals.