From the above remarks it will be perceived that the plant from near the Lakes of Mount Field offers some approach to E. urnigera; and this is borne out by specimens of evidently the same tree just submitted to me by Mr. T. B. Moore, as obtained by him during recent surveys across the Mount Wellington ranges. It rises there even to the stupendous height of 200 feet, half that size being still reached in the cool elevations of 2,000 feet. Mr. Moore observed the bark to be smooth, of a reddish or chocolate colour, but where fresh shed it being mottled with yellowish streaks or blotches. The leaves are ovate-lanceolar, and attain a length of four inches.

It remains now to be shown, in what precise position systematically E. vernicosa is standing to E. urnigera and to E. Gunnii, after this most highly developed state of the former became discovered; but these comparisons can be carried on much better by local observers in the forests themselves, than by observations on necessarily limited and fragmentary material in a remote study-room. But whatever exact place this tree found by Mr. Moore may phytographically occupy, it will add a most important one to the very few of the genus which bear considerable frost; and as the timber is pronounced by that gentleman as extremely hard, close-grained, tough and heavy, this hardy Eucalypt should be brought speedily and extensively under trial culture in cool climates—when also the characteristics of the seedlings would, for diagnostic purposes, come under observation. In conclusion I may add, that the small-leaved dwarf alpine state of E. vernicosa is now known also from Mount Arrowsmith (Gulliver), Mount Norfolk (Emmett), and Mount Sorell (Milligan)."

NOTES ON THE GEOLOGY OF THE KING RIVER, TOGETHER WITH A BRIEF ACCOUNT OF THE HISTORY OF GOLD-MINING IN AUSTRALASIA.

By Robert M. Johnston. F.L.S.

The Archæan and Silurian rocks of Western Tasmania forma series of folds whose axes traverse the country north and south. The great folds generally are anticlines, and are composed principally of quartzite, metamorphic schists, conglomerates, etc.

Queen River Group.

The axis of one of the great north and south anticlines running northward from the Gordon and immediately west and parallel to the Franklin River, seems to follow in the line of the West Coast Range, including the following rugged peaks, composed mainly of slates, conglomerated and quartzite, viz. :—Elliot Range, Craycroft Range, Mount Darwin, Mount Jukes, Mount Huxley, Mount Owen, Mount Lyell, Mount Sedgwick, Mount Tyndal, Mount Murchison. The line seems to disappear near the waters of the Mackintosh Valley, which trends westward to the Pieman. It is on the eastern and western slopes of the Elliot Range anticline where the lower Gordon River Group crops up to the surface. Between Mount Jukes and Mount Huxley the King River cuts through the same great axis on its westward course to the head of Macquarie Harbour. At a short distance west of the northern extremity of Mount Jukes the King River receives a tributary — the Queen River, — which flows southward from the southern slopes of Mount Sedgwick. The Queen River, like the Franklin, runs parallel to the ranges named which compose the crest of the anticlinal axis.

On the western side of the Queen River a subordinate ridge, sometimes rising into conspicuous prominences, as at Honeysuckle Hill, runs parallel to the Queen River and to the axis referred to. Thus, the Queen River runs in a trough formed along the strike of the Gordon River Group. The subordinate ridge referred to is composed of an interesting series of rocks, principally hydro-mica slates, with casts of encrinites and fenestellæ, and a fine greyish white gritty sandstone, replete with imperfect impressions of brachiopods. The brachiopod sandstones and hydro-mica slates are grouped as " The Queen River hydro-mica schists and slates," and from their position in relation to the main axis, and from the facies of the fossil organisms, I am inclined to believe that they not only succeed the members of the Gordon River Group, but mark the lower limits of the Upper Silurian division, and it is worthy of observation that the recently discovered auriferous "lodes" at Mount Lyell occur traversing rocks which appear to be identical with the hydro-mica schists of the group found a little further to the south.

The first evidence of the fossiliferous rocks in this part of the country was obtained by Mr. T. B. Moore, while engaged in opening up new tracks in this rugged country in the neighbourhood of the King River in the year 1884. Specimens of the " brachiopod sandstone " were also obtained for me by Mr. Atkins, of Hobart, from the same vicinity, but at a point nearer the Macquarie Harbour.

Although the impressions of casts of brachiopods are very numerous, they are invariably imperfect, and rarely exhibit traces of the finer superficial characters. Notwithstanding this, I have observed a series of fragments of forms which seem to me to be closely allied to *Spirifera crispa* (Hesinger), and *S. plicatella* (Linn.), *Orthis flabellum, and O. elegantula.* As similar fossils are obtained in the water-worn nodules of sandstone forming part of the Dial Range and Table Cape conglomerates, it is probable that the conglomerate has been derived from the waste of members belonging to the group of rocks of which the Queen River hydro-mica slates, schists, and sandstones are representatives. It is probable that the "brachiopod sandstone" occurs in the neighbourhood of Table Cape, but its presence as a bed-rock has not yet been discovered.

With respect to the party, 32 in number, organised by Mr. Chas. Gould, in 1862 and 1863, for the purpose of searching for gold and other minerals in the vicinity of the King and Gordon Rivers, it is now of the greatest interest to reproduce an account of the general results of their labours. It is true, Mr. Gould confesses in his report, that the expedition was somewhat disappointing, yet he was able to state that "the appearance of the country was more favourable than that presented by any other part we prospected, and although drift-gold was discovered by the party, as in previous cases, in small quantities in river drifts, we were unable to meet with it in anything like paying quantities."

Steel grey and yellow clay-slates, resembling those of the Mersey district, occur both in the King and Gordon Rivers, while a gradual passage into the metamorphic rock is presented by the granular quartzites and micaceous schists existing on the western side of the harbour, between Wellington Head and the Coast.

Mr. Gould further states that "it is reasonable to anticipate that all of this may be auriferous, although to what extent it is impossible to say. It is probable that some divisions of the formation may prove richer than others, and that hence the most valuable tracts will be found to lie in zones running in accordance with the prevalent strike in the direction from 20deg. to 30deg. W. of N. and E. of S." He was full of hope with regard to the King River district, having readily obtained traces of gold in minute specks in the bed of this river and its tributaries, for he states (p. 6)—"The character of the slates met with in the King River was much more promising than those existing elsewhere in the district, and I at one time entertained hopes that the favourable appearance might have been confirmed by results. This, however, was not the case, for, although what gold we obtained was slightly coarser than in other localities, the quantity was inconsiderable."

Seeing that the Linda and the Eldon tributaries of the

King River drain the southern, northern, and eastern slopes of Mount Lyell, while the Queen River branch drains the western slopes, we have now little difficulty in coming to a conclusion regarding the occurrence of fine specks of gold in the bed of the main stream further south. No doubt the fineness of the gold would favour its wide dissemination along the course of the main stream, especially when it was mechanically held bound by a lighter mineral. Other localities where gold was traced by Gould's party are stated to be in the vicinity of Frenchman's Cap, base of Mount Arrowsmith, Macquarie Harbour, Lake Dixon, Point Hibbs, junction of the Franklin with the Gordon, &c.

Mr. Gould strongly urged that this country should be more thoroughly investigated, and the results at Mount Lyell 24 years later seem to justify his hopes and predictions.

Since Mr. Gould's expedition left the locality no systematic prospecting was done until the discovery of tin at Mount Heemskirk, when prospectors made hurried examination of all the more accessible localities. Amongst these prospectors, Mr. Lynch, in a most persevering manner, penetrated to and examined the ground now held by the King River Prospecting Company, where he discovered very rich auriferous quartz, and from this all subsequent discoveries in the locality have resulted.

Reports referred to.—Report MacquarieHarbour by C. Gould, Paper 26, House of Assembly, 1862 (map). Ditto, ditto. Exploration for gold, *ibid.* House of Assembly Paper, No. 9, 1863.

Dial Range and North-West Coast Conglomerates.—

Massive beds of coarse conglomerates occur in many places in Western Tasmania. With our present knowledge it would be unwise to suppose they all belong to the same horizon, for some of them mentioned by Mr. Gould as being associated with the Gordon Group, and others forming bold ridges at Frenchman's Cap, may yet prove to be more ancient than those whose positions are deemed to belong to the present sub-division of Upper Silurian age. The members which may with some degree of safety be recognised as succeeding the Gordon and Queen River Groups are to be found on the Dial Range, which forms a bold conspicuous line of hills in the neighbourhood of the Penguin.

With still greater certainty may be included the coarse, highly indurated conglomerates upon which the Tertiary marine beds at Table Cape repose. These conglomerates are as a rule composed of greatly altered water-worn pebbles derived from various ancient rocks. Pebbles composed of highly indurated fossiliferous bluish-grey limestones and yellowish gritty sandstones are of common occurrence, and in these Mr. James Smith, Mr. Thomas Hainsworth, and the writer have at various times obtained specimens containing impressions of several species of brachiopods apparently identical with forms occurring in the limestones and gritty sandstones of the Gordon and Queen River Groups. These conglomerates have been described by the writer in the Proceedings of the Royal Society of Tasmania, 1876, pp. 86-87, and they extend, somewhat interruptedly, reposing unconformably upon a more or less vertically inclined slate formation, along the coast between Table Cape and the Penguin. In these localities they usually form dangerous reefs along the coast line. They have evidently been subjected to great denudation, and this may account for this irregular and interrupted distribution. It is difficult to determine the species, as the specimens or casts are fragmentary or imperfect. Fortunately, a number of these fossils were submitted by Mr. T. Stephens, and also by the writer, to Mr. Robert Etheridge, jun., of the British Museum, who described and figured the more conspicuous forms in a paper submitted to the Royal Society of Tasmania in the year 1882.—(See Proc. Roy. Soc. Tas., 1882, pp. 150-163; Plate II., figs. 1-16). The prevaling form is a species of *Pentamerus*, closely allied to *P. Knightii* (Sby.), and described as *P. Tasmaniensis* (Pl. II., figs. 1 and 3-8) by Mr Etheridge, jun. The associated forms also commented and described by the same authority are as follow :—

1. *Spirifer*, resembling *S. plicatella* (Linn.) (Figg. 9, a-c.)
2. *Spirifer*, or *Orthis*, "possessing the usual ribs and a smooth mesial fold." (Pl. II., fig. 2).
3. *Spirifer*, "not unlike *S. crispa* (His.) or *S. elevata* (Dalman)." (Fig. 9-b.)
4. *Orthis*, well marked, "a ventral valve with but few ribs, and those coarse and strong," resembling *O.biforata* (Schlothiem.) (Fig. 16.)
5. *Strophomena ?* fragment of a shell. (Fig. 11.)
6. *Spirifer ?* or *Atrypa ?* (Fig. 10.)
7. *Tentaculites ;* cast. (Fig. 13.)
8. Internal cast of a bivalve, undetermined. (Fig. 15.)

Besides these I have in my possession other forms from the conglomerates, resembling the following species :—

Orthis alternata.
Orthis flabellum.
Orthis elegantula (Dalman).
Rhynchonella nasuta (M'Coy).
Atrypa hemispherica (J. de C. Sow).

As forms strongly resembling these also occur *im situ* in the gritty sandstones of the Queen River, and also in a similar formation on the Corinna Track north of Long Plain, where they were obtained by Mr. James Smith, it is very probable that the fossiliferous portions of the conglomerates were derived from such rocks, and hence we are safe in referring them to a higher position, as in the present classification. This conclusion is to some extent borne out by Mr. T. Stephens, who has expressed an opinion that certain boulders contained in the conglomerates have even been "derived from rocks which are not older than the Lower Carboniferous or Devonian period." This must be a matter for future observation to settle. In the meantime I assign them a position in the Upper Silurian rocks between the Queen River group and the soft slates of Eldon Valley and Fingal. The latter formations have been deemed by Mr. Gould to be more recent than any other member of the Upper Silurian observed by him in Tasmania.

Eldon Valley Clay-slates and Mudstones.—In the Eldon valley Mr. Gould describes the occurrence of clay-slates and mudstones, containing fossil remains of undermined species of the following genera, viz. :—

Calymene.
Orthis.
Cardiola, &c.

The rocks of this group are to be found in a section described by the same observer between North Eldon River and the eastern extremity of Camp Hill. On either hand the metamorphic schists rise from under them towards the Rivers Murchison and Alma respectively, and evidently the latter have been formed in a deep syncline of the older metamorphic schists. Mudstones similiar in character to the Eldon beds are also described by Mr. Gould as cropping out near the mouth of the Gordon, where they are supposed to be succeeded by certain soft-clay slates at Head Quarters Island, which, on lithological grounds, Mr. Gould deemed to be the equivalents of those at Fingal. It is unfortunate that the fossils obtained by Mr. Gould are not now available as guides to local workers. The difficulties of access to this part of the country prevent us from obtaining more precise information regarding the stratigraphy and other matters of interest. It is shown, however, that in certain high peaks overlying the Eldon beds isolated bosses of greenstone appear whose bases are obscured by Upper Palæozoic marine mudstones and still more recent sandstones, among which, under peaks farther to the east (Coal Hill), beds of coal of supposed Mesozoic age are known to occur. It is apparent that denudation has removed the greater part of these later rocks, and has thus exposed the older rocks upon which they orginally rested. Boulders derived from these Upper Palæozoic rocks are found in the King River.

Mount Lyell and the Linda Goldfield.

Through the kindness of Mr. Jas. Crotty, and Mr. Belstead, Secretary of Mines, I have recently received a very fine collection of rocks from the neighbourhood of Mount Lyell and Mount Owen, which, with former collections from the same locality, afford valuable information respecting the geology of this interesting auriferous region. Since these were received, Mr. Thureau's report of the Linda Goldfield has been published, and his observations confirm the accuracy of the description given already by Messrs. T. B. Moore, J. Crotty, and others.

From the various sources of information, we learn that the major axis forming the West Coast Range, including the lofty peaks already named, are mainly composed of the following rocks in ascending order:—

1. Hydro-mica schists and slates, frequently of a soft unctuous nature, grandular and laminated in structure, with a prevailing silvery white or pearly lustre. 2. Indurated laminated hydro - mica schists frequently with fine tubular markings, and containing imperfect impressions of marine organisms (Strophomena, Spirfera, Fenestella etc.), overlying No. 1.	dipping to the West at an angle of from 60deg. to 80deg.
3. Indurated bands of granular or crystalline quartz of an igneous appearance, and of a pinkish colour on weathered surface, intimately associated with bands of a friable decomposed grit also of a pinkish hue, composed mainly of quartz and felspar.	dipping to the South, at an angle of from 25deg. to 40deg.

4. Coarse breccias and conglomerates, white and pinkish, forming the caps of Mount Owen, Mount Lyell, and other lofty crests, worn, furrowed and often isolated from contiguous masses, by long continued denudation.

It is evident that Nos. 3 and 4 are of a much later age than 1 and 2, and in all probability more recent than the Brachioped sandstone of the Queen River group, which may probably succeed Nos. 1 and 2.

It is not improbable, therefore, that the capping conglomerates of Mount Lyell and Mount Owen may be of the same horizon as the Dial Range and Table Cape conglomerates, which are known to contain similar fossils.

The rich auriferous deposit, now famous as "The Iron Blow," occurs on the low ridge connecting Mounts Lyell and

Owen, drained on the eastern side by the River Linda, and on the western side by the Queen River (both tributaries of the King River). The "Iron Blow," worked by the Mount Lyell Gold-mining Co., appears to be quite unique in the history of gold mining. Hitherto, in Tasmania at least, reef gold has been worked in quartz veins or dykes, traversing the Lower Silurian slates, quartzites, or conglomerates.

The "Iron Blow" has little resemblance to the ordinary auriferous veins. The absence of quartz throughout the more characteristic parts of the auriferous formation is especially remarkable. Where it does occur within the defined walls of the "blow" it is inconspicuous.

From various accounts it would seem that the formation occupies an enormous chasm penetrating or traversing the hydro-mica schists, the walls of which are stated by Mr. Thureau to be fully 280 feet apart. The outcrop of the "Iron Blow" has been traced for about $1\frac{1}{2}$ miles along its strike. The deposit itself is variously termed "lode," "iron blow," "blue iron," and "auriferous iron schists."

The strike of the principal fissure is nearly parallel with the direction of the southern face of Mount Lyell and North Mount Lyell, *i.e.*, in a direction nearly North 28° W.

Mr. Thureau also states that both hanging and foot walls, so far as they have been observed, dip at an exceedingly high angle in the same direction; the former at an angle of about 75 degrees. W., the latter about 64 degrees West. Where the mass of auriferous stuff is worked, a cross section has disclosed that about 57 feet, or about a fifth of the width, is composed of the more richly auriferous matrix, consisting mainly of peroxide of iron and barytes, either of a soft laminated character, or pulverised into a powdery mass of a dark purplish color. The remaining four-fifths, or western portion of the section, is in the form of solid pyrites; but an analysis made for me by Mr. Fred. Ward, the Government Analyst, proves that it is essentially the same in character as the softer mass to the east, and the latter is no doubt simply a decomposed form of the more solid pyrite mass of the western side. Strings and veins of solid barytes also are found penetrating the mass; and gold is found, in more or less extraordinary richness throughout the whole ferruginous mass.

When it is affirmed, as stated by Mr. Thureau, that the dark purple-colored rock has yielded at the rate of 187oz. per ton, its phenomenal richness is at once appreciated; and although it is too much to expect that this average will be maintained generally, it is enough to indicate that the deposit is probably the richest hitherto known.

The following analyses, kindly prepared by Mr. Ward, are of much value, as they will afford to those who are interested in the mode of origin of the auriferous deposit at the Linda better materials for forming an opinion :—

NOTES ON SPECIMENS OF MINERALS FROM MOUNT LYELL (CROTTY'S CLAIM).

No. 7 (IRON BLOW, 56 FEET WIDE).

Composition.	Per Cent.
Iron Pyrites	77·75
Barium Sulphate (Barytes)	19·85
Water, etc., lost at a red heat	2·40
	100·00

Specimen of deep purplish colour, soft and pulverulent, with indications of lamination becoming apparent as the Iron Peroxide dissolves out in Hydrochloric Acid. The residue insoluble in acid consists of Crystalline Barytes more or less regularly disseminated throughout the mass; fine specks of gold just visible to the naked eye present in residue.

IRON PYRITES.—No. 9.
(2 chains wide, partly overlying No. 7).

Composition.	Per Cent.
Iron Bisulphide (Pyrites)	83·0
Barium Sulphate (Barytes)	17·0
	100·0

Specimen oxidised on exposed surfaces and in cracks, easily cut with knife owing to the presence of the crystalline Barium Sulphate diffused through it. The particles of this barytes differ but little in appearance from those left on treating with acid portions of the "Iron Blow."

No. 11 (CAP OF No. 10.)

Composition.	Per Cent.
Iron Peroxide	63·9
Barium Sulphate	2·2
Silica (Quartz)	18·5
Water, &c., lost at red heat	15·4
	100·0

Specimen yellow from *hydrated* Iron Peroxide.

No. 10 (EAST OF No. 7).

Quartz or Quartzite ? contained 3·6 per cent. of Barytes, the remainder being chiefly Silica with a little Iron Oxide. This specimen has a distinct schistozie structure and cleavage.

Nos. 5 and 6—Footwall of lode.

Two specimens of Hydromica.

The darker colour of one specimen was due to the presence of organic matter from decomposing vegetation.

Mr. Ward also states :—" From results herewith (which are approximate only, and of course refer only to the very small specimens received) and from the description of occurrence in report by Inspector of Mines, and there seems little room for doubt that the 'Iron Blow' is the result of oxidations of Pyrites similar to that now associated so largely with it; the hydrated Oxide first formed being subsequently metamorphosed sufficiently to get rid of its combined water, and produce the slight change in the form of the small disseminated particles of barytes, as revealed by the microscope; or this change may have occurred during the process of oxidation. By oxidation three parts by weight of Iron Pyrites would yield two parts of Iron Peroxide."

From these analyses it would seem that the presence of barytes with iron and sulphur in the monster "Iron Blow" does not present any greater difficulty as regards mode of origin than is to be found in determining the mode of origin of the ordinary auriferous quartz or other metalliferous veins. I quite agree with Mr. Thureau in regarding the deposit as a most extraordinary one so far as auriferous workings are concerned, although the association of barytes in a small crystalline form with gold is known to occur in one or two gold mines in New South Wales, notably at the Canobolas and Winterton mine, Mitchell's Creek, near Bathurst.

Barytes is also often present in veins of lead, silver, and other minerals as the gangue of the ore, and as at the Linda it often occurs as an accessory, in a lamellated form, notably in the clay strata of Monte Perno, near Bologna.

Whether we suppose that the "Iron Blow" is due to hydrothermal agency or not, there is nothing in the composition of the pyrites or dark purplish rock which necessitates their having been formed originally in the way of "volcanic mud." It is more probable that the four principal elements, iron, barytes, sulphur, and gold, were originally precipitated together from solution. There is not the slightest correspondence between the Mount Morgan and Mount Lyell auriferous deposits.

Mr. Jack considers the auriferous formation at Mount Morgan to be derived from a thermal spring or geyser during the Tertiary age, and adds that "the frothy silicious sinter agrees in every respect with the deposits of New Zealand and Iceland geysers, and of the still more wonderful hot springs of the Yellowstone National Park." There is little resemblance between the silicious sinter, without definite bounds, of Mount Morgan, and the defined "fissure" at the Linda with its auriferous peroxide of iron and barytes, and I am inclined to the opinion that the formation at the latter place cannot have originated later than the Devonian era at least.

As there are many speculations by able authorities regarding the mode of origin of gold whether associated with quartz or otherwise, I have specially added an appendix to this paper, briefly dealing with the history of gold mining in Australasia. In it will be found a reference to the speculations of various authorities regarding its mode of origin. The one most commonly accepted, viz., "hydrothermal agency," is that which was favored by Dr. Barnard in a paper read before this Society in the year 1880. This theory is also favored by Dana, Lyell and other authorities, and it would appear also to be adopted by Mr. Thureau in respect of such mineral formations as the "Iron Blow" at the Linda, although the latter seems to be unaware of the fact that the mode of origin of the more common auriferous quartz reefs are also frequently ascribed to hydrothermal agency.

GOLD.

Gold is classed, with silver, platinum, iridium, and palladium, as one of the noble metals, and is widely distributed throughout the world, principally in the rocks of Archæan and Cambro-Silurian age. It occurs mostly in a native state, being either pure or only slightly alloyed with one or other of the following metals, viz., silver, tellurium, copper, iron, bismuth, palladium, rhodium. Although gold often richly occurs in the drifts, conglomerates, and igneous rocks of more recent systems,—notably those of Tertiary age, —it is now very generally acknowledged that the gold so found has been derived primarily from the decomposition and waste of the auriferous quartz reefs and veins which occur chiefly in rocks of Silurian and Devonian age. It was from the more recent auriferous superficial drifts, composed of clay, sand, and gravel, that gold was first derived by man. Reef gold mining, according to Davies, "although the oldest mode of occurrence in nature, is the one more recently known to men, and still more recently worked with success. Excepting some Brazilian mines, and one of doubtful success in the Ural Mountains, there was, only forty years ago, scarcely a gold mine profitably worked in the solid rock."

Important Gold Discoveries in Modern Times.

The following brief summary is confined to the more important discoveries of gold in the great producing centres of modern times. For the facts relating to ex-Australian centres I am indebted to Davies' useful work, "Metalliferous Minerals and Mining," 8vo., pp. 438; London, 1851.

RUSSIA.—Gold was first discovered in the Ural Mountains in the year 1723, and this region still continues to rank as one of the chiefest sources of the world's supply of gold.

AUSTRO-HUNGARY.—Gold has been mined in Hungary since the eighth century. In the existing Amalia mine, near Schemitz, gold is worked to a depth of 1,800 feet from the surface.

CENTRAL AMERICA.—Gold was discovered in Nicaragua in 1850—that is, only a year prior to Hargreaves' discovery of payable gold in Australia. In Brazil gold has been known to Europeans since 1543. The more important mines, still being worked successfully, near St. John del Rey, were first systematically developed by an English Company in the year 1830.

CALIFORNIA.—The first important discovery of gold in California was accidentally made in 1847 by Mr. Marshall, at Sutter's Mill, situated on the American Fork, near its junction with the Sacramento. The gold was first discovered as shining yellow particles in a newly formed mill-race in connection with Colonel Sutter's saw-mill.

AUSTRALIA.—Mining for gold in Australia commenced in the year 1851, immediately upon the discoveries of payable gold-fields by Hargreaves at Ophir in the beginning of the same year. Prior to this date the attention of colonists was not attracted to the subject.

The earliest recorded discovery of gold, however, is that of Mr. Surveyor M'Brian. Of this discovery Mr. Harrie Wood[a] gives the following account:—" Mr. Surveyor M'Brian, in his field notes of the survey of the Fish River, between Tarana and O'Connell, states:—' February 15, 1823.—At 81·50 to river, and marked gum-tree. At this place I found numerous particles of gold in the sand in the hills convenient to the river.' "

In 1839, Count Strzelecki, at Boree and Wellington caves, found gold in specks in silicate, but was induced by the Governor of the colony to refrain from giving publicity to the discovery, as it was feared such knowledge would make it impossible to preserve discipline among the soldiers and prisoners.

In 1841, the Rev. W. B. Clarke discovered gold at the head of the Winburndale Rivulet, and in the granite westward of the Vale of Clwydd; but although, in 1843, he had mentioned the matter generally, it was regarded as a curiosity only, " and considerations of the penal condition of the colony

a Mineral products of New South Wales, 1882, p. 22 See also the *Evening News* of Sydney for 7th August, 1875.

kept the subject quiet, as much as the general ignorance of the value of such an indication."[b]

In 1844 and 1846, without knowing anything of the previous discoveries, Sir R. Murchison published upon scientific grounds a prediction of the existence of gold in Australia. The following account, given by himself, is of much interest to Australians:—"Having recently returned from the auriferous Ural Mountains, I had the advantage of examining the numerous specimens collected by my friend Count Strzelecki along the eastern chain of Australia. Seeing the similarity of the rocks of those two distant countries, I could have little difficulty in drawing a parallel between them, in doing which I was naturally struck by the circumstance that none had *yet* been found in the Australian ridge, which I termed in anticipation the 'Cordillera.' Impressed with the conviction that gold would, sooner or later, be found in the great British colony, I learnt, in 1846, with satisfaction that a specimen of the ore had been discovered. I thereupon encouraged the unemployed miners of Cornwall to emigrate and dig for gold as they dug for tin in the gravel of their own district. *These notices were, as far as I know, the first printed documents relating to Australian gold.*" I have italicised the part which indicates that Sir R. Murchison was not led to make his sagacious predictions because of knowledge of what have since been revealed of earlier discoveries of gold by persons residing in the colony. The following testimony of Count Strzelecki indisputably confirms this view[c]:—"Nothing can give me greater pleasure and comfort at any time than to bear my humble testimony to the inductive power which you displayed on the occasion of your predictions in regard to the existence of gold in Australia; and consequently I can affirm now, as I did and do whenever necessity occurs, that I never mentioned my discovery or supposed discovery of Australian gold to you prior to your papers on the subject, nor after their publication."

The effect of the discovery of gold in payable quantities in 1851 gave a wonderful impulse to the search for gold in all the colonies, and within a month of the establishment of Victoria as an independent colony it became generally known that rich deposits of gold existed within its borders.

The results of the Select Committee appointed by the Legislative Council of Victoria to consider the order of priority of claims for gold discoveries in Victoria, is thus summarised in Mr. Hayter's Year Book, 1885, p. 24:—

b See Rev. W. B. Clarke's evidence before a Select Committee of Leg. Council, N.S.W., Sept. 1852. *Parl. Papers.*

c Presidential Discourse Trans. Royal Geol. Soc., 1884; also Murchison's Siluria, 1852, pp. 450—451

"The Hon. W. Campbell discovered gold in March, 1850, at Clunes; concealed the fact at the time from the apprehension that its announcement might prove injurious to the squatter on whose run the discovery was made, but mentioned it in a letter to a friend on the 10th June, and afterwards on the 5th July, 1851, which friend, at Mr. Campbell's request, reported the matter to the Gold Discovery Committee on the 5th July. Mr. L. J. Mitchell and six others discovered gold in the Yarra Ranges at Anderson's Creek, which they communicated to the Gold Discovery Committee on the 5th July. Mr. James Esmond, a California digger, and three others obtained gold in the quartz rocks of the Pyrenees, and made the discovery public on the 5th July. Dr. George Bruhn, a German physician, found indications of gold in quartz, 'two miles from Parker's station, in April, 1851, and forwarded specimens to the Gold Committee on the 30th June.' Mr. Thomas Hiscock found gold at Buninyong on the 8th August, and communicated the fact to the editor of the *Geelong Advertiser* on the 10th of the same month. This discovery led to that of the Ballarat gold-fields. Mr. C. T. Peters, a hutkeeper at Barker's Creek, and three others found gold at Specimen Gully on the 20th July; worked secretly to the first September; then published the account. This led to the discovery of the numerous gold-fields about Mount Alexander."

In New Zealand gold was discovered in 1842, less than three years from the foundation of the colony; but it was not practically worked until 1852, *i.e.* after Hargreaves' discovery in New South Wales. Mining for gold was first commenced at Coromandel, in the district of Cape Colville Peninsula, which, at the present time, forms the chief seat of true mining operations in New Zealand[a], and where reefs have been proved to a depth of over 600 feet below sea level.

In Queensland the opening of the gold-fields only occured about the year 1859, or about the time when it was severed as an independent colony from New South Wales.

In Tasmania, the first payable gold was found in 1852, about the Nook, near Fingal, and about the same time it was discovered in minute particles along the Tower Hill Creek and in the vicinity of Nine Mile Springs.[b] The first quartz mine commenced operations at Fingal in the year 1859. In the same year gold was found in the River Forth by Mr. James Smith, and also good prospects at the Calder, a tributary of the Inglis, by Mr. Peter Lette. At Lefroy (Nine Mile Springs) reef gold was discovered by S. Richards in the

a. See New Zealand Hand Book, by James Hector, M.D., C.M.G., F.R.S., 1879, p.

b Mr. Riva, of Launceston, is stated to have traced gold in slate rocks in the vicinity of Nine Mile Springs about the year 1849.

year 1869. Traces of gold were also obtained in several places between Hadspen and the town of Launceston. Gold was also discovered in the western and north-western portions of the island by Messrs. Gould, Jas. Smith, C. P. Sprent, Peter Lette, and S. B. Emmett The first recorded returns from the Mangana goldfields date from 1870; Waterhouse, 1871; the Aellyer, Denison, and Brandy Creek, in 1872; Lisle, in 1878; Gladstone and Cam, in 1881; Minnow and River Forth, in 1882; Branxholm and Mount Victoria, in 1883; Mount Lyell, in 1886.

EXTENT OF GOLD PRODUCE.

The importance of the gold industry in Australasia is best indicated by the fact that 76,462,619 ozs. of gold, valued at £300,864,352 were raised between 1851 and 1883.

The proportions yielded by the various colonies are thus given by Mr. Hayter[a]:—

	Quantity. ozs.	*Value.* £
Victoria	52,214,150	208,856,600
New South Wales	9,432,759	34,971,319
Queensland	4,170,254	14,939,304
South Australia	133,181	529,771
Tasmania	335,728	1,291,826
New Zealand	10,276,547	40,275,532
Total	76,462,619	300,864,352

The value of gold raised in Australasia during 1883 is estimated at £5,522,751, and the quantity at 1,411,712ozs., of which nearly two-thirds were obtained from the reefs or veins in the solid rock.

The average gold produce of the world during the last fifty years is variously estimated at between 23½ and 29 millions per year.

According to Mulhall[b] the gold produce of the world for the fifty years ending 1880 amounted to £1,448,000,000, *i.e.*, equal to an average of £28,960,000 per year.

Of the total amount for the fifty years, the same authority

a Year Book of Victoria, 1885, p. 384.

b Dictionary of Statistics, p. 220; Victorian Year Book, 1885, p. 384.

estimates that the percentages yielded by the principal and other sources of supply were as follow :—

	Per cent.
Mexico and South America	31·5
United States	19·7
Australasia	17·8
Russia	12·0
Other countries	19·0
Total	100·0

According to a report furnished to the British House of Commons, however, the gold produced between 1855 and 1875, presents a marked difference in the percentage for various countries, viz.:—

	Per Cent.
United States	42·43
Australasia	36·95
Russia	15·08
Mexico and South America	3·39
Other countries	2·15
Total	100·00

It would appear from the latter statement, therefore, that during the last thirty years the United States and Australasia together have produced 79·38 per cent. of the world's supply of gold.

Mr. Hayter estimates that the proportion of gold derived from quartz and alluvial in Victoria for the years 1883 and 1884[c] was—

Quartz, 60 per cent.

Alluvial, 40 per cent.

In Tasmania I find, from an analysis of the latest statistical records, that between 1866 and 1885 the total quantity of gold produced from quartz and alluvial was as follows :—

	ozs.		Per cent.
Quartz	253,636	or	67·04
Alluvial	124,732	or	32·96
Total	378,368	or	100·00

c Dana's Manual of Mineralogy and Lithology, p. 114.

GOLD PRODUCED IN THE VARIOUS MINING DISTRICTS OF TASMANIA BETWEEN 1866 AND 1884.

DISTRICT.	GOLD.			Per cent. to Total.
	Alluvial.	*Quartz.*	*Total.*	
	ozs.	ozs.	ozs.	
Beaconsfield	30,900	150,484	181,384	47·94
Lefroy and Back Creek	8,575	77,435	86,010	22·73
Lisle	62.800	—	62,800	16·70
Mangana and Black Boy	5,970	9,994	15,964	4·21
West Coast	11,907	—	11,907	3·20
Fingal	2,171	6,734	8,905	2·35
Mount Victoria	—	4,195	4,195	1·01
Waterhouse and Denison	60	2,548	2,608	·67
Gladstone	—	1,674	1,674	·44
Hellyer	585	—	585	·15
Minnow River & Forth River	200	7	207	·05
Cam	192	—	192	·05
Branxholm	50	13	63	·01
Other places	1,322	552	1,874	·49
Total	124,732	253,636	378,368*	100·00
Per cent to total	32·96	67·04	100·00	

* The value is estimated at £1,453,309.

GOLD REEFS.

Gold reefs in Tasmania have not yet been worked to any great depth. The following particulars with respect to the principal shafts sunk have been kindly supplied to me by Mr. C. J. Atkins :—

District.	*Depth of Shaft.* *feet.*	*Direction of Reef.*
Lefroy—		
New Native Chum	812	Strike east and west
New Chum	404	„ east and west 6° S.
Mathinna—		
City of Hobart	650	„ north and south (a little to east of south.)
Beaconsfield—		
Lefroy Co.	400	„ east and west, dipping south
Tasmania	277½	„ ditto.
Florence	268	„ ditto.
Dally's United	200	„ ditto.
South Esk—		
Chesterfield's shaft	270?	

These reefs vary from a few inches to 5 feet in width.[b]

a Victorian Year Book, 1885, p. 385.
b The so-called auriferous "lode" at Mount Lyell is stated to be over 280 feet thick. It is ferruginous rather than quartziferous in character.

The reefs in New South Wales vary from a few inches to 10 feet in width, and have generally a meridional strike,—although there are exceptions showing a strike N. and S., as at Hill End, Trunkney, and Adelong; at Dalmorta, from E. 10° N. to E. 30° S.; at Grenfell, N.E.; at Temora and Copeland, N.E. to E. and S.E.

With respect to Victoria, Mr. W. Nicholas, F.G.S., has furnished valuable information, which is thus summarised by Mr. Brough Smith, F.G.S.[a]:—

"Of eight hundred and forty-one distinct reefs observed in the Lower Silurian strata, two-thirds have an average direction of strike bearing N. 20° W. and the remaining third an average direction bearing N. 11° E.; and that of one hundred and fifty-seven reefs examined in the Upper Silurian rocks, three-fourths have an average direction along the strike of N. 34° W., and one-fourth an average direction bearing N. 27° E. In addition about eighty-five cross reefs have been observed, varying in the direction of the strike from N. 85° W. to N. 74° E. These are so called from their divergence at nearly right angles from the prevailing courses of the reefs. . . . The reefs which occur in the Lower are much thicker than those in the Upper Silurian rocks, and that, so far as yet observed, those reefs showing the greatest thickness have been found to be the richest and most extensively wrought in Victoria."

The shafts sunk in Victoria as a rule attain a much greater depth than in New South Wales and Tasmania. Mr. Hayter states[b]:—

"At least 17 of the shafts sunk in Victoria in search of auriferous quartz have attained depths exceeding 1,000 feet. The deepest shaft in the colony is the Magdala, at Stawell, which is 2,409 feet, or nearly half-a-mile deep, and other shafts in the same locality are 1,940, 1,830, 1,815, 1,770, 1.676, and 1,326 feet from the surface. At Sandhurst the shaft of Lansell's 180 mine is 2,041 feet deep, and that of the Victory and Pandora Company is 2,000 feet deep. There are also shafts 1,778, 1,563, 1,490, 1,483, and 1,450 feet deep respectively; at Maldon there is one 1,220 feet deep; and at Clunes there is one shaft 1,210, and another 1,193 feet deep."

In New South Wales, shafts have not been sunk to a much greater depth than in Tasmania. At Adelong a shaft has been sunk to the depth of 874 feet. Two other shafts have reached the depth of 830 feet and 716 feet respectively.

The yield of gold from Tasmanian quartz reefs varies considerably from year to year. The yield at Beaconsfield varied from 1oz. 5dwts. 6grs. per ton in 1882, to 1oz. 0dwts. 16grs.

a. Report of Progress Geol. Survey of Vict., No. IV., p. 14.
b. Victorian Year Book, 1885, p. 388.

in 1883; at Lefroy, the yield in 1882 was 10dwts. 13grs. per ton, and in 1883 the yield fell off to 7dwts. 22grs. The average yield from all quartz reefs in Tasmania for 1883 was 15dwts. 9grs. In Victoria, it is stated that the average yield of the crushings in 1883 and 1884 was 9dwts. 12·82grs. and 9dwts. 21·07grs. respectively. In the deepest mines the yields varied from 4dwts. 17grs. to 2ozs. 6dwts. 14grs. per ton.

Gold Nuggets.

In Tasmania, alluvial gold has not been worked to the same extent as in the Australian mainland, and the only nuggets of importance recorded are the following:—

(1.) Nugget found at Long Plains by Buckner, May, 1882. Weight, 9ozs.

(2.) Nugget found on the Whyte River by M'Guinty and party, March, 1883. Weight, 243ozs.

(3.) Nugget found on the White River by Griffen and party, March, 1883. Weight, 143ozs.

Models of these Tasmanian nuggets are exhibited in the Tasmanian Museum, Hobart.

The largest masses of gold known have been found as nuggets in alluvial workings. The "Welcome Nugget," found in Victoria, weighed 2,195 ounces, or nearly 183 pounds, and yielded £8,396 10s. 6d. of sterling gold. From South Australian alluvial workings the "Blanch Barkley Nugget" was obtained, which weighed 146lbs. Besides the "Welcome Nugget," two other nuggets were found in Victoria, weighing 1,621 and 1,105 ounces respecitvely.

On the 13th May, 1851, soon after the gold discovery in New South Wales by Hargreaves, there was discovered at Summer Hill Creek, N.S.W., a nugget weighing 1lb. 1oz. This is probably the first nugget of importance found in Australia. The most remarkable nuggets found in New South Wales weighed 106 and 107lbs. Troy respectively. Of these the first was found by a native boy in July, 1851, at Meroo Creek, or Louisa Creek, River Touron; the second was found on 1st November, 1858, at Burradong, near Orange. An interesting account of the more remarkable nuggets found in New South Wales is given by Professor Liversidge.—("The Minerals of New South Wales," Sydney, 1882, pp. 66-69.)

Dana, in his Manual of Mineralogy and Lithology, p. 115, also informs us that masses of gold of considerable size have been found in North Carolina. The largest was discovered in Cabarrus County; it weighed 28 pounds avoirdupois—(steelyard weight equals 37 pounds Troy.) . . . . In Paraguay, pieces from 1 to 50 pounds weight were taken from a mass of rock which fell from one of the highest mountains . . . . The largest mass yet reported from California weighed 134lbs 7ozs. A remarkably beautiful mass, consisting of a congeries of crystals weighing 101 ounces (value $4,000), was found in 1865, seven miles from George Town, in El Dorado County. At Maisk, in the Ural Mountains, a nugget of gold was found—weight, 96lbs. It would seem, therefore, that the largest masses of gold known were found in Australia.

Theories Regarding the Origin of Gold Veins and their Mode of Occurrence.

Regarding the origin of gold found in quartz veins, there is much that is obscure or little understood. Of course nearly all authorities now agree in referring the formation of auriferous quartz veins to an aqueous origin. But suppose we admit that the gold is carried into rock fissures in solution with quartz from certain strata in the surrounding rocks, we have still to enquire how and from whence came the gold there in a finely-divided state? What is the true cause of shoots of gold? Why, for example, are auriferous quartz veins principally confined to rocks of Palæozoic age? Why should particular rocks, say diorite, appreciably affect the deposition of gold in veins passing through that rock? What is the exact thermal condition and the exact nature of the fluid which will hold silica, gold, and other metals in solution at the same time and in such a manner that they may in some form be deposited together? Many speculations have been advanced by able authorities, which, though of great value, fail to satisfy all the conditions required to arrive at a proper appreciation of the subject.

According to J. Arthur Phillips,[a] the formation of auriferous veins is now going on in various parts of the Pacific Coast. He states (see p. 601, Lyell's Elements of Geology)—"For example, there are fissures at the foot of the eastern declivity of the Sierra Nevada, in the State of that name, from which boiling water and steam escape, forming siliceous incrustations on the sides of the fissures. In one case, where the fissure is filled up with silica, enclosing iron and copper pyrites, gold has also been found in the veinstone." And again, with reference to California, he states:—"The auriferous quartz of these drifts is derived from veins apparently due to hydrothermal agency." Again, Sonstadt states that "the sea water of the British coasts contains in solution, besides silver, an appreciable amount of gold, estimated by him at about one grain to a ton of water."[a]

a Phillips on "The Goldfields of California."—Proc. Roy. Soc. Lond., 1868.
a J. Sterry Hunt.

Richard Muller, from experiments conducted by him, established the fact that "solvent action is more facilitated by increased pressure than by prolonged digestion," and hence probably the speculation of J. C. Crawford,[b] who supposes that mineral veins have been formed in the depths of the sea, and speculates thus:—"The filling of metallic veins, particularly gold and silver, has chiefly taken place at a depth of about 2,500 fathoms or over; the precipitation may have proceeded from metals in the waters of the ocean, or in passes, or in water heated from below."[c] According to Sonsdadt, iodine in sea water is the agency which keeps gold in a soluble and oxidised condition.[d] Dana[e] is of opinion "the veins of quartz which contain the gold occupy fissures through the slates and openings among the layers which must have been made when the metamorphic changes or crystallization took place. It was a period for each gold region of long-continued heat (occupying probably a prolonged age), and also of vast upliftings and disturbances of the beds; for the beds are tilted at various angles, and the veins show where the fractures of the layers or the separations and gapings of the tortured strata. The heat appears not to have been of the intensity required for the better crystallization of the more perfectly crystalline schists. The quartz veins could not have been filled from below by injection; they must have been filled either laterally or from above. In all such conditions of upturning and metamorphism the moisture present would have become intensely heated, and hence have had great dissolving and decomposing power; it would have taken up silica with alkalies from the rocks (as happened in all Geyser regions), along with whatever other mineral substances were capable of solution or removal, and the vapour, thus laden, would have filled all open spaces, there to make depositions of the silica and other ingredients it contained. The mineral ingredients would have been derived from the rock adjoining the veins or open spaces, or from depths below through ascending vapours. By one or both of these means the quartz must have received its gold, pyrites, and ores of lead, copper, and other materials, all having been carried into the open cavities at the same time with the silica or quartz. The pyrite of the vein is usually auriferous, showing that it was crystallized under the same circumstances that attended the deposing of gold in strings, crystals, and grains, and the same is often true of the galena."

With respect to the mine waters of Australasia, Messrs.

b Trans. New Zealand Inst., Vol. IX., pp. 570-561.

c Geol. Record, 1877.

d. Brough Smythe.

e Manual of Mineralogy and Lithology, 1879, p. 115.

Newberry, Taylor, Skey, and others have conducted experiments for determining the presence of gold, which they had reason to believe was held in solution in the saline waters of the deep mines. Mr. Newberry states that considerable difficulty is experienced in conducting experiments on this subject, as extreme care is requisite to exclude all possible chance of the presence of finely-divided gold, which has been held in mine-waters either by itself or with pyrites, quartz, and earthy matter. With such precautions Mr. Newberry admits that a portion of the evidence had to be discarded, and the final results were not deemed to be conclusive on the point. Much investigation is yet necessary before we can arrive at final conclusions respecting the origin of gold in quartz veins.

In this place it is of interest to observe that Sir R. Murchison's settled opinion of the "downward impoverishment of gold-bearing quartz veins" has not been sustained by practical experience in Australia, where gold is now successfully worked in many places over 2,000 feet below the surface, and in one place at 2,409 feet, or nearly half-a-mile deep. His peculiar views with respect to the superficial distribution of gold, and of the downward persistence of silver, were no doubt coloured to a great extent by the idea that the sacred writer of Job[a] indicated such a form of distribution as regards gold and silver, in the aphorism—

"Surely there is a *vein* for the silver. . . . The earth hath *dust of gold.*"

His fears for the ultimate failure of the gold supply were therefore unnecessarily increased.

NOTES AND DESCRIPTIONS OF CRINOIDEA FROM THE UPPER PALÆOZOIC ROCKS OF TASMANIA.

By Robt. M. Johnston, F.L.S.

ENCRINITE STEMS FROM PACHYDOMUS BEDS, DARLINGTON, MARIA ISLAND.

I have recently examined a very interesting collection of articulated encrinite stems, variously sculptured, obtained by Mr. Perrin. The inside casts of similar forms are also of common occurrence in the Porter Hill and Shot Tower beds. In the Darlington specimens, however, the external sculpture is exhibited in great perfection. As these forms may be of service in matters relating to the correlation of the various divisions of the Upper Palæozoic rocks, I have taken pains