TRANSACTIONS

OF

The Philosophical Society

OF

VICTORIA.

TRANSACTIONS

OF THE

PHILOSOPHICAL SOCIETY

OF

VICTORIA,

(To be Incorporated by Royal Charter.)

INCLUDING

THE PAPERS AND PROCEEDINGS OF THE SOCIETY

FOR

THE PAST YEAR, ENDING IN JULY, 1855.

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NOTE.

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NOTE.

THE Papers contained in this Volume have been read at various times before the Philosophical Society of Victoria, from its inauguration in August, 1854, to its amalgamation with the Victorian Institute, and this volume is the first and only one of the kind that has ever been issued in Victoria. Perhaps some of the Articles are not exactly similar in their character to the publications of like Societies in Europe, yet it is hoped that the many facts now collected in this form will be found useful to those whose pursuits are in any way connected with scientific investigations.

The Papers refer chiefly to matters of practical importance to the colony, but as they also contain recent discoveries in Geology, Botany, and Zoology, they will be read with equal interest in other countries, altogether apart from their value as records of the advances made by the Colony in these departments of science.

The names of the various contributors are attached to their productions, and they are each individually responsible for their opinions—the Society, in no case, having pledged itself to support or verify these opinions.

It is probable that trifling errors may be discovered in the text, but as some of the members were absent while their papers were passing through the press, these must not be too

harshly dealt with, nor charged upon those on whom it fell to revise and arrange the whole.

The Philosophical Society and the Victorian Institute, now united under the title of the "Philosophical Institute of Victoria," will continue to publish scientific Papers in a manner similar to this—the commencement of the series; and it is the duty of all true disciples of science to assist cheerfully in adding to the variety and usefulness of the contents of their volumes.

Melbourne, September, 1855.

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TRANSACTIONS

OF THE

Philosophical Society of Victoria.

Inaugural Address of the President, Captain Clarke, R. E., Surveyor-General, &c., &c.

In accepting the office of your President, in now assuming the task of, for the first time, addressing your Association when launched on its course, I have been, not regardless of the responsibility I have taken upon myself, nor have I forgotten the absence of so many of those essential qualifications which would have rendered your selection less embarassing to myself, or my address to you more worthy of the Society we seek to establish.

Not alone in the offshoots of the older world, but in the more ancient seats of learning, positions of this nature have customarily been occupied by men distinguished for their rank

or eminent for their learning, and it would therefore have been most difficult for me to reconcile to myself my occupation of this place had I not felt assured of your recognition in me of those more humble, but perhaps not less useful qualities which may aid our common object, but in the language of one who had far less reason for using it under circumstances not unlike the present. I repeat that "in zeal for the welfare of this Association, in intense interest for the accomplishment of its object, I yield to none, and if these may suffice, I hope I shall not be found unworthy of the trust you repose in me." Yet it is no common responsibility with which you have charged me, for this Association is one of the great powers which the altering phases of this world have called into action; yet a few years since and it could not have existed; and even now some persons are found unable to appreciate its worth or understand its purpose.

And now may I be permitted to urge the necessity of that mutual support and co-operation upon which the progress and ultimate success of the Society is entirely based. From as simple an origin have the noblest institutions of our parent lands had birth, where their founders, however few their numbers, have shewn that earnest perseverance which is the sure index of success; nor need we doubt our success in securing the same issue, for whilst every other interest is progressing with no ordinary rapidity, we may rest assured that the facilities for experiment and observation will become daily more attainable.

If we look back upon the early history of the human family, when the arts of husbandry reigned alternately with those of warfare; and if we compare the comforts of life, and the means of intellectual enjoyment in those ages, with those of the present day, we shall perceive how vain it would be to attempt to measure the advantages which have resulted from the pursuit of knowledge and the study of the natural sciences.

An enumeration of the items which supply our daily wants, and minister to our enjoyments, would at once shew that the advantage which we thus possess, surround us so closely on every side, that, like the air we breathe, we direct to them the less attention on account of their invariable presence.

When we further note the amount of discovery and improvement which each age in the history of man has contributed, it becomes apparent that the progress has partaken less of an arithmetical than a geometrical proportion. Each discovery has opened a wider field for new discoveries; improvement in one branch of knowledge has lent assistance to the development of every other, until the amelioration of the conditions of life, and the facilities of action have become such as to react, in no common degree, upon the available power of a single life devoted to the pursuit of truth.

Thus while a knowledge of the nature and origin of disease has afforded the means of prolonging the average duration of life, the appliances of locomotive printing and other machinery have made that life of thrice its former duration, measuring it by the scale of the number of events for which it is available.

But these extensive advances by no means shew reason for relaxing our efforts, for while we are daily encouraged by important discoveries and a nearer approach to long desired truths, we are at the same time obtaining sight of a more widely extended horizon.

With this stimulous to our efforts and mindful of the duty incurred by the acceptance of these bequests of exclusive knowledge, we must each endeavour to add his tribute to the common store.

Reflecting that Australia is destined to fill no unimportant part in the coming history of a more advanced civilisation, and remembering that Victoria in material wealth has made a century's advance in the span of time which has elapsed since her foundation; with this progress, the result of one disovery, are we to rest content? Should we not

rather question the continuance of this prosperity, recognising in it the means to a more desirable and higher end.

The disturbances which we have experienced with our acquisition make room for the foundation of a future social greatness.

Admitting this position, how can we advance this end? The difficulties of experiment in a new country will, doubtless, give additional importance to the culture of correct and minute observation. Who can predict the result which will arise from the simplest discoveries? A stain upon a stone, a drop of coloured water, may prove of sufficient significance to fill the mountain's solitudes with the iron life of machinery. Let us prove, rather than assert, the utility of research. Let us enforce a due recognition of the labour of the inventor and discoverer until his national importance be acknowledged.

And while thus in a general view, we cannot fail to see the value of those pursuits, how much more do they force themselves upon our observation when we scan them in detail.

The objects of our Institution will not be answered unless the geologist, the chemist, and the representative of the associated sciences conjointly labour to produce those results which have justly become the pride and glory of the civilised world.

The mere mechanical arts are but the secondary results of science, and as accumulating facts, though necessarily laborious, are the first step towards eliminating truth; let us therefore sturdily arm ourselves to the acquisition of them, forgetting even what has been termed the sublimity of deductive philosophy, in the no less honourable, but no less arduous and valuable, efforts of the practical experimentalist.

Such labours, ever pursued under difficulties, seldom rewarded commensurately with their importance, it shall be our duty and our interest to facilitate; and while thus striving for these ends let us endeavour to secure, by singleness of purpose and unity of action, the general sympathy.

ART. II. *Definitions of rare or hitherto undescribed Australian Plants, chiefly collected within the Boundaries of the Colony of Victoria, and examined by Dr. Ferd. Mueller.*

IF I venture to lay before the Philosophical Society a series of descriptions, by which a number of plants, but imperfectly known or entirely new to science, are briefly illustrated, I beg to state, that in doing so I am only actuated by a desire of combining my humble acquirements with those of so many superior minds for the purpose of contributing perhaps towards that important object, for which this Society was formed, to diffuse useful knowledge throughout our adopted country, to elucidate its own productions, or to show how much a land, equally favoured by inexhaustible mineral resources, by a serene climate and most fertile soil, may produce, so that we may learn to appreciate those vast treasures, which as yet hidden and undeveloped are dormant in its virgin soil.

In offering some results of my last researches to the Philosophical Society, I endeavour to fulfil those duties which every one of us has seriously taken upon himself in joining this union; although I must confess, that I only answered with hesitation the honourable call of commencing the series of dissertations, which we hereafter may expect before this auditory, and with which so many will adorn the annals of this Society, as I could not conceal from myself how inadequate my powers are for such a task. Only the thoughts, that science does not disdain the smallest gift, that the last links of a long chain of observations are often closed by a most insignificant discovery, which isolated would be unimportant—only those thoughts could induce me to offer out of the botanical treasures of this country some novelties or rarities which rewarded my last explorations.

I shall bring under review chiefly such plants as have enlarged genera, with but a limited number of species, such as

have unfolded new disclosures in the affinity or geography of the vegetable kingdom, or such as have required an altered position in the system of botany, or such again as exhibit medicinal properties like Velleya, Trachycaryon, Beyera, Eriostemon, and other Diosmeæ; and not to scatter the connected observations I deemed it expedient to annex occasionally, also, notes and descriptions of allied species indigenous to other parts of Australia.

RANUNCULACEÆ.

Myosurus Australis.

Scapi filiform or setaceous, upwards but slightly thickened; petals and sepals very small; fruitspike narrowly terete, somewhat acute, about an inch long; carpels numerous, closely imbricate, rhomboid or almost deltoid, acuminate, at the thickened base slightly spreading; styles very short.

On moist places or in the open plains where rainwater lodges for a considerable time, near the Emu Creek, Hopkins' River, Avoca, Avon, Richardson and Murray, sometimes abundant. It is not little surprising that this genus, of which hitherto only two species, namely: M. minimus from Europe and M. aristatus from the Cordilleras of Chili have been noticed, should find its representative also in Australia. Our species is closely allied to M. minimus; it differs chiefly in the loose extracurved basis of the carpels.

PITTOSPOREÆ.

Marianthus bignoniaceus.

Innovation silky; branches climbing, slightly pubescent, at length smooth; leaves patent, petiolate, out of an almost heart-shaped base ovate, oblong or lanceolate, apiculate, net-veined, above puberulous soon smoothening, beneath slightly hairy, at the margins undulate revolute, as well as on the nerve densely hairy; pedicels axillary single or two, rarely three together, at the base bracteolate, of equal or twice the length of the petiole, as well as the calyx pubescent; flowers pendulous; sepals lanceolate, acuminate, four or five times shorter than the cylindrical, somewhat bell-shaped puberulous orange-yellow corolla; anthers yellow; germen villous silky; capsules narrow-elliptical, somewhat compressed, with a longitudinal furrow, biloculate, villous, cells many-seeded.

On shady rivulets, cataracts, and in fissures of the rocks in the Victoria and Serra Range and the Grampians. In South Australia, on the Onkaparinga and in the Lofty Ranges.

This remarkable and beautiful species extends the geographical limits of the genus Marianthus to the eastern portion of this continent, and is the only one hitherto known from beyond the boundaries of Western Australia. At the Grampians it is also accompanied with other features of the Swan River flora, as Lepidobolus, Lhotzkya, Calectasia, not previously observed towards the east.

DROSERACEÆ.

3. *Drosera angustifolia.*
(Sect. *Arachnopus.*)

Stem foliate, simple, decumbent or adscendent; leaves scattered, nearly sessile, long and narrow caudate, above and along the margin glandulously pilose; racemes, either opposite to the leaves or alternating with them, hardly of their length, three-ten-flowered, covered with short gland-bearing hairs; segments of the five-parted calyx lanceolate, gradually narrowed upwards, about equal in length with the capsule, and half as long as the whitish petals; styles 3, divided to the base, its divisions filiform, incurved at the top; seeds egg-shaped, clathrate.

On the moist gravelly margins of the Lakes on the Murray River towards Eustone. This is the first extratropical species of this section of Drosera with which we are acquainted. It approaches next to Drosera Finlaysoniana from Cochinchina. But this is only one of the many tropical forms of plants, which, transgressing the torrid zone, advance so far southerly as the Murray desert.

POLYGALEÆ.

4. *Comesperma polygaloides.*
(Sect. *Disepalum.*)

Smooth; leaves approximated, flat, narrow or linear-lanceolate, acutish, glaucous; racemes somewhat dense, purple; pedicels shorter than the flowers; lateral bracteoles about half as long as the intermediate one; lobes of the anterior sepal acutish; carina gibbous at the top, hardly shorter than the wings.

In barren plains at the Avoca, Guichen Bay, and Encounter Bay.

In its characters approaching to C. æmulum; in its habit to C. calymegum.

VINIFERÆ.

5. *Cissus Australasica.*

Leaves palmate, quinquefoliate; leaflets coriaceous, stalked, smooth, ovate-lanceolate, acuminate, towards the top remotely serrate or entire, below glaucous; the paniculate cymes or the tendrils shorter than the opposite leaf or equally long; flowers four-parted.

On the wooded banks of the Broadribb River.

This second Australian species, which forms a high climber, appears to agree best with Cissus diversifolia of Candolle, (not Walpers.)

SAPINDACEÆ.

6. *Dodonaea procumbens.*

Branches prostrate; twigs hardly angulated; leaves somewhat scabrous, flat, cuneate, grossly three-toothed at the top; pedicels at the summit of the twigs solitary or rarely two or three together, shorter than the leaves, as well as the calyx hirtellous; flowers dioecious, pentamerous, with a long style; capsule with three broad rounded wings.

In subsaline flats and peaty places at the foot of Mount Sturgeon and Mount Abrupt.

This Dodonaea is with facility recognised by its procumbent growth, and the extremely long style which generally measures one inch.

7. *Dodonaea deflexa.*

Upright, somewhat scabrous, viscose; twigs angulated, patent; leaves coriaceous, nearly round or ovate, repand and undulate at the margin, and sometimes remotely toothed, truncate or rounded at the top; flowers dioecious, axillary, solitary or geminate; pedicels deflexed, shorter than the leaves; sepals ovate, nearly round; capsule truncate, with four or five wings, which are expanded upwards.

In the desert scrub along the Murray River and Spencer's Gulf.

8. *Dodonæa bursarifolia.*

Smooth, not viscous; twigs indistinctly angulated; leaves coriaceous, nearly opaque, flat, obovate, cuneate, blunt, rarely apiculate or emarginate, always entire; flowers dioecious, axillary, and terminal, solitary, or two and three together; sepals, oblong-linear; anthers whitish; capsule three or four sided, with extremely narrow wings; seeds shining black.

In the barren scrub-country on the Murray and St. Vincent Gulf.

This species agrees in many points with Dod. trigona and Dod. aptera.

ZYGOPHYLLEÆ.

9. *Tribulus acanthococcus.*

Prostrate; leaves longer than the peduncules, with generally five or six pairs of leaflets, which are oblique, ovate-lanceolate, approximate and in size almost equal to each other, subsessile, beneath appressed hairy; flowers decandrous; petals obovate, exceeding somewhat in length the narrow-oblong sepals; anthers ovate; rays of the stigma reflexed, half as long as the thick style; fruit depressed, consisting of 5 puberlous, triseeded carpels, which are in the middle bispinose, on the back crested and hairy, at the commissure lacunose, and are destitute of a wing.

On the sandy, loamy, arid plains along the Murray and Murrumbidgee, towards their junction.

Only one Australian species has been previously described from this genus, T. Hytrix, R. Br. in Sturt's exp. into Centr. Aust., II, app. p. 69 (T. lanatus, Walp. annal. II, 243,) for the discovery of which we are indebted to the enterprising Captain Sturt.

DIOSMEÆ.

Asterolasia.

A new genus of Diosmeae. Flowers hermaphrodite, solitary sessile. Sepals 5, petaloid. Petals 5, membraneous, diminute or wanting. Stamens 10, hardly exceeding the length of the calyx. Filaments alternately shorter. Anthers erect, inappendiculate, fixed at the base, bilocular, cells bursting longitudinally. Style simple. Stigma deeply five-cleft, with filiform or clavate lobes. Germina five, concrete, with two gemmulæ, affixed to the central angle. Carpels five, tomentose, one-seeded. Seeds, strophiolate. Australian shrubs, resembling Phebalium species, covered with stellate hair, in allusion to which the generic name has been formed.

This splendid genus is exactly intermediate between Chorilæna and Gelcznowia. It differs from the former in its inflorescence, smooth filaments, basifixed anthers, and smallness or absence of petals. Through the last character it approaches to Geleznowia; but the stigma of the latter is undivided orbicular; and this character is supported by a habitus extremely alienate.

Two species have been hitherto discovered.

10. *Asterolasia phebalioides.*

Branched; leaves sessile, oblong or obcordate-cuneate, retuse, on both sides tomentose, with flat margins; sepals golden-yellow, excelling twice or three times the length of the carpidia; petals wanting; lobes of the stigma filiform, only a little shorter than the hairy style; seeds opaque.

On the stony declivities of the Grampians, the Serra and Victoria Ranges, particularly frequent on Mount Sturgeon and Mount Abrupt.

11. *Asterolasia trymalioides.*

Much branched; leaves coriaceous, ovate, on short petioles, above glabrescent, beneath tomentose, with revolute margins; sepals of equal length with the carpidia, twice or three times longer than the petals; lobes of the stigma clavate, much shorter than the smooth style; seeds shining.

On the rocky summit of the Cobboras mountains in the Australian Alps, at an elevation of more than 6,000 feet above the level of the sea.

Here at so apt an opportunity, I adjoin the diagnosis of a second and very remarkable species of Chorilæna, occurring in the interior of New South Wales.

12. *Chorilæna angustifolia.*

Leaves as well as the branches covered with stellate hair, approximate, oblong-linear, blunt, on short petioles, with revolute margins, at length glabrescent, scabrous; corymbs capitate terminal; bracteoles linear-filiform; sepals broad-linear, half as long as the corolla, externally somewhat hairy, connate at the base; filaments smooth, surpassing in length the narrow-lanceolate petals; style smooth; stigma punctiform; germina five distinct, narrow, perberulous.

13. *Eriostemon hillebrandii.*

Diffuse or upright; leaves oblong, ovate or heart-shaped, truncate or short bilobed at the top, with recurved serrate or entire margin, on both sides smooth or somewhat scabrous on the surface; corymbs terminal; sepals minute, deltoideo-ovate; filaments of subequal length with the petals, as well as the style smooth; anthers inappendiculate; carpels obliquely ovate rostellate; seeds even and somewhat shining.

A, *brevifolius,* diffuse, leaves ovate or cordate, 2-4‴ long, imperfectly toothed or with entire margin.

On the rocky banks of rivulets in the Victoria Ranges.

B, *longifolius,* strictly upright, leaves oblong serrate, upwards of an inch long.

On the rocky summit of Mount William, 5,000 feet above the level of the sea.

This highly ornamental plant forms a connecting link between Phebalium and Eriostemon, and has been described by Dr. Lindley as a species of the former genus (under the name of Phebalium bilobum) in Sir T. Mitchell's third expedition vol. II, p., 178.

It might be almost considered as a genus distinct of both; and South Australian specimens have been under these considerations distributed with the name of Hillebrandia Australasica.

14. *Crowea exalata.*

Much branched, upright or diffuse; twigs indistinctly angulate, wingless, puberlous; leaves alternate or fasciculate, broad-linear, gradually towards the basis narrower, blunt, minutely apiculate, with recurved margins; pedicels of sub-equal length with the calyx, solitary; petals rose-red.

On the rocky tops of Mount M'Farlane, about 5000 feet above the sea; on the gravelly banks of the Mitta Mitta and Livingstone River towards Lake Omeo, and on the Boggy Creek in Gipps' Land.

Easily to be distinguished from Crowea saligna, by thicker much smaller leaves, which are not gradually narrowed at the top, by wingless twigs and smaller flowers.

15. *Boronia coerulescens.*

Suffruticose; stems upright, branched, terete; leaves thick, sessile, oblong-linear, obtuse, channelled, beneath glandulose-tuberculate; pedicels axillary and terminal, solitary, thickened at the apex, sub-equal in length to the leaves; flowers octandrous; sepals oblong or lanceolate, of less than half the length of the bluish petals; filaments ciliate; seeds reticulate-venose.

A, *glabrescens*: branches, leaves and pedicels smoothish, scabrous; flowers smaller, with acute lanceolate sepals.

In barren places from the Mallee scrub on the Murray River to Spencer's Gulf.

B, *pubescens*: branches, leaves and pedicels short-pubescent; flowers larger; sepals oblong, obtuse.

On rocky hills in the Grampians, and in the desert towards Guichen Bay.

16. *Boronia veronicea.*

(Zieria veronicea Ferd. Mueller, Coll.)

Covered with a velvet-like indument; leaves approximate,

simple, ovate or subcordate, blunt, sessile, with revolute margin; flowers tetrandrous, axillary, solitary, on short pedicels, forming at the end of the branches a foliate raceme; sepals acute lanceolate, half as long as the corolla; filaments hispidulous; carpels elliptico-oblong, compressed, pubescent.

On sandy places about Encounter Bay and in Kangaroo Island.

By this interesting species the genus Zieria becomes united with Boronia, to which I am also inclined to refer Cyanothamnus.

17. *Boronia clavellifolia.*

Fruticose, diffuse, much branched, smooth; branches tuberculate; leaflets small, ternate, short-stalked, sub-clavate, terete, blunt; flowers axillary and terminal, solitary, geminate or ternate, octandrous; pedicels shorter than the flower; sepals ovate-triangular, ciliolate, less than half as long as the corolla; filaments smooth, glandulose.

On sandy, loamy plains in the scrub near Lake Lalbert and towards the mouth of the Murray River.

MALVACEAE.

18. *Sida intricata.*

Fruticulose, upright or diffuse, much branched; leaves small, ovat-roundish, truncate at the top, toothed, but entire at the cuneate base, above scantily, beneath densely covered with grey stellate hair, petioles much shorter than the leaves, surpassing in length often the subulate-setaceous stipules, peduncles axillary, solitary, drooping, shorter than the leaves; segments of the calyx subdeltoid; carpels five, a little depressed, on the back almost even and puberulous, at the commissura netted; seeds brown, puberulous.

In sandy, loamy plains between Mount Hope and the Murray, also towards the Darling River.

It bears some affinity to Sida corrugata, but its growth is upright intricate, it is much more robust, the flowers and leaves and capsules are much smaller, the latter not rough.

19. *Sida humillima.*

Suffruticose, procumbent; leaves thin, ovate-oblong, obtuse, cordate or rounded at the base, unequally and deeply crenate, above scantily, beneath densely covered with a stellate somewhat shining indument; petioles hardly of the length of the leaves, but longer than the subulate-linear stipules; peduncles axillary, solitary or two or three together, filiform, towards the middle articulated, sub-equal to the length of the petiole;

segments of the calyx subdeltoid, acute; carpels eight-ten, depressed, rough, smooth, at the commissura asperous; seeds brown, smooth.

In dry plains on the Avoca and Murray.

In South Australia, on St. Vincent Gulf and the Kapunda.

Not dissimilar to Sida corrugata.

20. *Abutilon Behrianum.*

Stem herbaceous, upright, hardly branched, as well as the leaves covered with a velvetlike toment; leaves cordate, acuminate, repand or slightly crenate, about as long as the petiol; stipules linear-subulate deciduous; peduncles axillary, solitary, one-flowered or terminal with several flowers, above the middle articulated, often shorter than the petiol; segments of the calyx ovat-lanceolate, acute; carpels 9–12, tomentose-pubescent, compressed, oblique-ovate, aristate, with 2–4 black somewhat scabrous seeds.

In lagoons which become dry, and on the margins of lakes on the Murray, Loddon, Darling, and Murrumbidgee.

21. *Abutilon otocarpum.*

Fruticose, upright, all over grey-velutinous; leaves cordate-orbiculate, blunt, inequally crenate, of nearly equal length with the petiol; stipules linear-subulate, deciduous; peduncles axillary, solitary, one-flowered, towards the top articulate, but little surpassing the length of the petioles; segments of the calyx inflated, cymbiform, long acuminate; carpels numerous, shorter than the calyx, very compressed, earshaped, nearly membranaceous, velutino-pubescent, with one to three black glabrous rough seeds.

Very rare on Sandhills on the Murray towards the junction of the Darling.

This Abutilon stands in some relation to Ab. halophilum (Ferd. Mueller in Linnæa xxv., p. 381) from Spencer's Gulf.

Scleranthea.

23. *Mniarum singuliflorum.*

(Scleranthus mniaroides Ferd. Mueller collect.)

Stems caespitose, somewhat flaccid; leaves upright or little patent, as well as the branches smooth, lævigate; peduncles one-flowered, at the top bibracteate; calyx turgid, 5-cleft.

On bare rocks at the summit of the Cobboras mountains, 6000 feet above the level of the sea. Easily to be distinguished by the above notes from Mniarum biflorum (M.

fasciculatum R.Br., Scleranthus Mniarum Ferd. Mueller), the only known species, and like this varying in the length of the peduncles. By the constantly 5-cleft calyx of this kind Mniarum becomes so closely allied to Scleranthus, that hardly any objection can be raised against the conjunction of the two genera.

Portulaceae.

22. *Mollugo Novo-Hollandica.*

Stems numerous, prostrate, dichotomous; leaves pseudo-verticillate, unequal, spathulate-lanceolate, at the top indistinctly serrulate, finally glabrescent, young ones together with the branches wooly-pubescent; flowers triandrous, pseudo-verticillate; sepals blunt, a little longer than the ovate capsule, and about equal in length to the pedicel; seeds reniform-ovate, shining brown, densely seriato-granulate.

On the sandy sometimes inundated banks of the Murray.

This presents the first Australian species of this genus, and must be systematically placed next to Moll. hirta from the Cape of Good Hope.

Euphorbiaceæ.

24. *Phyllanthus trachyspermus.*

Annual, smooth, glaucous; stem upright, branched; branches angular; leaves imbricate, deciduous, oblong, obtuse, on very short petiols; pedicels solitary, very short; sepals lanceolate-acute, much shorter than the capsule, with broad membranaceous margin; stigmata very small; capsula subglobose, smooth, drawn out into an umbonate apex; seeds large, livid, acut, triangular, at the internal angul deeply excavate, on the sides and back rugosely asperate.

On places subject to inundations at the junction of the rivers Darling and Murray.

25. *Phyllanthus lacunarius.*

Annual, smooth, glaucous; stem upright, branched; branches angular; leaves imbricate, deciduous, obovate- or cuneate-oblong, obtuse, on short petiols; flowers monoecious, axillar, solitary, on short pedicels; sepals minute, subovate, obtuse, with broad membranaceous margin; stigmata very short; capsule depressed, trigastrous; seeds trigonal, blackish, with longitudinal streaks.

On the margins of lagoons which become dry during summer, at the junction of the Murray and Darling rivers.

26. *Phyllanthus Fuernrohrii.*

Frutieulose, upright, branched, with a grey velvet-like indument; branehes nearly terete; leaves imbrieate, deeiduous, spathulate-obovate, on very short petiols, apieulate; pedieels axillar, subsolitary, half the length of the leaves; sepals laneeolate-ovate, aeutish, with membranaeeous margin, outside as well as the depressed capsule hairy seabrous; seeds brown, lævigate.

On gravelly sandhills near the Murray, rare.

This speeies reeeived its name in grateful aeknowledgment of mueh kindness, whieh the author experienced from Professor Fuernrohr, in Ratisbon.

27. *Trachycaryon Klotzschii.*

Leaves opposite, very short stalked, ovate-laneeolate, aeute, irregularly erenately toothed, serrate or repand, above smooth or imperfeetly puberulous, beneath grey-velutinous, at the base of the petiole on both sides furnished with one or two small stipitate glands; femal flowers apetalous; sepals ovate, subacuminate; styles free, hardly to the middle bifid; eapsuls verrueulose, ovate-globose, slightly impressed at the suturas; seeds grey, ovate, shining.

On sandhills near Corner Inlet, and in various loealities in South Australia.

28. *Trachycaryon Cunninghami.*

Leaves alternate, in eireumferenee laneeolate-ovate or heartshaped, short-or deep-trifid, smooth or below tomentose, irregularly and coursely serrate, at the base truncate or rounded, with aeute lobes and teeths, on the base of the petiole furnished on both sides with one or two large stipitate glands; femal flowers apetalous; sepals laneeolate, aeuminate; styles free, deeply bifid; eapsuls subglobose, not furrowed at the suturas; seeds spotted.

A, TOMENTOSUM;

Leaves short-stalked, below as well as the twigs and eapsuls tomentose; braets and sepals eiliate.

B, GLABRUM;

Leaves long-stalked, as well as the eapsuls sepals and braets smooth.

Between granite-roeks and on the sandy banks of the Snowy River.

To variety A belongs probably Adriana aeerifolia of Allan Cunningham, and to B, A. heterophylla of Sir William Hooker.

29. *Trachycaryon Hookeri.*

Leaves alternate, long-petiolate, lanceolate-oblong, gradually narrowed into the base, acute or obtuse, smooth or grey velutinous, irregularly crenate-toothed or bluntly lobed, at the base of the petiole on both sides beset with a small gland; femal flowers apetalous; sepals ovate-lanceolate, acut; styles at the base connate, deeply bifid; capsule trigastrous, glabrescent.

A, velutinum;

Leaves above thinly, below together with twigs and flowers thicker velutinous.

B, glabriusculum;

Leaves on both sides smooth, twigs and flowers glabrescent.

On sandridges along the Murray, towards the junction of the Darling and the Murrumbidgee.

30. *Beyeria opaca.*

Smooth; twigs compressed, yellowish-green; leaves narrowly or linear-oblong, rounded-blunt, gradually narrowed into the base, hardly viscous or shining, with flat or slightly recurved margins, above light-beneath pale-green; pedicels of subequal length with the calyx; capsuls ovate-globose, hardly furrowed at the suturas; seeds shining, variegated, with a thick caruncula.

In the Mallee scrub, between Lake Lalbert, Lake Tyrrell, and the Murray River.

MYRTACEÆ.

31. *Lhotzkya genethylloides.*

Flowers terminal, nearly capitate; leaves crowded, exstipulate, spreading, petiolate, without stipules, tetragonal, at length above flattening, subobtuse, as well as the twigs and the tube of the calyx hirtellous; bracteols shorter than the pentagonal tube of the calyx, connate to the middle and apiculate by the excurring carina.

In rocky arid declivities of the Grampians, the Serra, and Victoria ranges.

B, glabra;

Dwarf, leaves almost smooth.

On the subalpine summit of Mount William.

I do not hesitate to refer to this species Genethyllis alpestris, of Lindley, (in Mitchell, Three Expeditions, vol. ii. p. 178,) described from specimens, collected by Sir Thomas Mitchell on Mount William. These specimens, transmitted to Professor

Lindley, were probably not well developed, being gathered in the month of June. Examining the plant last year in the month of November, I became convinced that it belongs to the genus Lhotzkya. I have neither retained the specific name alpestris, as the plant occurs most abundantly on the lower parts of those mountains, and in localities much exposed to the hot north-westerly winds.

Cucurbitaceæ.

32. *Cucurbita micrantha.*

Stems prostrate, angulose, simple, as well as the petioles strigosely asperous; leaves subcordate, with 5 short blunt dentato-sinuate or incised lobes, on both sides hirtello-asperous, on the margin and beneath along the nerves densely strigulose; tendrils short undivided; peduncles axillar, filiform, fasciculate, much shorter than the petiole, with the calyx pubescent; flowers monoecious; berries globose, even, smooth, manyseeded.

On the sandy-loamy banks of the Murray, sometimes washed by the floods.

The fruit might, on account of its intense bitterness, perhaps be substituted for colocynth.

Gentianeæ.

33. *Limnanthemum crenatum.*

Leaves cordate-orbiculate, crenate, obsoletely palmatinerved, above even, beneath densely glandulose; segments of the calyx narrow-lanceolate, less than half as long as the corolla, exceeding but little the length of the capsule; segments of the yellow corolla on the margin and orifice fimbriate, inside longitudinally broad-cristate; style thick, abbreviate; stigma with five lacerate wings; hypogynous glands fimbriate; capsule polyspermous; seeds ovate, laevigate, hardly keeled.

In tranquil bends of the Murray river, Murrumbidgee, and Mitta Mitta, and in the nearest lakes and lagoons.

A most handsome, and, with regard to its crenate leaves and the structure of the stigma, equally singular species.

Goodeniaceæ.

Velleya, R. Brown.

Sect. Aceratia.

Calyx five-parted. Corolla violaceous, hardly gibbose, with wingless underlip and half-winged upperlip.

34. *Velleya connata.*

High, glaucous, smooth; stem upright, dichotomous, with bearded axils; leaves all radical, elongate-lanceolate, onenerved, entire, contracted in a petiole of equal length; bracts very large, almost deltoid, acute, half concrete, entire; segments of the calyx lanceolate and ovate, acuminate; style villose; seeds densely punctate, surrounded by a broad wing.

On scrubby sandhills towards the junction of the Murray and Murrumbidgee.

This highly curious plant also possesses the tonic bitterness which I discovered in numerous species of Goodeniaceæ.

Solanaceæ.

35. *Solanum lacunarium.*

Armed all over with setaceous-subulate straight prickles; stem dwarf, suffruticose, branched; leaves petiolate, in circumference oblong-ovate, sinuate-pinnatifid, above conspersed with stellate hair, at length calvescent; beneath as well as the branches covered with a thin grey toment; lobes of the leaves oblong, rounded-blunt, with entire margin; peduncles terminal, 2–6-flowered, aculeate; segments of the calyx acutish, deltoid-lanceolate; anthers yellow.

In lagoons which are dry during the summer season near the junction of the river Darling and Murray.

It differs from Solanum cinereum (R. Br. prodr. i., 446), the only one to which it bears similarity, in its blunt entire leaf-lobes, which are together with flowers and berries considerably smaller, by almost constantly armed peduncles and and pedicels, and by hardly cuspidate segments of the calyx.

36. *Solanum pulchellum.*

Unarmed; stems procumbent, suffruticose; leaves on somewhat long petiols, ovate-or narrow-oblong, blunt, repand, entire, above pale green, laxely tomentellous, below clothed with a shineless, thin, grey toment; peduncles 2-5-flowered, generally surpassing the length of the petiole; calyx half as long as the corolla, carinulate, with triangular acuminate segments; anthers yellow, slightly attenuat, surpassed in length by the style.

Along the Wimmera, Avoca and Murray rivers; thence through the desert-country as far as Lake Torrens, Spencer's and St. Vincent gulfs.

Allied to Solanum dianthophorum (Dunal Sol. 183) and to an undescribed species discovered in Central Australia by Capt. Sturt, of which I subjoin the definition :

37. *Solanum Sturtianum.*

Stem upright, fruticose, scantily armed with short acicular prickles ; leaves on somewhat long petioles, lanceolate-oblong, blunt, entire, unarmed, above glabrescent, beneath cloathed with a very thin toment ; peduncles 3-5-flowered, generally surpassing the length of the petiole ; calyx much shorter than the corolla, with triangular, acute teeths ; anthers yellow, attenuate.

Another species brought from the interior of this island-continent by the same intrepid traveller, might be characterized as follows,—

38. *Solanum oligacanthum.*

Stem upright, fruticose ; branches beset with distantly scattered setaceo-subulate prickles ; leaves small, cordate, obtuse, entire, on both sides as well as the branches covered with a very thin grey toment, hardly armed, short-stalked ; pedundes 2-or many-flowered, short ; calyx half as long as the corolla, with deltoid acute segments ; anthers yellow, excelled in length by the style.

This species approaches to Solanum orbiculare (Dunal syn. 27), from which it differs chiefly in its not shining toment, and its exact heartshaped somewhat larger leaves.

To complete my additions to the elaborate description of more than 900 Solanum species, published by Prof. Dunal in the 13 vol. of Candolle's prodromus, I beg to add yet the diagnosis of an unknown South Australian species, having also given since an account of three others in Prof. Schlechtendal's Linnaea (vol. xxv. p. 432-434).

39. *Solanum simile.*

Unarmed, smooth ; stem upright, suffruticose ; leaves narrow-lanceolate, elongate, entire or lobed at the base, thin-venose ; corymbs lateral, few-flowered, simple or divided ; segments of the half five-parted calyx rounded, apiculate ; berries globose, nodding.

On less fertile plains on the Murray and Angas river, on Spencer's and St. Vincent gulfs, and in Kangaroo Island.

It is distinct from Solanum laciniatum in its constantly

low stem, smallness of all parts, its never pinnatifid leaves, its shorter nodding pedicels, and smaller always spherical berries.

I conclude these contributions towards the Australian Solaneae with the remark, that this order received by the first and ever memorable expedition of the unfortunate Dr. Leichhardt the addition of the genus Datura (in Datura Leichhardtii), and by the researches of Dr. Behr the additional genus Lycium (in L. Australe), both unnoticed not only in the golden prodromus of R. Brown, but also in Dunal's monographia published in 1852.

Loganiaceae.

40. *Mitrasacme distylis.*

(Sect. Lysigyne.)

Annual, minute, glabrous; stem upright, simple or a little branched, smooth; leaves oblong-linear, somewhat carnulent; pedicels axillar and terminal, setaceous, solitary, rarely two or three together, at least twice as long as the leaves; calyx bellshaped, very short bilobed, not excelled in length by the corolla; styles separated; capsule inclosed; seeds net-veined.

Around swamps near Mount William. In stature resembling Mitrasacme paradoxa, but from this as well as all the other species widely different in its disjoint styles.

Borragineae.

41. *Heliotropium lacunarium.*

Stems herbaceous, upright or procumbent, appressed-hairy; leaves somewhat long petiolate, oblong-or lanceolate-ovate, nearly blunt, entire, not rugose, on both sides scabrous, beneath along the margin and nerve pilose; spikes ternate geminate or solitary ebracteate; segments of the calyx subequal to each other, of the length of the corolla-tube; caryopsides subovate, rugose, glabrous.

Around the lagoons, and in low localities on the Murray.

Scrophularinae.

42. *Anthocercis myosotidea.*

All over hirtellous from short gland-bearing hairs; leaves small, sessile, ovate, blunt, broader towards the base, unequally revolute; pedicels shorter than the hirtellous calyx;

segments of the calyx semiovate, blunt, twice shorter than the tube; corolla half exserted, with short blunt lobes.

In gravelly sandridges on the Murray, but only rare.

A species next to A. scabrella, but well marked by the short blunt corolla.

43. *Anthocercis angustifolia.*

All over glandulously pubescent; leaves linear, flat, entire; pecidels of equal length to the calyx; segments of the calyx linear, acutish; laciniae of the large corolla lanceolate-linear, acuminate, nearly twice as long as the tube.

In stony glens near Mount Lofty in South Australia, not frequent.

Proteaceae.

44. *Grevillea dimorpha.*

(Sect. Calothyrsus.)

Diffuse; branches angulate; leaves coriaceous, undivided, long-lanceolate or linear, acute, callously mucronate, almost sessile, trinerved, above smooth, on the recurved margins and the lateral nerves somewhat scabrous, beneath grey-silky; racems fascicular on very short peduncles; calyx almost three times longer than the pedicels, outside rutilous-silky, inside at the middle white bearded; style long exserted, together with the germen and its stipes perfectly smooth; stigma lateral, ovate, centrally umbonate.

a, latifolia,
leaves ovate-or narrow-lanceolate, 2-4'' long, 4-8''' broad, rarely broader.

b, angustifolia,
leaves elongate-linear, 2-4'' rarely 6'' long, 1-1½''' broad.

In the Grampians, Serra and Victoria ranges on barren rocky places.

This splendid species bears much affinity to Grevillea Victoriae; it is however readily distinguished by its thicker subsessile generally narrower leaves with a distinct marginal scabrous nerve, by its short racemes on an abbreviate peduncle with rusty brown rhachis, by its smaller flowers inside nearly up to the limbus barbate, and finally by smaller folliculs tapering into a longer stipes.

It flowers in the spring, not as Grevillea Victoriae in the autumn.

45. *Grevillea confertifolia.*

(Sect. Lissostylis.)

Diffuse; twigs pubescent; leaves crowded, linear-subulate, even, short-mucronate, above smooth, beneath with the innovations silky; margin refract to the on both sides prominent middle-nerve; fascicules of flowers sessile, terminal, concealed by the leaves; calyx outsides and its pedicel grey silky, inside at the middle densely bearded; pistil hardly half an inch long, smooth, exserted; germen stipitate; stigma ovate, oblique-terminal, with central papilla.

On the subalpine summit of Mount William, and on rocky ridges towards Mount Zero.

This species resembles Grevillea juniperina and G. riparia (R. Br. prodr. 377.)

46. *Grevillea lobata.*

(Sect. Eugrevillea.)

High, upright, many branched; twigs spreading, angular, covered with a very thin whitish indument; leaves in circumference ovate, deeply laciniate, venose, with hardly recurved margin, contracted by a wedge-shaped basis into the stalk, above pale-green, glabrescent, beneath tomentose as the branches; segments two or three on both sides, distant, lanceolate, mucronate, entire, rarely teeth-bearing; racemes dense, ovate, many-flowered, at length drooping; calyx outside as well as pedicels and rhachis grey from an appressed indument, inside smooth; style long exserted, with exception of the basis smooth; hypogyne gland very short; stigma oblique-lateral, broad-ovate, centrally umbonate; germen and its stipes white-tomentellous.

In the desert along the Murray river, from Swan Hill away to the westward.

Nearest to Grevillea ilicifolia (R. Br. suppl. p. 21), but much higher, upright, tomentum white shineless not silky, leaves deeper divided with distant segments, and flowers more numerous.

47. *Grevillea pterosperma.*

(Sect. Cycloptera.)

Upright; branches strict, holosericeous; leaves glaucous, somewhat rigid, narrow-linear elongate, undivided or bi-trifid, glabrescent, ending in a sphacelate mucrone, above

convex and manifestly striated; margin refract to the beneath very prominent middle nerve; racemes alternately crowded at the end of the branches, elongate, dense-flowered, calyx outside with pedicels and rhachis grey-pubescent, inside together with the style smooth; germen stipitate, tomentose; stigma ovate, oblique-terminal centrally umbonate; folliculi globose-ovate, turgid, hardening, with a short stipes, grey tomentellous; seeds flat, ovate, even, all-around winged with a thin membrane.

In the Mallee scrub on sandhills towards the junction of the Murray and Murrumbidgee.

Allied to several tropical species, particularly to G. angustata (R. Br. suppl. p. 24).

Polygoneae.

48. *Polygonum diclinum.*

(Sect. Avicularia.)

Suffruticose, glaucous, perfectly smooth; stems upright, many branched; leaves linear, at both ends narrowed; stipules short, binerved, entire, smooth, laxely clasping; fascicles axillary, few-flowered; flowers dioecious, octandrous and trigynous, greenish, imbricate-bracteolate, cernuous; pedicels shorter than the 5-parted glandless calyx; caryopsis subglobular-trigone, shining black, hardly rugulose.

On shifting sandhills at the junction of the Murray and Murrumbidgee, and rarely at the Mitta Mitta.

Santalaceae.

49. *Choretrum chrysanthum.*

Branches terete; twigs angular, not pungent; leaves almost persistent, lanceolate-subulate, at length somewhat deltoid; glomeruls yellow, 2-5-flowered, on the top of lateral very short twigs; bracteols 3 subovate or roundish, ciliolate.

On low scrubby ridges along the Avoca and Murray river.

Not dissimilar to Choretrum glomeratum, from which as well as the few other already known species it is easily distinguished by its golden flowers.

Eriocauloneae.

Electrosperma.

A new genus of Eriocauloneae. Flowers in androgynous heads, all furnished with a bracteola. Receptacle conical,

as well as the bracteolae smooth. Male flowers central pedicellate. Sepals smooth, the three externals coherent at the base; the three internals concert in a long tube, the free lobes bearing a gland. Stamens six inserted to the limbus. Anthers bilocular, introrse. Female flowers marginal on short pedicels, destitute of a calyx. Style one, short, with three filiform stigmata. Capsule smooth, tricoccous, loculicide dehiscent. Seeds in the cells solitary, smooth, not costulate, of the structure of Eriocaulon.

This genus is chiefly characterised by the want of the floral envelope in the female flowers, but agrees otherwise in habit and structure with Eriocaulon. The name is derived from the colour and shining transparency of the seeds, not unlike that of amber.

50. *Electrosperma Australasicum.*

On wet places along the Murray, towards the junction of the Murrumbidgee.

A small annual scapebearing herb. Leaves grass-like, fenestrate-nerved, pellucid. Scape monocephalous, vaginat at the base.

Art. III.—*On the Comparative Value and Durability of the Building Materials in use in Melbourne. By Robert Brough Smyth.*

The selection of building materials has always been a work of difficulty, as indeed is every branch of knowledge, where the experience of a single individual is substituted for those simple principles which arise naturally from an accumulation of facts, —not the records of one life time, but of many,—not of one department of science, but of all. The mistakes that have been made from time to time, as evidenced in the decay of some of the finest architectural works in Europe, have drawn considerable attention to the subject of late years; and that such mistakes may, in a great measure, be provided against, if not wholly prevented, we have the evidence of the Scientific Commission appointed to examine the stone to be used in the New Houses of Parliament, and of the Corps of Royal Engineers, whose sound and practical observations, founded on actual experiments, are worthy of the highest consideration.

It not only has immediate reference to the conservation of those edifices wherein the genius of the architect is para-

mount, but is so connected with our wants and necessities, of a common kind, that we cannot but injuriously sacrifice it to considerations of cost, time, and convenience.

As this paper will treat more particularly of the building materials used in Melbourne, it is necessary to remark that the geological character of the district is similar to that from whence are derived some of the best building stones in Great Britain. The prevailing formation is inclined sandstone and clay slate, changing so much in its lithological character that, had we not clear and satisfactory evidence of its antiquity, it might sometimes be mistaken for a recent deposit. We find in it every variety of sandstone, from a coarse grit to that of a fine, close-grained structure, which last passes into a claystone, containing very few quartz grains, and a little white mica.

Overlying this, and extending through a considerable area, is the Basalt, or "Bluestone," which is well adapted to structural purposes, and generally obtains where durability is desired. This rock is recognised by geologists as a volcanic product, and may be considered second only to the Plutonic rocks, in its wide distribution and economic importance.

Basalt.

The specimens that I have examined differ very little in their composition as far as it effects their durability; though the proportions of their chemical constituents are variable. It is composed of angite, felspar, iron, and lime, with occasional crystals of olivine; and the contact of these minerals is close and perfect. The most common colour is greyish blue. The fracture is uneven. An analysis shews its component parts to be—*

Silex	50
Alumina	22
Carbonate of Lime ...	10
Magnesia	4
Iron	10
Loss	4

It sometimes contains traces of other metals, but this analysis gives its most important constituents. The average weight of a cubic foot is 165 lbs., the maximum being 167 lbs., and

* The figures in this analysis must be considered only as approximate; my appliances not being of a kind to ensure rigid accuracy.

the minimum 164 lbs. It does not absorb so much water as might be supposed from its structure. After immersing an average specimen for 96 hours its increment in weight was 1·751 per cent.; and a mean of various experiments made on stones procured from the neighbouring quarries approach very nearly to this result. Were it not that this stone was exceedingly costly, both in obtaining it from the quarry, and in all its subsequent stages, it would be used in this Colony in preference even to granite.

In addition to its value as a building stone, it is quarried for road metal and kerbstones, for which it is peculiarly adapted, and that is perhaps the best proof of its durability.

The styles of architecture adopted in Melbourne, where Basalt is used, are not generally favorable to its appearance; where it has received some degree of finish it is extremely handsome, and it is to be regretted that it has not been chosen for our public buildings.

Basalt may be advantageously employed in the composition of mortar. When it is calcined and reduced to powder, it imparts to the cement the property of hardening under water.

Sandstone.

The Sandstones which I have examined are by no means favorable specimens of the formation which they represent. In general they have been procured at or very near the surface, and from the quality and properties of such specimens very erroneous opinions have been formed of their nature.

In the older formations, and here I would allude to an age antecedent to the Carboniferous era, it must be remembered that the surface of the strata has been exposed for countless ages to incessant changes; and the alterations which it has undergone will extend to various depths in exact proportion to the structure of the rock.

The term "metamorphic," as used by geologists, is applied to rocks which have been altered by the effect of heat. Little attention has been paid to changes which take place by infiltration, by the decomposing effects of air and water, and other causes, requiring lengthened periods of time for their completion.

Inclined strata, of a schistose structure, are more liable to such alteration than the comparatively undisturbed deposit of a coal basin; and though I am far from attributing the perishable nature of the Melbourne Sandstones wholly to

these causes, they undoubtedly have exercised an influence more powerful than we are at first inclined to admit.

The Sandstone procured from Irrewarra, in the parish of Boroondara, singularly contrasts with other beds in the immediate vicinity. Though, as will be shewn, it is neither so durable nor so valuable in other respects as the Geelong Sandstones, it is a proof that the changing character of the beds needs only to be noted and followed to lead to other deposits of a better description.

The block which has been handed to me for examination is composed of course quartz grains, much water worn, agglutinated by an argillaceous and siliceous cement. Its shades vary from pale cream color to nearly pure white, and it is irregularly traversed by red and brown ferruginous streaks and spots. It yields readily to the hammer in the direction of its cleavage, as is usual with stones of this class. The average weight is 155 lbs. per cubic foot. Its capacity of absorption is so great that that alone is a sufficient reason for its rejection as a material for large buildings. After immersing a portion of the block, weighing 55·85 ozs. for 72 hours it absorbed 3·043 per cent. by weight, and another experiment on a smaller piece gave 3·217 per cent. By simple immersion, allowing it to remain till air bubbles had ceased to escape, the results were as follow:—

Experiment,	No. 1,	2·542	per cent.
„	2,	2·320	„
„	3,	2·194	„

Thus, it not only absorbs a large amount of water, but what speaks more strongly in its disfavor, such absorption is carried on very rapidly.

This stone has been subjected to a variety of tests, some of which it is necessary to particularize. A small specimen of the average quality was immersed in a solution of a carbonate till it had absorbed the maximum quantity; it was then placed in a weak solution of acid: this gave rise to brisk effervescence, and frequent repetitions of this resulted in the destruction of the surface of the stone. This test I have found valuable in practice: it is needless to state that it can only be used when the cement is not of a calcareous nature.

Another series of tests were instituted by immersing the stone in solutions of various salts, and then suspending it over the vessel containing the fluid. After this process was many times repeated the salt re-crystallised in the stone; and the

mechanical force thus exerted very gradually effected the disintegration of the surface.

A good building stone would long resist such experiments, for it is manifest that if the amount of water absorbed was inconsiderable, the mere crystallisation of the salt upon the surface would produce little or no change. In estimating the durability of a building-stone it is particularly necessary to note what quantity of water it will absorb, and whether it long retains moisture. This is a matter of primary importance where the frosts are severe and of long continuance, and it ought not the less to enter into our calculations, for we have climatic variations in this country which tend almost as rapidly to disintegration.

Water requires its greatest density between the temperatures of 39° and 40° Fahrenheit, from which point both heat and cold cause expansion. Here, where we have sometimes a deluge of rain succeeded by extreme heat, it follows that the mere expansion of the fluid, rapidly exerted, must cause the destruction of an absorbent body.

If we observe the rocky bed of a river or creek where the water and the sun have alternately acted upon the stone it will be seen that the surface is, in every case, in a state of decay, sometimes to the depth of several inches. This illustration is drawn from the highly indurated Trappean rocks which abound in our neighbourhood. How much more liable are the ordinary Sandstones to such influences. We must also take into account the dew which falls very heavily throughout some months of the year. Moisture absorbed in such a state will tend to lower the temperature of the walls, and that again is as quickly raised during the day. It is the continual repetition of these influences which ultimately destroys the cohesion of bodies so constituted.

An accurate analysis of the Boroondara stone would give those constituents which are found in some of the best Sandstones, but that does not in itself afford us criteria whereby we may judge of its value. It is more dependent upon the mechanical structure, due to compression, and the unretarded progress of those chemical changes which tend to consolidate the mass.

My meaning may be better understood by examining its fracture. We do not find the particles of quartz shivered and split, but they uniformly separate from the cement, leaving perfect casts of the imbedded grains.

The freedom with which this stone may be wrought into

almost any shape, and its cheapness compared to basalt or limestone, render it suitable for cottages or other small buildings, where there is no great pressure on the walls; but all building stones of similar properties ought to be rejected in extensive erections.

The Toorak sandstone, as I am informed, is from the same formation as that of Boroondara. It is composed of very fine water worn quartz grains, and minute plates of white mica, with an argillaceous base. It is deeply tinged with iron oxide in patches and streaks; none of the specimens in my possession being of a uniform colour. The weight of a cubic foot is 145 lbs—the maximum being 147 lbs., and minimum 143 lbs. It is easily frangible. It may be wrought in large masses. It absorbs water very quickly, and to a great extent. It gains 3·952 per cent. by weight if immersed for a few minutes; and a piece that was placed on its end in water for ninety-six hours showed an increment by weight of 5·109 per cent. In comparing the sandstones, one with another, it will be observed that some very rapidly absorb their maximum quantity of water, and others very slowly. The close grained sandstone from Geelong, for instance, gains ·336 by simple immersion, but the actual amount that it will absorb, if sufficient time is allowed, may be stated at 3·831.

Subjecting the Toorak stone to the usual tests it is soon destroyed. Such of the specimens as I have met with are not suitable for building purposes, all of them possessing features similar to the above. A small piece that was placed in a vessel containing sufficient water to moisten the lower portion, was soon completely saturated, the cavities of the stone acting like so many capillary tubes. With such a stone for outer walls a house would be always damp and cold in winter; a matter of deep importance to the health and well-being of the occupants, which ought ever to enter into calculations of this kind.

A deeper section of this quarry may probably afford a less perishable material, and such a discovery would be of the greatest value at the present time.

For durability, beauty, and economy, the sandstones are undoubtedly of the first class.

The lightness, and architectural elegance of the buildings in Edinburgh, which are so famous, are due to the circumstance of the sandstones being there procurable of a superior quality. Perhaps it would be impossible to construct such edifices of any other material, which at once combines hard-

ness, strength, and impermeability, with a peculiar richness of effect.

As an example of the waste of labour and capital which sometimes results from using an untried sandstone, I may cite the case of an enterprising citizen of Melbourne, who some ten years ago built an hotel of a material quarried from the extensive formation to which the Boroondara stone belongs. Within three years after its completion the stone was found to be so far decayed that it became necessary to protect the walls with a facing of another material. This is sufficient to illustrate the practical utility of inquiries such as these.

Major-General Sir John Burgoyne, in speaking of this class of stones, has thus expressed himself:—"From the nature of the composition of sandstones, it results that their resistance against or yielding to, the decomposing effects to which they are subjected, depends to a great extent, if not wholly, upon the cementing substance by which the grains are united; these latter being comparatively indistructible. . . . . Uniformity of colour is a tolerably correct criterion of uniformity of structure, and this constitutes, other circumstances being equal, one of the practical excellencies of building stones."

Bricks.

The great expense attending the working and procuring of building-stone in this City, has led to the adoption of Bricks as a convenient and ready substitute. Very little attention has been paid to their manufacture, as a detail of the following experiments will shew.

I have procured my specimens from large buildings which are at present in course of erection, with the hope of drawing attention to a matter of such importance.

These Bricks are composed of clay which has resulted from the decomposition of clay slate and Basaltic rocks, and that again is mixed with a large per centage of siliceous earth, washed down from the more recent formations which form the capping of the adjacent hills.

The fracture is rugged and uneven, shewing the presence of embedded quartz pebbles, with occasionally pieces of unmixed talcose clay of a pure white color. They are light and porous, and readily yield in any direction to a slight blow.

The specific gravity is 2·078, and compared with other Bricks is as follows:—

Ramsay's Fire Brick, Newcastle-on-Tyne,	2·204
White Brick, Launceston, ...	2·153

They absorb water very rapidly: one specimen gaining 11·523 per cent. by weight in 20 hours, and another 13·257 per cent. When it had absorbed its maximum quantity it was easily crumbled between the fingers. A good Brick does not absorb so much water as the Melbourne Sandstones. One of Ramsay's manufacture was immersed for 20 hours and its increment was 2·841 per cent. and after 72 hours 3·216 per cent. Subjected to the ordinary tests the common red Brick very rapidly disintegrates. It may be inferred that a small amount of force would be required to crush it; and it is a matter of regret that I have no present means of ascertaining the exact weight. Such a material is certainly not suited for buildings three storeys high; and yet a considerable number of houses in this City are so constructed.

There is a very slight difference in the quality of the Melbourne Bricks. The fault is owing not so much to the material of which they are composed, as to the improper manner in which they are manufactured. They are usually burnt in clamps, and the clay is not ground and tempered as is customary in other countries. If suitable kilns were erected, and care was taken in the preparation of the raw material, it would be possible to make as good Bricks in Melbourne as any that are imported, excepting perhaps the fire bricks.

Bricks which are made of pure clay, and heated to vitrification, have been found to resist atmospheric influences most completely. Such a material is unsuitable for high walls, as its cohesive strength is not so great as when a proportion of sand is used. The best English bricks are manufactured from a clay which contains about one-fourth of sand, and if it should contract considerably in burning, the proportion of the latter is increased. Much of the fine clay around Melbourne contains lime and magnesia, but not in excess; and if it were mixed with the superficial clay at present in use, a manifest improvement would be apparent in the bricks. All materials of this manufacture are rendered more durable by glazing. This is effected by throwing a due proportion of salt into the furnace, the result of which is the vitrification of the outer crust. When the manufacture is otherwise imperfect, this system, if properly conducted, will lessen the tendency to decay, and obviate the unsightly and expensive system of painting, which is often resorted to in Melbourne. Not until we have the same spirit that animates the manufacturers in England and America will this branch of industry be fully developed. Machinery has there super-

seded the slow and tedious operations of hand moulding and smoothing, and the work of one man is now equivalent to that of six under the old style. The fashioning of bricks is not the only use to which the plastic clays are adapted. The fabrication of draining pipes and tiles employs a large capital in England, and the success which has there attended the manufacturer has been of incalculable value to the Agriculturist. It has sufficed to bring under cultivation many thousand acres of land, thereby increasing the demand for labour in all classes, and proportionably lessening the evils due to a surplus population.

The Melbourne bricks, as they are now manufactured, will be too costly when we shall have brought in the aid of machinery. With the ordinary appliances, a mill, a moulding machine, and kilns, the clay in this neighbourhood could be wrought into pipes for sewerage, flower-pots—indeed, into every article, whether of utility or ornament, for which there is such a demand; and not of an inferior quality, but quite equal to what is imported.

If time permitted I would willingly advert to the manifest dangers attending the use of ill-burnt bricks in large buildings, such as hotels, stores, &c., &c. It is not a matter entirely confined to the occupant and the proprietor. Many of these edifices abut upon our public streets and promenades, and though in all probability the greater number of them will be taken down ere many years pass away, it would be a much better state of things if done forethought preceded their erection.

In concluding this paper, I would beg reference to the accompanying Table, wherein I have stated as accurately as possible, under present circumstance, the most characteristic properties of the Melbourne Building Materials:—

TABLE OF EXPERIMENTS ON BUILDING MATERIALS.

	Mean Specific Gravity.	Maximum Capacity of Absorption per Cent.	Minimum Capacity of Absorption per Cent.	DESCRIPTION.
Granite—Geelong (?)	2·688	0·153	0·017	Composed of felspar and quartz, with a large proportion of black mica. Cohesion generally perfect. Not of good quality, as the mica rapidly exfoliates. Colour greyish-white. Some varieties of the Geelong granite are very durable.
Basalt—Melbourne	2·650	1·751	0·518	Close texture. Fracture uneven. Good quality.
Sandstone—Geelong	2·329	3·831	0·336	Coal Measures. Fine quartz grains, with mica, felspar, and these minerals decomposed. Bituminous matter and iron. Argillaceous cement. Colour greyish-brown.
Sandstone—Boroondara	2·480	3·703	2·542	Coarse quartz grains, and a little mica. Argillaceous and siliceous cement. Colour, yellowish-white with ferruginous streaks and spots.
Sandstone—Toorak	2·290	5·300	3·952	Fine quartz grains and small plates of white mica, with an argillaceous base. Colour irregular. Light and dark ferruginous brown.
Limestone—Geelong	2·622	1·670	0·493	Magnesian. Very suitable for building purposes. Colour, greyish-yellow.
Fire Brick—Newcastle-upon-Tyne	2·204	5·216	2·796	Composed of ordinary fire-clay. Vitrified. Fracture sharp and clean.
White Brick—Launceston	2·153	10·858	7·717	Composed of a fine clay with little of foreign admixture.
Red Brick—Melbourne	2·078	13·854	9·950	Composed of clay and siliceous earth. Fracture rough and uneven.

ART. IV. *Definitions of rare or hitherto undescribed Australian Plants, chiefly collected within the Boundaries of the Colony of Victoria, and examined by* DR. FERD. MUELLER. (Continued.)

CRUCIFERÆ.

1. *Cardamine laciniata.*

Perennial, erect, glabrous; leaves nearly all radical, on long petioles, lanceolate, remotely toothed or laciniate or sometimes pinnati-partite; flowers in the raceme remote; petals oblong-cuneate, hardly twice as long as the sepals; siliques as well as their pedicels spreading; style short; seeds brown, slightly wrinkled.

On moist grassy as well as on boggy places, along rivers and creeks; it often indicates a saline soil.

2. *Sisymbrium cardaminoides.*

(Sect. Arabidopsis.)

Annual, diffuse, somewhat hairy; leaves lanceolate, entire or on both sides with one or two teeth; pedicels expanded, hardly half as long as the silique; nerve of the valves thin; petals white; filaments linear-subulate; style short; stigma indistinctly bilobed.

On sandridges near the entrance of the Murray River.

3. *Capsella antipoda.*

(Sect Hutchinsia.)

Annual; stems simple or little branched, ascending, foliate; leaves all petiolate, pinnately parted or entire, glabrous; lateral lobes two or three on each side, ovate or oblong, the terminal one larger; petals white, ovate, unguiculate; calyx for some time persistent, half as long as the corolla; silicles elliptical, shorter than the pedicles, 4-12-seeded; stigma subsessile.

In the Black Forest, and on the summit of Mount Alexander. Of great affinity with Hutchinsia petræa.

4. *Lepidium ambiguum.*

(Sect. Dileptium.)

Perennial; stem upright, branched, somewhat scabrous;

upper leaves linear, entire or with a tooth at the apex and with a broad basis, sessile; flowers furnished with petals; silicles of the length of the pedicels, ovate-oblong, attenuated at the apex, with a very short emarginature, which includes the subsessile stigma.

On the Murray River in South Australia. Allied to Lepidium hyssopifolium; silicles 2 lines long.

5. *Lepidium monoplocoides.*

(Sect. Lepia.)

Perennial; stems upright or ascending, branched, scabrous from small papulæ; leaves linear, entire, slightly tapering into the base; flowers without petals; silicles orbicular, acuminate, with a broad keel, a little longer than the flat pedicel, their lobules connivent, surpassing in length the style.

In the Mallee Scrub on the Murray River, towards the junction of the Murrumbidgee.

A rare species, almost intermediate between Lepidium and Monoploca.

6. *Monoploca leptopetala.*

Fruticulose; branches numerous, scabrous; leaves semiterete; petals lanceolate-linear, long acuminate; silicles ovate, of equal length with the pedicel; their lobules at the extremity connivent, half as long as the style.

In the Murray desert not unfrequent.

7. *Stenopetalum sphaerocarpum.*

(Sect. Camelinella.)

Glabrous; stems filiform; lower leaves of the stem tripartite, their segments and the upper leaves linear, entire; pedicels filiform, nodding, longer than the calyx; petals white, exceeding with its linear curled appendage twice the sepals; silicles globose, nerveless, hardly of the length of the pedicel; each cell containing from six to eight seeds; funicles shorter than the seeds.

On moist sandy places on the Murray River, at Lyndock Valley, Crystal Brook and various places on Spencer's Gulf.

Buettneriaceæ.

8. *Thomasia petalocalyx.*

T. macrocalyx of Schlechtendal, (Linnæa xx. p. 633.) not of

Steudel. Hispid from starry hair; leaves petiolate, oblong, entire, blunt on the summit and rounded on the base; stipules large, foliaceous, oblique, ovate or half cordate; racemes lateral, simple, few-flowered; segments of the hypocalycine bracteola lanceolate; petals five or wanting; germen short-downy, pointed; style glabrous, as long as the anthers, which are at the top short-dehiscent; capsule three-celled.

On coast rocks of Wilson's Promontory, on scrubby places of the Bugle Ranges, and on the Gawler and Murray River. The first species known from the eastern portion of Australia.

9. *Lasiopetalum Behrii.*

Leaves coriaceous, narrow-oblong, obtuse, above at length perfectly smooth, beneath covered with a velvety grey-brown toment; cyme few-flowered, about as long as the opposite leaf; basilar bracteole linear, the upper one tripartite and half as long as the calyx, with unilateral linear scarcely unequal segments; lacinæ of the calyx outside starry grey-hairy, inside smooth, ovate-lanceolate, acute; germen blunt, white velutinous.

In the Mallee Scrub on the MurrayRiver and St. Vincent's Gulf, where it was at first observed by Dr. H. Behr.

10. *Corethrostylis Schulzenii.*

Leaves thin, cordate, somewhat acute, above asperulous, beneath grey-green and thinly tomentose; cyme about as long as the opposite leaf; bracteoles linear-filiform, undivided, solitary, the upper one a little remote from the calyx, which is whitish, almost membraneous, marcescent and not spotted; petals opposite to the filament, smooth or outward hairy; germen white from glandless velvet hair; style with exception of the summit densely retro-pilose.

In the Salt Flatt at Guichen Bay and on Mount Benson. Intermediate between C. membranacea and C. cordifolia from the western coast of Australia, to which part of the country the genus was formerly considered restricted.

Stackhousiaceæ.

11. *Tripterococcus spathulatus.*

Smooth, stems branched, ascendent; branches almost terete, streaked, foliate; leaves fleshy, oblong or obovate-spathulate;

flowers nearly sessile; unguis of the petals longer than their lamina; style tripartite.

On the rocky and sandy shores of Wilson's Promontory, of Rivoli Bay and Lake Alexandrina.

Leguminosæ.

12. *Acacia tenuifolia.*

Procumbent or rarely erect, twigs soon terete, hispidulous; leaves scattered, opposite or sometimes fasciculate, spreading, often retroflexed, linear-subulate, rigid, pungent, nearly tetragonal from the prominent nerve, hardly tapering into the base, glandless, scabrous; stipules setaceous, persistent; peduncles solitary or twin, smooth, about as long as the leaves; heads globose, many flowered; sepals ciliolate, nearly three times shorter than the four-parted corolla; pods glabrous, linear falcate, hardly between the seeds contracted; seeds shining, supported by a conduplicate thick brownish strophiole.

In dry stony ranges near Ballarat, towards the Goulburn and Broken River. It stands in relation to A. Brownii, and varies like many other species with downy leaves.

13. *Acacia Wilhelmiana.*

Viscidulous; stems angular, puberulous; phyllodia incurved, upright, short linear-filiform, compressed, ending in a broader blunt recurved apex, above or on both sides furrowed and furnished with two thin veins; stipules ovate, acuminate, very glutinous, deciduous or at length spinescent; peduncles axillary, solitary, shorter than the flower-heads; pods viscid, narrow, arcuate, between the seeds slightly contracted.

In the Mallee Scrub on the Murray, where it was first discovered by Mr. Wilhelmi.

Allied to Acacia Hookeri.

14. *Oxylobium procumbens.*

Podolobium procumbens, Ferd. Mueller, first gen. rep. p. 12.

Fruticulose, procumbent; leaves opposite or rarely ternate, lanceolate or round-ovate, flat, entire, prickly pointed, soon glabrous; stipules setaceous, reflexed; umbels terminal, pedunculate, few-flowered, sometimes compound; bracteoles, affixed to the base of the calyx, long persistent; calyces

scantily clothed with short grey hair; germina silky; pods stalked, many-seeded.

On wooded hills; for instance, at Mount Disappointment, in the Goulburn Ranges, on the Delatite, in the Black Forest, at Balaarat, &c.

This plant and several allied species tend to show, that the distinctions drawn between the genera Chorizema, Podolobium and Oxylobium are merely artificial.

15. *Oxylobium alpestre.*

Fruticose, diffuse or erect; leaves ternate or opposite, oblong-lanceolate, entire, sharp-pointed, soon glabrous, on the margin recurved; stipules linear-setaceous, reflexed; umbels terminal, pedunculate, few-flowered, sometimes compound; bracteoles affixed to the base of the calyx, deciduous; calyx short grey-hairy; germina densely silky; pods villose, short-stalked, few-seeded.

Not unfrequent in the higher parts of the Australian Alps.

16. *Pultenæa Benthami.*

Robust, erect; twigs angular, somewhat silky; stipules lanceolate-subulate, concrete at the base; leaves nearly flat, coriaceous, lanceolate or oblong, awnless or ending in a sharp point, either smooth and even on both sides, or below silky; petiole very short; heads terminal, few-flowered, surrounded at the base by imbricate brown, ovate, or roundish ciliolate bracteas; bracteoles navicular-lanceolate, with exception of the margin, smooth, brown, scarious, affixed to the tube of the whitish silky calyx; upper-lip of the calyx short-bilobed, considerably shorter than the lanceolate subulate laciniæ of the lower lip; germen, together with the basis of the style silky.

On springs and rivulets in the Grampians, and amongst rocks on the top of Mount Abrupt.

This elegant species, which stands nearest to P. myrtoides All. Cunn., has been named in honour of Mr. George Bentham, the eminent monographer of this class of plants.

17. *Phyllota pleurandroides.*

Twigs pubescent; leaves recurved, spreading, linear, sharp pointed, scabrous, with refract margin, the floral ones crowded and below the middle villose; flowers concealed between the

leaves, either axillary, solitary, or collected in terminal few-flowered heads; bracteoles ovate, keeled, shorter than the tube of the silky calyx; standard surpassing considerably the length of the keel, but little that of the wings; style below the middle appressed-hairy, unbearded on the apex; pod somewhat hairy, ovate, slightly compressed; seeds destitute of a strophiola.

In arid plains, at the foot of Mount Abrupt, in Kangaroo Island, and Encounter Bay.

18. *Burtonia subalpina.*

Twigs almost silky, soon glabrescent; leaves crowded, undivided, filiform, channelled, awnless, smooth, scabrous; stipules longer than the petiole; flowers sessile, terminal, capitate; calyx and germen villose-silky; corolla purple; style below hardly broader.

On the rocky summit of Mount William, at an elevation of about five thousand feet.

Not dissimilar to B. diosmifolia, from which it differs as well as from all other Western Australian species of the genus in producing stipules. The pod is yet unknown.

19. *Bossiaea distichoclada.*

Erect, unarmed; branches and twigs in two rows, terete, grey-velutinous, densely foliate; leaves small, on very short petioles, bifarious, assurgent, coriaceous, nearly kidney-shaped, at the top awnless and divided into two very short lobes, their margins recurved, above scabrous, on both sides, with the exception of middle rib, glabrous; stipules ovate- or lanceolate-subulate, long persistent, at length reflexed, often of the length of the leaves; pedicels short, axillary, solitary, with rounded or ovate ciliate bracteoles; upper lip of the somewhat silky calyx bifid, lower lip three-parted; pod much compressed, roundish-rhomboid, covered with rusty downs, containing from one to three brown black-spotted seeds.

In the Australian Alps from the Mitta Mitta to the tributaries of the Snowy River, as well between rocks as along the peaty margins of the rivulets.

This singular and beautiful plant descends never to regions lower than four thousand feet; and being at five thousand for many months during the year covered with snow, it will, like the new previously mentioned Burtonia and many other of our alpine plants, form an exquisite addition to the garden flora of colder countries.

20. *Psoralea parva.*

Sparingly pilose; stems herbaceous, procumbent, almost simple; leaves trifoliolate, on long petioles; leaflets narrow-lanceolate or of the radical leaves elliptical, perfectly entire, dotted, ending in a sharp point, the intermediate one larger; stipules streaked, ovate-lanceolate, with a subulate apex, peduncles long; spike at first capitate, but generally at length interruptedly extended; bracteoles roundish-cordate; calyces somewhat silky, nearly sessile; pods slightly hairy.

In dry pastures on the Thompson and Latrobe Rivers, and in South Australia, on the Torrens and Gawler Rivers, on the Barossa Ranges, near Villunga, &c.

It differs from Ps. tenax in always trifoliolate smaller and less acute leaves, in sessile less deeply divided calyces, in the form of the longer persistent bracteoles, in the whitish or pink corolla, and in the pod, which is neither black nor smooth.

21. *Psoralea adscendens.*

Smooth or sparingly pilose; stems herbaceous, diffuse adscending, at the base procumbent; leaves trifoliolate, on long petioles; leaflets lanceolate, acuminate, entire, sharp pointed, dotted, the intermediate one larger; stipules lanceolate-subulate; peduncles long, upwards as well as the calyces somewhat hairy; racemes dense, almost spicate, many-flowered, of the length of the leaflets; bracteoles lanecolate-ovate, acuminate; pods black, wrinkled-scabrous.

On the grassy moist banks of the Snowy River, Gibbo River, Mitta Mitta, Ovens River, and along the torrents of the Australian Alps.

This fine plant approaches nearer to Ps. Australasica than to Ps. tenax; the colour of the flowers is purple like that of the former, not deep blue as in the latter, from which it differs besides in the greater size of all parts and the above notes. It may be considered a subalpine plant, whilst Ps-tenax hardly advances any where into the mountains.

22. *Leptocyamus sericeus.*

All over grey—silky; stems procumbent; leaflets lanceolate-linear, acuminate, above at length a little glabrescent; pedicels axillary, subsolitary; pods silky; seeds shining-black, even.

On sandridges along the Murray River towards the junction of the Murrumbidgee.

To the same genus belongs Ziehya Latrobeana of Meisner, (in Lehmann plant. Preiss. I, p. 94.)

Cunoniaceæ.

23. *Bauera sessiliflora.*

Hirsute; leaves lanceolate or subovate, generally entire; flowers axillary and terminal, sessile, pseudo-verticillate; calyces to the middle eight-cleft, with subulate-lanceolate or linear segments and with a slightly ribbed obconico-cylindrical tube; petals purple; stamens about twelve; anthers oblong-ovate, emarginate, black.

On the rocky subalpine summit of Mount William, and thence descending along the rivulets into the valleys.

Flowers larger and of a much deeper colour than in Bauera Billardieri.

Celastrineæ.

24. *Celastrus Australis.*

(Harvey & Mueller.)

Climbing; branches warted; leaves glabrous, lanceolate, acuminate, crenate or repand-serrated, their teeth mucronulate; panicles terminal; capsules three-valved, with one- or two-seeded cells.

On the Snowy and Buchan Rivers, not only in rich humid ground, but also on rocks.

The first Australian species described of the genus, resembling C. paniculatus and C. dependens from East India.

Lythraceæ.

25. *Ammannia Australasica.*

Annual, glabrous; stem erect, simple or branched, square; leaves ovate- or linear-oblong, blunt, with a dilated base clasping; cymes axillary, on very short peduncles, or rarely the flowers solitary in the axils; calyces cupshaped, with four very short acute teeth and four indistinct ones alternating with them; petals four, nearly lanceolate, flavescent, very soon falling off; stamens four; capsule globose, extremely thin, one-celled.

On boggy places, periodically under water, along the Rivers Murray, Darling and Murrumbidgee.

The first species discovered in Australia, bearing affinity to A. multiflora from East India, and to A. pusilla from South Africa; differing from both already in the colour of the petals.

Araliaceæ.

26. *Panax augustifolius.*

Fruticose, unarmed, glabrous; leaves simply or bi-pinnate; leaflets spreading, carnulent, in three to seven pairs, oblong —linear, perfectly entire or sometimes again dissected, almost veinless, opaque, above dark-green, beneath pale; umbels distant in the panicle, pedunculate, many-flowered; calyx obsoletely toothed; styles two, reflexed at the extremity.

Dispersed through the Mountains from Dandenong and Mount Macedon to the Buffalo Ranges, and through a great part of Gipp's Land.

The berries are bluish-white, like those of the following species, but somewhat smaller.

27. *Panax dendroides.*

Arborescent, unarmed, smooth; leaves simply or bi-pinnate; leaflets in five-seven pairs, lanceolate, acute, entire, opaque, beneath paler, with above prominent veins; umbels many-flowered, forming a divaricate panicle, which is of equal length with the leaves; calyx with five short teeth; styles two, reflexed from the base.

Not rare in the valleys of the southern and eastern ranges of this colony.

Caprifoliaceæ.

28. *Sambucus xanthocarpa.*

Arboreous; leaves pinnately three- or five-foliolate or bi-pinnate, smooth, without stipules; leaflets lanceolate or ovate-lanceolate, long-acuminate, with exception of the basis sharp-serrated, cymes with five or seven principal branches; flowers three- or rarely four-parted; berries yellow, three-seeded.

On the shady moist banks of the Brodribb, Snowy and Cabbage Tree Rivers.

A tree with the habit of the common Elder and perhaps of equal utility.

Compositæ.

29. *Brachycome leptocarpa.*

Annual; leaves linear-cuneate, as well as the branches covered with articulate hair, at the upper end cut or pinnatifid, their teeth or segments acute; peduncles naked, filiform, upwards smooth; scales of the involucre blunt, glabrous; akenia cuneate-linear, compressed, pale-brown, with naked margin, on both sides hairy-scabrous; pappus conspicuous.

In low grassland, not unfrequent in the colony of Victoria, as well as in South Australia.

Similiar to B. debilis.

30. *Brachycome ptychocarpa.*

Annual, glabrous-scapes filiform, generally naked; leaves pinnatisected, with linear acute segments; scales of the involucre blunt, ciliolate; akenia very small, brown, surrounded by a ciliolate wing, on both sides with three hairy-scabrous ribs, the middle rib more prominent; pappus minute.

In the Buffalo Mountains.

Like the following a small tender herb.

31. *Brachycome nivalis.*

Perennial, herbaceous, smooth; leaves all radical, somewhat carnose, pinnatisected, or rarely entire, on long petioles; their segments distant, linear, entire or pinnatipartite, acute; rachis linear; stems simple, much longer than the leaves, naked or with a solitary bractea; scales of the involucre lanceolate-oblong, with ciliate torn margin; receptacle hemispherical; akenia compressed, oblong-cuneate, with a conspicuous pappus; those of the disk very narrowly winged; those of the ray surrounded with a broad torn membrane, on both sides slightly convex, rough towards the summit.

On the highest summits of the Australian Alps, in grassy or peaty soil; for instance, on Mount Buller and the Cobboras mountains.

A remarkable species, often tinged with a purple hue.

32. *Brachycome multicaulis.*

Suffruticose, somewhat scabrous; stems numerous, ascending, foliate, simple or a little branched, naked towards the summit; leaves nearly sessile, pinnatifid; their segments

linear, acute, close to each other, short in the upper leaves; scales of the involucre cuneate-oblong, somewhat scabrous, blunt, with membranaceous ciliate-torn margin; receptacle convex; akenia compressed, oblong-cuneate, with a very short pappus; those of the disk with very narrow hardly ciliolate wings; those of the ray with broader somewhat callose margin, rough towards the summit.

On the highest cliffs of Mount Buller.

33. *Brachycome chrysoglossa.*

Perennial, glandulously pubescent; leaves only on the lower part of the stem, oblong-cuneate, at the top rounded or truncate with a few notches; scales of the involucre blunt, obovate, with a broad membranaceous torn-ciliate margin, glandulous on the back; ray golden-coloured; akenium tawny yellow, margined, compressed, surrounded by a broad irregularly pectinate-ciliate wing, thickened and somewhat scabrous on the disk; pappus conspicuous.

In the Mallee scrub towards the north-western boundaries of the colony.

Remarkable for the colour of its flower-ray, otherwise closely approaching in affinity to B. calocarpa.

34. *Calotis anthemoides.*

(Sect. Acantharia.)

Smooth; root fibrous, producing runners; stems simple; radical leaves on long petioles, pinnately divided, the lower segments linear, entire, the rest pinnately cut into linear acute divisions; leaves of the stem small, remote, sessile, lanceolate, entire or rarely toothed; scales of the involucre few, disposed in two rows, ciliate, but smooth on the back, outer ones almost round; akenia cuneate, nearly compressed, margined and broadly winged, with exception of the tops even and smooth; awns generally eight, valid, retro-hispid, alternately very short, and of the length of the akenium.

In muddy localities in the neighbourhood of Station Peak.

A singular plant, differing from the rest of the species, as well in habit as in the hermaphrodite flowers of the disk.

Ray whitish.

35. *Angianthus brachypappus.*

Glomerules tapering gradually into the base, at last

brownish; pappus ciliate-torn, shorter than the akenium, or producing a single hair, which is not plumose at the summit, and shorter than the corolla.

On barren plains near Swanhill.

Although the above notes appear to offer the only distinctive marks between this and Ang. tomentosus, the only hitherto know species, yet this new one may be most easily recognised by them.

36. *Hæckeria ozothamnoides.*

Branches scantily woolly; leaves linear, mucronate, with revolute margin, beneath grey-tomentose; heads 5-7-flowered; all scales of the involucre upwards pale-yellow.

In dry places on Barker's Creek, on the Upper Murray and Snowy River.

The species upon which I founded the genus originally may be briefly thus characterized.

Hæckeria cassiniæformis.

Leaves semiterete, blunt, as well as the branches scabrous; heads 2-3-flowered; interior scales of the involucre upwards white.

37. *Antennaria, Gaertner.*

(Sect. Actina.)

Scales of the involucre radiating. Heads of the fertile plants with several rows of female flowers in circumference, and with hermaphrodite ones in the centre. Heads of the sterile plants with only hermaphrodite flowers, a few rarely fertile. Pappus at the extremity clavellate, with exception of that of the female flowers, which is not thickened.

Antennaria nubigena.

Stems herbaceous, creeping, corymbose, short, upright, cespitose; leaves dense, flat, oblong or ovate-cuneate, somewhat acute, entire, spreading, clasping at the base, one-nerved, on both sides covered with a thin appressed silver-grey toment; flowerheads terminal, generally solitary, sessile; involucres hemispherico-campanulate; its scales smooth, acute, entire, the middle ones lanceolate-oblong, white at the top; akenia tereti-oblong, scabrous.

On the rocky summits of the Cobboras mountains, covered nearly throughout the year with snow.

A truly alpine species like most others of this interesting genus, formerly not found represented in Australia, unless erroneously referred by Candolle to Gnaphalium (as G. Catipes.)

38. *Senecio vagus.*

Glabrous; stem suffruticose, with spreading branches; inferior leaves large, pinnati-sected, with generally two pairs of segments, which are long-lanceolate, acute, remotely and grossly toothed; the terminal segment very large, trifid and toothed or laciniated; upper leaves lanceolate, entire or trifid, tapering into a short petiole; flowerheads panicled, with a conspicuous peduncle, and large lanceolate-linear bracteas; scales of the almost bell-shaped involucre ten to twelve, equal in length to the disk, acute, on the margin scarious, on the back with black papills; ray spreading; akenia glabrous, angulate, furrowed, transversely rough, half as long as the pappus.

In shady moist valleys of the Dandenong ranges, of Mount Disappointment, and on the Delatite.

A smaller variety (alpestris) with thicker more dissected leaves occurs on the rocky summit of Mount Buller.

Stylideæ.

39. *Coleostylis Sonderi.*

All over glandulously pilose; stem simple or branched at the top, foliate; leaves alternate, roundish—heartshaped or rhomboid, the uppermost sessile, the rest petiolate; pedicles axillary, solitary, forming a terminal corymb; basis of the corolla tubulose.

On wet places near the Violet Creek found by Mr. C. Wilhelmi.

A neat little plant of the habit of C. Preissii.

Gentianeæ.

40. *Sebæa albidiflora.*

(Sect. Phyllocalyx.)

Leaves somewhat fleshy, broad-ovate, the lower ones roundish, blunt, almost nerveless; sepals indistinctly keeled,

oblong, blunt, winged at the base; cyme simple, close; lobes of the corolla four, whitish, ovate-oblong, blunt, half as long as the tube; style short-exerted, with a bifid stigma.

In saline pastures from Port Phillip to Port Fairy, and at George Town in Tasmania.

Approaches next in its characters to S. albens from South Africa.

Myoporinæ.

Pholidia, R. Brown.

(Sect. Sentis.)

Leaves alternate. Calyx four-parted. Drupe bony, hard-beaked, with imperfectly divided cells.

41. *Pholidia divaricata.*

Twigs spreading, spinescent, glabrous or with a row of white short hair; axils of the leaves somewhat bearded; leaves glabrous, linear-oblong, blunt, gradually tapering into the base, entire; flowers axillary, solitary, nearly sessile; segments of the calyx narrow-lanceolate, long-acuminate, ciliated; corolla outside starry-velutinous; its upperlip with two very short lobes, lower one three-parted.

In bushy plains, subject to inundations on the banks of the Murray River, the Darling and Murrumbidgee.

An ornamental shrub, several feet high, with purple or white generally spotted flowers.

(Sect. Eremicola.)

Leaves alternate, deciduous. Calyx five parted. Drupe dry, acuminate, with almost entirely divided cells.

42. *Pholidia polyclada.*

Glabrous; branches and twigs spreading, not spinescent; leaves linear, somewhat channelled, blunt, entire, sessile; pedicels axillary, solitary, upwards thickened, longer than the calyx; axils glabrous; segments of the calyx nearly cordate, acuminate, with minute ear-like appendages at the base, indistinctly ciliate at the margin; corolla outwards glabrous, very wide, surpassing many times the length of the calyx; upper lip bifid, lower one three-parted.

In sandy-loamy desert plains at the junction of the Darling and Murray.

A shrub with intricate branches, about six feet high. Flowers large white.

This species forms an intermediate link between Eremophila and Pholidia. To the same genus I refer also Myoporum brevifolium of Bartling.

LABIATAE.

43. *Prostanthera spinosa.*

Branches numerous, spreading, hispid; twigs short, spinescent, foliate at the base; leaves lanceolate or roundish-ovate, acute, entire or repand, glabrous or below imperfectly hairy; peduncles thin, axillary, solitary, surpassing twice the length of the calyx, at the middle bibracteate; calyx sparingly hispid, its lips entire, the lower one hardly longer; corolla of lilac-colour, outward but little hairy; longer spur of the anthers exceeding nearly twice the cell; the other abbreviate.

On springs and irrigated rocks in the Grampians.

This species is remarkable for its prickly branchlets.

44. *Prostanthera coccinea.*

Branches hirtellous; leaves small, somewhat thick, with reflexed apex, linear-oblong or simply linear, blunt, flat or on the margin slightly recurved, hairy-scabrous, at length glabrescent, in the axils fasiculate; flowers near the top of the twigs axillary; peduncles a little shorter than the calyx, which is with exception of the ciliolate margin glabrous; its lips entire, the lower one a little longer; corolla red, three times longer than the calyx, somewhat hairy, its upper lip longest; spurs of the anthers adnate, the longer one hardly as long as the cell.

In the Mallee Scrub on the Murray, on St. Vincent's and Spencer's Gulf.

A low diffuse bush, allied to P. microphylla (All. Cunn., in Benth. lab. p. 454).

45. *Prostanthera eurybioides.*

Branches puberulous; leaves thick, very small, glabrous, linear-oblong, entire, slightly concave; the younger ones fasiculate, those surrounding the flowers broad ovate; flowers axillary, solitary, on short peduncles; the lower lip of the glabrous calyx nearly retuse, little exceeding the rounded upper lip; longer spur of the anthers surpassing the length of the cell.

In the Mallee Scrub towards the mouth of the Murray River.

Resembles in habit Eurybia lepidophylla.

46. *Westringia senifolia.*

Erect; stems densely hirsute; leaves about six in a whorl, crowded, spreading, lanceolate-linear, acute, sessile, with revolute margins, above glabrescent and scabrous, beneath as well as the calyces hirsute; flowers white, axillary, nearly sessile, forming on the top of the twigs a foliate spike; cayces to the middle divided, hardly as long as the leaves; its segments lanceolate-subulate.

On rocks in the Buffalo Ranges and on the summit of Mount Buller.

47. *Westringia violacea.*

Leaves three in a whorl or rarely opposite, linear-lanceolate, awnless, with slightly recurved margins, glabrous on both surfaces or beneath along the rib hairy, above dotted-scabrous; pedicles, calyces and twigs appressed-hairy; bracteoles linear-subulate, four or five times shorter than the calyx; teeth of the calyx lanceolate, acuminate, hardly longer than its tube; corolla violaceous, puberulous.

48. *Westringia grevillina.*

Leaves three in a whorl, coriaceous, broad-linear, spreading, acute, with revolute margin, above smooth, beneath as well as calyces and branchlets more or less grey velvet-hairy; teeth of the calyx much shorter than its tube; corolla velvet-hairy.

On the rocky coast of the Port Lincoln District. C. Wilhelmi.

Nearest in its affinity to W. cinerea.

SCROPHULARINÆ.

49. *Veronica Hillebrandi.*

Stems short, erect or ascending, all over covered with short reclined hair; leaves thick, on short petioles, somewhat rough, oblong or hastate-ovate, grossly and remotely serrated, truncate or rarely tapering at the base; racemes corymbose, axillary, few-flowered; bracteas ovate-lanceolate;

segments of the calyx lanceolate-oblong; corolla large, white; capsules broad-obcordate, slightly compressed, glabrous; seeds compressed-ovate, brown, wrinkled.

On barren ridges along the Coorong, and on limestone rocks around Lake Alexandrina.

Lentibularinæ.

50. *Polypompholyx exigua.*

Urticles ovate; leaves narrow-lanceolate or oblong, tapering into the petiole; scape filiform, one-three-flowered; corolla rose-red; lower lip nearly horizontal, trifid, at least three times longer than the upper lip, its segments oblong-linear, blunt, the middle one larger, the lateral ones hardly longer than the spur; upper lip nearly erect, bipartit, with linear subulate divisions; palate yellow, with an orange margin.

In mossy, peaty or boggy places at the Grampians, Serra and Victoria ranges, and in South Australia at Echunga.

It differs from Polypompholya tenella, besides in the characters pointed out already, in its larger flowers.

Art. V.—*Personal Observations made in an Excursion towards the Central Parts of Victoria, including Mount Macedon, McIvor, and Black Ranges.* By William Blandowski, Esq.

Read 21/10/1854

The Victorian Government having conferred on me the honour of assisting in the formation of a museum of Natural History, and of reporting upon the physical character of those parts which, in the execution of that mission, I should happen to visit, I accordingly selected for the scenes of my early labours that portion of the country including within its area, Mount Macedon (40 miles north of Melbourne), McIvor (30 miles north of Mount Macedon), and the Black Ranges, on the upper Goulburn River, 40 miles eastward of McIvor. I have now the honour to lay before the Philosophical Society, the principal results of my observations during the three months devoted to this interesting object, having reduced them under the following distinct heads:—

I. The physical character of the midland portions of the country; with a review of the general capabilities of its surface.

II. The Geology, Mineralogy, Paleontology and } of those
III. Zoology } districts.
IV. The Aborigines; their manners, habits, and customs.

I. The general character of the country in the neighbourhood of Melbourne, and between that city and Mount Macedon, is flat and open, comprising a series of extensive plains. They are intersected in every direction by the Yarra and Saltwater rivers, Jackson's and the Deep Creeks, whose beds, running through in steep gullies, are remarkable for their great depth, averaging about 150 feet. The banks of these streams are adorned more or less by avenues of thick she-oak (*Casuarina quadravalvis*) and he-oak (*C. leptoclada*). A belt of clay slate, commencing about half way between Melbourne and the Mount, forms a semicircle around the latter on the south and eastern sides. The soil of those districts which are comprised in that circuit is much inferior to that of localities favoured by the more fruitful basalt formation, which is very extensively developed around Mount Macedon, its rich agricultural qualities rendering that district particularly encouraging to the farmer. The only circumstance at all detrimental, is the great elevation of the land above the sea level, which exposes it to the influence of the cold; ice sometimes forming, of the thickness of half an inch.

The ranges known as Mount Macedon itself, are covered with an exceedingly rich soil, except perhaps one portion which makes a semicircular sweep towards Alexander's Head, consisting for the most part of quartzy slate, and enclosing the granite of the south and eastern portions of the chain. Mount Macedon is a lofty and picturesque peak, its sides clothed with forests of gigantic eucalypti; the gullies and ravines which everywhere intersect it, being alike overrun with immense fern trees (*Dicksonia antarcticæ*), so dense as to present an almost impassable barrier to the progress of animals.

About two miles from the mount, at the head of Five Mile Creek, is a remarkable hill called Diogenes' Mount, commonly known to the colonists as "Dryden's Monument," a name singularly inappropriate, being the cognomen of a settler in the neighbouring district. For a description of this highly interesting mount, I refer to a subsequent page, where full details concerning it will be found.

The dividing ranges between the Deep Creek and the Campaspe River consist of granite, covered with a sandy and unproductive soil. They rise to a considerable elevation, and

on their surface are many remarkable groups of granite boulders; the soil between these, resulting from the decomposition of the basalt, being of an exceedingly rich quality. The two localities last mentioned, viz. the dividing ranges and Dryden's Monument, for the interest of their geological conformation and the extreme beauty of their scenery, are almost unequalled throughout Victoria; and offer to the inhabitants of the city, a quiet and instructive retreat for the employment of their leisure hours.

Crossing these ranges the traveller merges into the Murray district. Once arrived on the plains, a milder climate than that of the more southern portions of the country, is distinctly experienced. These elevated plains belong more or less to the basalt formation, and from the fertility of the soil, especially in particular places, (as in the neighbourhood of Dr. Baynton's station,) as well as good water, a fine climate, gently undulating ground, and most beautiful scenery, are highly deserving the attention of the future settler.

North of the Mie Mie Inn, famous as being the spot where the celebrated gold escort robbery took place, the soil is cold and unproductive; but towards Patterson's station expands into open and fertile plains, entirely free from stones and boulders.

Arrived at the McIvor diggings, the only particular object of interest, is the track marked out by Sir T. Mitchell, in the first exploring expedition ever undertaken through Australia Felix.

The surface of the country north of McIvor, is both clayey and rocky; is densely timbered and abounds with precipitous ravines, being thus available only for pastoral pursuits.

Between Lancefield and Kilmore the road leads over an elevated plateau formed of basalt strata. The face of the country is here extremely rocky, and unfit for cultivation; but in the neighbourhood of the latter township its character changes, and rich alluvial land gratifies the eye of the observer. Kilmore is fast becoming the centralizing point of an important agricultural district, and is already the largest inland town in the whole colony.

Eastward of the line of road leading from Kilmore to Seymour, is seen the singular peak known to the colonists as Ferguson's "sugar loaf" which possesses a considerable degree of interest on account of its remarkable conformation and appearance. The rich character of the land around this peak is well known to the settlers, but owing to its elevated position, it is, like the plateaux of Mount Macedon, much exposed to the injurious influence of the cold.

On arriving at Seymour (lat. 37°) the bald granite hills of the black ranges become visible on the eastern horizon. The latitude is the characteristic weather line of our meteorological phenomena, which is especially manifest in the advanced state of vegetation north of that parallel. This, I imagine, is chiefly owing to the influence exerted by the different adjoining ranges, viz. Mounts Benson and Gambier, the Grampians, the Pyrenees, Victoria, Alexander and Kilmore ranges, which all lie under the same latitude, and present an effectual barrier to the cold south wind, thus rendering the vegetation to the north of them fully four weeks in advance.

Approaching Seymour I was delighted to behold the magnificent river, the Goulburn, upon whose banks it is situate; its sides adorned with rows of shady wattle (*Acacia molissima*) and lofty gum trees. I am convinced that by the removal of but few obstructions, steam communication could be easily effected between that river and the Murray Settlements.

The highest point of the Black Ranges is formed of granite. The view from certain points of this hill is grand and imposing; at its foot is seen the Goulburn hastening into the Murray, after traversing a vast tract of dark forest land extending as far as the eye can reach, and clothing with the deep and sombre hue of the eucalyptus the sides of the lofty Alps, whose glistening summits are crowned with snow.

The southern slopes of the Black Ranges are exceedingly steep, so much so, that finding it impossible to proceed with a dray in that direction, I was compelled to retraee my steps and pursue a different route.

The right bank of the Goulburn, on that side opposite to the Black Ranges, is both rugged and mountainous; it is densely covered with thick forest, and will for centuries be of use only as pasture ground. Now and then, however a rich gully occurs; but these are exposed to counterbalancing drawbacks, being subject in winter to sudden and heavy floods, scooping out ravines in the alluvial soil, of considerable extent and depth. In May and June, the months in which the cold sets in, the higher ranges become, during the night, covered with snow, which however disappears with the warmth of the morning sun. The scenery of these mountains reminds one of the rugged passes of Switzerland or the Rhine, and the hospitality which characterizes the inhabitants of mountainous districts in every part of the world, is fully borne out by the settlers of the Goulburn,

who are proverbially the best riders in the country, and surpass anything we read of concerning the horsemanship of other countries; this superiority being attributable only to the rugged nature of the district in which they reside.

II. Melbourne, as is well known, rests on strongly compressed silurian strata, entirely surrounded by the basalt formation. Extremely minute fossils (*Atrypa*) are found in these strata; but those typolites obtained near Flemington, scarcely two miles from Melbourne, and of which I have procured living specimens from Western Port Bay, are large and perfect. The latter are petrified in brown iron ore belonging to the uppermost tertiary formation.

The extensive plains between Melbourne and Mount Macedon, as has been stated in the former part of this paper, belong almost entirely to the basalt, or, as some English geologists term it, the trap formation. The rocks of this class are composed principally of felspar and augite, the latter predominating; and a soil of very superior capabilities arises from their decomposition.

The trap rocks which occur throughout Victoria, I have arranged under two distinct heads, viz., basalt proper, and dolerite; the former a black homogeneous mass, sometimes impregnated with different zeolites and iron ore. That both are the result of volcanic action there cannot be the slightest doubt, as they exhibit the most unmistakable signs of having been once in a molten state.

The different varieties of basalt which occur in the plains above mentioned are:—

1. Common basalt or bluestone; in columnar platforms and irregular boulders.
2. Porous basalt in irregular forms; on account of its porosity unfit for building purposes.
3. Pumice stone, like basalt. Swims in water; attracts and retains the heat very powerfully.
4. A lithodomous mass of an ochre-brown colour; easily crumbled. It is questionable whether it be not of aqueous origin, its formation taking place when the volcanic power was finally subdued.
5. Black soil of a crumbling nature. The decomposition of this species produces a soil highly valued for agricultural purposes. When mixed with clay the ground becoming what is termed by the colonists "honeycombed;" and if stones be intermingled with it, mounds are raised, designated "dead men's graves."

Eastward from Alexander's Head, on the Deep Creek, is a gully containing groups of basaltic columns of considerable interest. They are from fifteen to twenty feet in height, and about one foot apart; the bases very convex, but at the summits concave. Below these columns is a stratum of porous basalt a few feet in thickness; and beneath this another extremely porous, and perforated with large irregular holes, whose edges are rounded by the action of internal fire. The whole rests on a stratum of basalt conglomerate.

The low ranges east of Mount Macedon are composed of quartz, and though similar in character to the Cambrian formation, are apparently devoid of fossil remains.

Near Fawkner's old station is a bald hill formed of dolerite boulders, from 2 to 10 feet in diameter and about the same height, cropping out from the smooth surface, and in-investing the hill with a rugged appearance.

The fine grained granite which forms the summits of the Mount Macedon chain, exhibits a strong inclination to shelve off in horizontal layers. The felspar which enters into the composition of this granite bears a very large proportion to the quartz, the black mica is distinct and characteristic.

I could nowhere detect any indications of precious stones on these ranges, which are very scantily covered with a thin coating of alluvial soil.

Some distance N.E. from the peak of Alexander's Head, is the spot where the discovery of bones of gigantic antediluvian fossil birds took place, 5 or 6 years since, in a basaltic cavern. I was much disappointed at my ineffectual endeavours to obtain similar specimens, in consequence of my inability to suppress the springs of water sufficiently to enable me to reach the proper depth.

Two species of granite occur on the dividing ranges between the tributaries of the Deep Creek and the Murray River. The first is composed of coarse crystallized felspar, oligoclass and albite, with a little mica and quartz. This granite is found in shapes somewhat similar to ladies' thimbles; varying from two to one hundred feet in height, and from ten to three hundred feet in circumference. The fantastic arrangement of these groups is calculated to afford a constant theme of speculation as to the original cause which produced it, amongst those whose fancies lead them to the consideration of such things. On Perry's run I saw a boulder of an enormous size resting on a base of scarcely twenty square feet. So remarkable an occurrence deserves to be re-

corded amongst those geological wonders which in different countries have so frequently excited the curiosity of even the most thoughtless of mankind. There is also a very interesting group of boulders on Dr. Baynton's run.

The second species of granite on the dividing ranges, consists of fine crystallized felspar, with a small admixture of mica and quartz, the latter in minute particles. This granite constitutes the higher ranges on Mollison's run, and appears similar to that at Mount Macedon; it exhibits a strong tendency to split perpendicularly.

The celebrated spot which supplies the natives with stone (phonolite) for their tomahawks, and of which I had been informed by the tribes 400 miles distant, I was unable, at this period of my journey to trace out; but subsequently was fortunate enough to hit upon it accidentally while in search of other objects, with the assistance of F. Mackenzie, Esq.

Three miles east of Lancefield is a lofty chain of hills, running nearly north and south; the highest summit of which is called Mount William. These ranges are intersected by the road leading from Lancefield to Kilmore, and which divides the basaltic strata, on the north from the clay slate rocks and slate of the southern portion of the range. The basalt gradually changes its specific character, northward, till at Mount William it becomes distinct phonolite, of a hard and glassy texture. A most excellent stone for macadamizing roads occurs in this locality, and will be a treasure to the neighbouring district, when the progress of the country shall demand its application. Good brown iron ore also occasionally occurs, though not in great quantities.

Having observed on the tops of these hills a multitude of fragments of stones which appeared to have been broken artificially, and which I recognised as phonolite or clinkstone, I was led to trace them to the source from which they appeared to have proceeded, a spot three-quarters of a mile eastward, on somewhat lower ranges. Here I unexpectedly found the deserted quarries (kinohahm) of the aboriginals, which I had previously been unable to discover.

The phonolite (tadijem), as before mentioned, is that of which their tomahawks are formed. The quarries which extend over an area of upwards of 100 acres, present an appearance somewhat similar to that of a deserted gold field, and convey a faithful idea of the great determination displayed by the aboriginals, prior to the intrusion of the white races. They

are situated midway between the territories of two friendly tribes,—the Mount Macedon and Goulburn,—who are too weak to resist the invasion of the more powerful tribes; many of whom, I was informed, travel hither several hundreds of miles in quest of this invaluable rock. The hostile intruders, however, acknowledge and respect the rights of the owners, and always meet them in peace.

The phonolite is of great hardness, and is distinguished from basalt by its greater specific gravity, its chemical composition being—silica, 67; alumina, 18; natrium, 7; calcium, 7. The surface of the stratum is very rugged, and of a greenish colour. It is rather difficult of fracture; otherwise it is well adapted for metalling roads.

The basalt formation extends about four miles westwards of Lancefield, but is then interrupted by slate and milky quartz, strongly indicative of auriferous strata. Still further westward these are succeeded by dolerite, which extends over Alexander's Head, Mount Macedon, and Dryden's Monument.

Dryden's Monument is, as well on account of its geological character as its singular conformation, one of the most remarkable spots in Victoria, if not in whole Australia, and were a careful and minute description of it made, accompanied with good drawings, it would not fail to engage the attention of every geologist. The approach to it presents a scene of the most imposing grandeur. A massive wall of dolerite, whose deep and sombre hue is in exquisite harmony with the dark green of the eucalyptus, rises almost perpendicularly above the loftiest of the trees, and imparts a striking majesty to the whole view. The interest increases at every step approaching the monument, and a beautiful variety of rapidly changing scenery is unfolded like a panorama before the observer's eye. At the base about a thousand pyramidal columns, from fifteen to thirty feet in diameter, and thirty to one hundred feet in height, rise in bold relief from the surface, and invest the hill, which is about a mile in circumference, with an appearance not dissimilar to that of a gigantic porcupine, or to a colossal representation of the structure formed by the termes bellicosus.

That this hill was formed by subterraneous agency, acting at two separate periods, there can be little doubt. At the first era of its formation a naked semicircular hill was raised; and before sufficient time had elapsed to allow the surface to cool and harden, and while it was yet in a plastic state, a

second eruption took place, resulting in the production of the peculiar columns mentioned in the preceding paragraph. The origin of their formation reminded me of the phenomenon attendant on the refining of silver, as in both cases a discharge of gases must have taken place. The columns are solid, although they contain a considerable number of hollow concretions (septarians), from one to three feet in diameter, which are, however, filled up with *tripoli* or steinmark, a finely pulverised earthy deposit, of a greyish yellow colour, and a dry harsh texture. This tripoli, whose component parts are as follows:—silica, 80; alumina, 2; iron, 8; water 5; sulphurous acid, 5—is, I think, mostly derived from the decomposition of silica; it is very soft, and is much valued in other parts of the world, as a polishing material for hard metals and precious stones.

Many of the septarians are fractured or burst, and their internal structure thus exposed to view. I attribute these fractures to have originated from the following cause, viz., from the decomposition of the outer surface of the columns by the usual atmospheric action. The last laminæ being at length penetrated, the rains gained access through the fissures, and the expansive power of the tripoli, arising from the moisture, ultimately burst the septarians; and their contents, issuing from the opening, on to the rocks beneath, dotted them over with white spots, some of which are still observable, though the greater part of them are wholly erased by time. The soil between the columns, which are so numerous and thickly disposed as scarcely to allow a rider to pass between, arises from the decomposition of the dolerite, and is extremely rich. The physical conformation of Mount Macedon is identical with that of Diogenes' Mount, although the peculiarities of the former, which I have here endeavoured to describe, are not so marked, or so fully developed as the latter.

Between Dr. Baynton's and Mr. Perry's run, and the Mie Mie Inn, are extensive basaltic plains. Between Mr. Pohlman's and Mr. Perry's I found boulders of magnesite, about one foot in diameter, and similar in appearance to the stone which I had previously observed on Brock's run.

The steep banks of the Campaspe consist partly of basalt and of slate, with quartz scattered over the surface. Eastward of the Campaspe, from Dr. Baynton's to the Mie Mie Inn, the country exhibits every indication of being of an auriferous character.

A few miles south-east of Perry's home station, I came upon a stratum of a granitic character, about one chain broad; and, which is particularly worthy of notice, as it is a species of rock entirely new. The stones on the surface of this stratum are all more or less rounded, and quartz crystals are remarkable, forming regular dehexahedrons.

The whole of Perry's run eastward of the McIvor gold-fields is of an auriferous character. The stratification, which consists of slate alternating with quartzy rock, is almost perpendicular, and pursues a gently undulating course, whose general run tends nearly north and south. At McIvor I observed boulders of dolerite of considerable size, and having a peculiar depression on their summits, extending across the auriferous strata.

From information which I received through the kindness of Mr. Chauncey, I was enabled to obtain chromium, antimony, chlorite slate, and a considerable number of petrifactions, on the mountainous ranges to the north of Heathcote. The whole of the strata on these ranges (Mount Ida) consist of quartzy rocks containing rhodicrinites. I am of opinion that it is the Cambrian, and not the upper Silurian formation, which is there represented; in support of which I refer to the following passage from Lyell:—

"Below the silurian strata in Great Britain is a vast thickness of stratified rocks, for the most part slaty and devoid of fossils. In some places a few organic remains are detected, but they are usually obscure, and whether the species will prove to be sufficiently distinct to entitle the rocks containing them to rank as an independent group, may be doubted. They attain a thickness of several hundred yards, and are chiefly formed of slaty sandstone and conglomerate, with brachiopoda and a few zoophytes."

At the Mie Mie Inn, I met with a stratum of slate; and in attempting to ascertain its degree of cleavage, split it with perfect ease into thicknesses of pasteboard, whence its adaptability to the roofing of houses is at once obvious, and needs no comment. I have also seen it in slates of great size split naturally.

The Black Ranges consist of a compact globular mass of granite surrounded with slate. Imbedded in this granite is a fine felspathic stone, similar in character to that met with in the dolerite at the McIvor Gold Fields.

On certain points of this ridge, covered with sandy alluvial soil, are found specimens of smoky quartz and black tourmaline (schörl) imbedded in *kaoline* or decomposed felspar.

The chemical constitution of the latter is aluminum 35, silica 48, and water 13; it is found in cavities twenty or twenty-five feet in diameter; and could be profitably turned to account in the manufacture of china glass. The smoky quartz is of great beauty, and besides being an ornament to museums, is valuable as an article of trade for jewellers' purposes. Hence it would be a profitable investment for the employment of labour; many valuable specimens could in a short time be procured by three or four workmen under good superintendence, and the principal expended (£200 would cover all) would be profitably returned by the sale of specimens.

The black tourmaline or schörl is interesting on account of the peculiar form in which it is crystallised. While on these ranges, as well as on other occasions, the absence of mountain limestone and mica slate in our primitive rocks struck me as a very remarkable fact, in some measure accounting for the scarcity of precious stones in our plutonic rocks.

III. *Fish.*—In the spring months the Goulburn is too deep to afford a plentiful supply of fish, but later in the season they may be obtained in large quantities. As soon as the volume of the rivers begins to diminish, the finny inhabitants leave the mud at the bottom, where they had concealed themselves for warmth, and disport themselves in the higher temperature on the surface of the water. Seven different species of fish are known by me to exist in the Murray; and five other distinct species inhabit our smaller rivers.

Of Mollusca *only four species* have as yet been found in the rivers and lakes of Victoria, viz., three varieties of univalve, and one of bivalve. It is difficult to account for this remarkable and somewhat characteristic fact; but I am inclined to think that the absence of limestone in our mountains and the long summer droughts stand in some connection with it. The Mollusca referred to are—

1.—*Lymnaea palustris* (?) *of Lamarck.* This shell is about one inch in length, and consists of three or four rapidly decreasing volutions, from left to right. It is diffused through all our lagoons.

2.—*Lymnaea peregra* (?) *of Lamarck.* The shell of this species is about three-eighths of an inch in length; the volute winds from left to right, and the colour is a dark grey. It is very plentiful in the low plains, which in winter are covered with water, but become dried up in the warm season.

3. — *Bullinus obscurus* (?) — This shell is about three-eighths of an inch in length, the convolutions winding from left to right; colour—dark yellow. It is plentiful in the numerous brackish lagoons.

4.—*Unio tumidus* (?) — This shell is very plentiful in all our rivers, and forms a considerable portion of the food of the natives during the summer season.

Frogs.—During my stay at the Goulburn in September, three species of frogs came under my observation, all very plentiful along the banks of the river.

Snakes and Lizards.—In the earlier part of October snakes and lizards become plentiful; and in the beginning of the ensuing month change their skins. They prey upon young broods of birds and animals at this season.

Black duck.—In the middle of July the sheltered places at the base of the Mount Macedon ranges become the resort of swarms of birds of every class. The natatores in particular congregate in vast flocks on the swampy plains. Conspicuous amongst these is the black duck (*Anas superciliosa*) and little teal. The *wood duck* (*Bernicla jubata*) is also observed in groups of three or four individuals in these immense flocks; and the gay plumage of the mountain duck (*Casarca tadarnoides*) here and there becomes visible.

Towards the latter end of July, the commencement of the breeding season, these birds separate in couples; they breed in the following month, and the young are brought forth in September.

Plover.—At this period (July and August) two varieties of plover, the alarm bird (*Lobivanellus lobatus*), and black breasted plovit, (*Sarciophorus pectoralis*), gather in considerable force around Mount Macedon, on the plains, especially where the ground is honeycombed.

Blue Crane (*Ardea Novæ Hollandiæ*). — In this month the blue crane may be observed flying singly through the gullies and along the creeks. This well known bird chooses his mate in September, and evinces the most ardent attachment towards her; the female, aware of this, and desiring to raise the jealousy of her paramour, pretends not to reciprocate his affection, and continually manifests a pretended desire to desert him.

The black shag or cormorant (*Phalacrocorax carboides*), frequents the creeks and gullies at this period, and is seldom observed in groups.

The curlew plovers (*Oedicnemus grallarius*), which gather

in groups of three or four, disturb the quiet of the night with their loud and shrill voices.

The order of Rassores is here represented by several varieties of quail. The predominating species (*Coturnix pectoralis*), frequents the high grassy ground near the banks of the creeks.

In September pigeons begin to arrive from the northern countries at our more grassy and congenial plains.

The absence of the woodpeckers in Australia is rather remarkable, as they are universally distributed over the whole world, Polynesia excepted.

The family psittaci, (order *incessores*), are not very frequently seen during the winter months, if we except two varieties of parrot, the blue mountain (*Trichoglossus Swainsonii*, and *Trichoglossus porphyrocephalus*), who are observed in the box trees, which, at the season alluded to, are beginning to blossom.

Cockatoo.—At the commencement of the sowing season the white cockatoos, (*Cacatua galerita*), concentrate in large flocks in the agricultural districts, and cause much annoyance to the farmers.

The gang gang cockatoo, or red crowned parrots, (*Callocephalon galeatum*), evince the most extraordinary attachment to each other, and which I have repeatedly had occasion to remark. If one of a group of these birds be shot, the wounded bird, clinging to the tree, cries loudly till dead; and a number of others, in sympathy for the fate of their unfortunate companion, refuse to quit the tree, and may be secured one after another.

King Parrot.—The beautiful king parrot or red lory, (*Aprosmictus scapulatus*), is far from being plentiful at Mount Macedon. It frequents the tops of gigantic eucalyptus, and is a very restless bird, continually flying from tree to tree.

Cuckoos.—Of the cuckoo I have observed a number of species. These moody birds sit motionless on the lower branches of the eucalyptus, and observe with lethargic indifference the exciting love affairs of the other inhabitants of the forest.

Magpie (*Gymnorhina organicum*). — In September the magpie chooses his mate, but invariably has many aspiring rivals to contend with.

Magpie Lark.—The magpie lark, (*Grallina Australis*), takes advantage of the contests which arise between other birds, especially the white magpie, at the commencement of the

BIRDS OF VICIORIA

V. COCKATOOS
(*Head with moveable crest.*)

361
Cacatua galerita
Sulphur Crested Cockatoo

365.
Licmetis Nasicus
Long billed Cockatoo

362
Cacatua Leadbeaterii
Leadbeaters Cockatoo

372
Calyptorhynchus funereus.
Funereal Cockatoo

375
Callocephalon galeatum
Gang Gang Cockatoo

W. P. Blandowski Australia.

Drawn & Engraved by Redaway & Sons Melbourne.

coupling season, and dexterously plucks feathers from the excited combatants, with which to line the interior of his nest.

In September the crows (*Corvus coronôides*) concentrate in large numbers around the squatters' home stations; where they pick the skins which are there hung out to dry, and feed upon the refuse of the stations. They are very troublesome to the bullocks, by picking in the hide for insects; and I have often seen one of these animals surrounded by them, and being far too lazy to rise, maintaining a perpetual flourish of his tail, in the vain endeavour to drive them off.

In July the satin birds (*Ptilonorhynchus holosericus*) gather in multitudes in particular localities, especially round deserted sheep stations. These large flocks consist principally of females, being accompanied only by one or two males, living in polygamy. In August and September, however, these birds retire into the more secluded districts.

The white-winged chough, or black magpie (*Corcorax leucopteris*), throughout the whole year associates in groups of ten or fifteen, and frequent the dense and hilly parts of the forests. Its voice is both loud and deep, and, when roused, breaks the silence of the bush by its monotonous cries, and peals forth an alarm to all the birds and animals of the forest. Hence it is looked upon with a distrustful eye by the sportsman; and I can myself testify to the annoyance which it in this manner causes.

Squeaker.—The squeaker (*Strepera anaphonensis*) is a shy and solitary bird, living entirely on the flats, and is remarkable on account of its frequenting only the same locality. He is hence easily distinguished from the Gymnorhina tibicen, whose shrill and piping voice is so well known on all the high lands.

Little Kingfisher.—The little kingfisher (*Halcyon sanctus*) is plentiful along the banks of the creeks and rivers, but quickly disappears at the approach of the observer.

Laughing Jackass.—The great kingfisher (*Dacelo gigantea*) or, as it is more familiarly known, the laughing jackass, during the winter lives entirely on small fish, but in the summer months snakes and lizards form the staple of its food. It is well known to the colonists for its peculiar cry; at the first dawn of sunrise its wild laugh is heard resounding far and wide through the woods, waking up the birds and animals of

the forest. At sunset, again, his loud notes summon all nature to rest, and peal forth a last good night to all.

Friar Bird.—The *Tropidorhynchus corniculatis* is well known to the colonists by the names "poor soldier," "leather-headed jackass," "friar bird," &c., &c. This curious bird, in common with several other varieties of honey-eaters, is remarkable on account of its extreme liveliness, and the singular resemblance of its notes to the human voice, which is a source of much amusement to ladies residing in the bush, and who are sometimes inclined to maintain that the bird possesses the power of verbally expressing its emotions.

Flycatchers, &c.—The flycatchers, robins, and finches, are plentiful along the banks of the creeks and rivers, and in the neighbourhood of huts or villages.

Of the hawk tribe Australia contains but few distinct families, but the number of species is exceedingly large; about thirty-seven.

Eagle.—In the mountainous districts, the eagle (*Aquilla fucosa*), is numerous, and may be observed wheeling majestically through the air, at an immense altitude, scanning the earth with a greedy and rapacious eye, and anticipatory of a luxuriant repast on the carcasses of scabby sheep which strew the plains, and which, indeed, are sufficiently numerous to satisfy the appetite of the whole tribe.

Six hundred species of birds have already been discovered in Australia, and about half of these, viz. 300, are inhabitants of Victoria. In the National Museum are about 230 species (with an equal number of duplicates), and when we consider that the institution has been scarcely eight months in existence, we have no reason to be ashamed of the progress made when a comparison is drawn with the museums of our sister colonies.

Animals.—Of mammalia Australia possesses but very few orders; the marsupial division is however developed to its fullest extent, more so than in any other portion of the globe, being in fact characteristic of this continent.

Of the *chelopoda* we have only one representative, the dingo or wild dog, of which there are three species.

Marsupials.—The first of the marsupial order of animals was discovered in America, and the astonishment which pervaded the ranks of scientific men upon the occasion was still more heightened when it was made known, that in a far

more distant part of the globe, the marsupiala were developed to their fullest extent. "Australia," says Waterhouse, "is the great metropolis of these animals," upwards of seventy species having been already discovered in that vast territory.

This division of the animal kingdom is marked with characteristics, of so peculiar and remarkable a nature as to render them of the highest interest to the zoologist; I allude to the pouch and to the marsupial bones. The latter perhaps are not so well known to the general public as the more obvious characteristic of the female pouch. Another point of unusual interest in the marsupiala is the manner in which the young are born. The embryo, at the time of its birth, is so little advanced when compared with the young of other animals, that many naturalists, in order to explain the difficulty of so imperfect a creature reaching the pouch, have started the opinion that it is born through the teat and not through the uterus, in the usual way; but this hypothesis is now almost entirely abandoned, and it is pretty generally received that the young marsupial is conveyed to the pouch by the mother, and carefully placed on the teat, where it remains till it has attained a considerable size. It is a curious and remarkable provision of nature that the young animal obtains the power of vision, so soon as its increasing weight has disengaged it from the teat, although it lives entirely in the pouch a considerable time after the commencement of this, its secondary period of existence. It is not however till the third period that the skin becomes covered with fur, and the animal obtains its full sight; it then quits the pouch, but upon the least approach of danger is received into it.

The class reptantia is represented in Australia by the *ornithorychus rufus* or *paradoxus* (*platypus anatimus* of Shaw), and the *echidna histryx* or porcupine anteater of the colonists.

Platypus.—In the first colonisation of Australia both these animals was regarded with so much interest as to elicit the most minute description from every naturalist who visited that vast continent, and rendering later investigations respecting them in some measure superfluous. My observations in this quarter are therefore both few and limited; and though I have had many opportunities for investigations of this nature, I have thought proper to confine myself to those of which less is known. The heel of the platypus is furnished with a large pointed spur, said to be moveable, and which in the male animal is hollow. The object for which nature

provides this appanage is at present unknown, though I am inclined to think that it is intended as a means of defence against attack. Be this as it may, however, the natives entertain a strong prejudice against touching a platypus, though they are not ready to state the reason of their apprehensions.

These animals frequent the quiet waterholes of the creeks and rivers, and are easily detected in the water by the circles and eddies which are formed around them. "On the slightest alarm," says Waterhouse, "they instantly disappear, and indeed they seldom remain longer on the surface than one or two minutes, but dive head foremost with an audible splash, re-appearing, if not alarmed, a short distance from the spot at which they dived. Their action is so rapid, and their sense of danger so lively, that the mere act of levelling the gun is sufficient to cause their instant disappearance; and it is, consequently, only by watching them when diving, and levelling the piece in a direction towards the spot at which they seem likely to re-appear, that a fair shot at them can be obtained. A near shot is absolutely requisite; and when wounded they usually sink immediately, but quickly re-appear on the surface." The burrows which the platypus makes are very extensive, from twenty to fifty feet in length; its entrance is invariably close to the water's edge, and its other extremity terminates in a capacious chamber, sufficiently large for the residence both of the adults and young.

Porcupine.—This extraordinary animal, which somewhat resembles a hedgehog, but like the platypus is distinguished by a long and slender bill, like that of a duck, is nowhere observable during the winter months, but makes its appearance on the higher ranges in September. The skin of the porcupine is double, the outer one being covered with the fur, while the pines are inserted in the lower skin, which is very muscular and fully half an inch thick. Between this and the flesh is a layer of fat. Like the platypus, the hind foot of the echidna is provided with a powerful horny spur, evidently intended by nature as a weapon of defence. The facility and the rapidity with which this animal burrows is truly astonishing, its powerful claws, beak-like snout, and even the spines of its back being brought into requisition. Flinders relates that his dogs having discovered a porcupine anteater were quite unable to produce any impression upon it, and he escaped, "by burrowing in the loose sand—not head foremost, but by sinking himself directly downwards;

and thus presenting nothing but his prickly back to his adversaries." The body of the animal, when burrowing, is contracted into a minimum space, and the loose earth thrown backwards, the whole of its spiny back thus becoming gradually covered, till, by suddenly expanding its quills, it is thrown off. An echidna being placed in a large chest of earth containing plants, the animal arrived at the bottom in less than two minutes, (*vide* Quoy and Gaimard). I kept two living specimens on a tether rope for a considerable length of time, with the intention of bringing them to Melbourne alive, but unfavorable circumstances compelled me to kill them, and content myself with securing the skins alone.

Many naturalists make the platypus and echidna the representatives of a new order. Both these animals possess the *ossa marsupiala*, though no traces of a pouch are at all discoverable, whence it appears to me that they cannot with propriety be classed with the marsupials. "The platypus," says Waterhouse, "is decidedly the lowest of the mammalia yet discovered; and both it and the echidna, in many of their anatomical characters, evince a considerable approach towards the class reptilia. The latter animal, too, is known to possess a power of fasting which had hitherto been ascribed only to reptiles, and becomes dormant when exposed to any considerable degree of cold.

Prenziculantia.—Of this order, only one species, viz.:—the Hydromis is at present known to me.

Incredible numbers of water rats (*Hydromis leucogaster*) frequent the lagoons of the Goulburn during the spring months. These animals are remarkable for their sharp sight, and the mode in which they swim: the whole body, with the exception of the extremities of the nose and tail, being immersed. Their extreme vigilance renders them very difficult to be obtained, the least movement being sufficient to cause their instant disappearance; hence it is only by a series of close observations that the beholder is apprised of their great numbers.

Wombat.—This clumsy, but well known, animal (*Phascolomys wombat*) during the day conceals himself in his gloomy lair in the loneliest recesses of the mountains, and usually on the banks of a creek, and at night roams about in search of food, which it finds by grubbing about the roots of gigantic eucalypti. Thus protected by the darkness and the dense forest, but few opportunities occur to the naturalist of making close observation of its habits, which accounts for

the scarcity of information on this subject, in books treating on the Zoology of Australia. Their capture is also attended with a very considerable degree of difficulty, so much so that the utmost exertions of three or four men for several days are insufficient to effect it. As an illustration of this, I subjoin the following extract from my diary, showing the mode which the natives pursue in endeavoring to effect its capture.

Sept. 10, 1854.—The aborigines, Sandy and Mackenzie, searching the banks of the creek for wombats; and succeeding in tracking one to a hole, the opening of which was then carefully obstructed.

11*th.*—Sandy and Mackenzie again repaired to the hole, which, having been cleared of the logs placed before it, was entered by Sandy; the other remaining above, listening attentively to the knocking of his companion below, indicative of the situation of the animal. This spot is carefully marked on the surface, and the native having come out, the hole is again blocked.

12*th.*—The three natives sunk a shaft on the spot, which had been ascertained by them yesterday, and bottomed it at a depth of twenty-two feet. Found, to their astonishment, that the animal had disappeared, and left the work for the day; the opening, as before, being carefully obstructed.

13*th.*—The natives almost exhausted, so myself and assistant began to dig for the wombat, and sunk a new shaft of seventeen feet; but on bottoming it, had the mortification to discover that the animal had again disappeared. Here we lost all traces of him, the natives being equally at fault; and at length gave up the search.

The flesh of the wombat is by the natives esteemed as a great delicacy. The taste when roasted is not unlike that of veal; as I have on several occasions, owing to a scarcity of provisions, been obliged to avail myself of it.

I could never induce a native to skin a wombat, and after considerable inquiry as to the cause assigned for this refusal, I was enabled to ascertain that it was owing to a supposed pernicious effect which it had upon the bones of the hand. Whether the fat of the animal in a raw state may not exert some influence on the phosporus of the bone, I leave it for others to decide.

Koala.—The koala or karbor *(Phascolarctos cinereus)* frequents very high trees, and sits in places where it is most sheltered by the branches, hence it is with difficulty detected, especially as its fur is of the same colour as the bark of the

tree on which it sits. This remarkable animal, like the cat, has the power of contracting and expanding the pupil of the eye. Its skin is remarkably thick, and the back is covered with dense woolly fur. It is very difficult to skin, and the natives regard it with the same superstition as the wombat, already mentioned. The male has a gland on the breast which emits a very strong and offensive odour. The kaola uses the two first toes on the fore paws jointly for the thumb; it is a very inactive animal, being known to remain several days on the highest branch of a tree, without any other motion than that of drawing the branches to it, on the leaves of which it feeds. Even when shot it merely shrinks at the report of the gun, but in nowise offers to move. The natives aver that the koala never drinks water, and from the insufficiency of opposite testimony on this point, it is highly probable that such is the case; as I have myself kept one alive for three weeks without being able to induce it to drink. When thus placed in confinement, it barks in a melancholy tone during the night, like a dog.

In September the young koala is in the last period of dependency upon its parent, and may be observed sitting on the back of the mother.

Halmaturini (Kangaroos).—During my travels in Victoria I have met with seven distinct species of kangaroo; but insufficiency of leisure time has prevented me from making those observations which I otherwise should have desired, and I add only a few remarks concerning those varieties which are the most common.

1. *Halmaturus gigantea.*—This species, so well known to the colonists by the names of forester, old man, boomer, &c., has now entirely disappeared from the neighbourhood of Mount Macedon, a locality in which it was formerly exceedingly plentiful. The Black Ranges, however, on the Goulburn, are yet inhabited by considerable numbers of these animals.

The Wallaby (Macropus nalabatus) is plentiful in the lonely passes of Mount Macedon; but the amazing rapidity with which it retreats into the dense scrub, at the least signal of alarm, renders it of very difficult capture, unless the sportsman be well provided with good dogs trained to the chase.

Hypsiprymnus (Kangaroo rat).—Two species of this animal have come under my notice, viz., the common variety, with the white-pointed tail; and a new species, the tail of which is completely destitute of fur.

Dasyurini.—This order is divided into two great branches: the first group contains the bandicoot *(Perameler nasutus)* and the bush rat *(P. Gunnii)*.

Both these animals are extremely plentiful throughout the whole colony; in the summer they frequent the plains, whence they are driven by the heavy winter rains, and forced to take refuge in the higher lands. They are not fitted to ascend trees, and being thus confined to the ground and surrounded by enemies, including bush fires, can never become more numerous than they are at present.

To the other divisions of dasyurini belong the tiger cat, *(dasyurus maculatus,)* and the native cat, *(Dasyurus viverrinus)*, of which there are two varieties.

The Tiger Cat though its dimensions are not sufficiently great to invest it with a formidable appearance, is nevertheless a most ferocious and blood-thirsty little animal. Of late years, however, it has become very scarce, so that it is with difficulty obtained at the present time. During a stay of two months on and around Mount Macedon I was only enabled to procure one specimen.

Native Cat.—Of the *Dasyurus viverrinus* or native cat there are two varieties, as has been mentioned, viz., the *alba niger* and *alba castarea*. These little animals are extremely courageous when attacked; and are very plentiful around sheep stations, where the settlers use every means for exterminating them. There are now large numbers of them in localities where, before the intrusion of the European, they were extremely rare; in short, their numbers have augmented in proportion as those of the dingo have diminished, in accordance with that inscrutable law of nature which regulates the equilibrium of animal life.

The Rabbit Rat. (—?)—This little animal is well known to hutkeepers and to residents in the bush, on account of its prying and inquisitive propensities, and the fondness which it appears to possess for sugar and other stores.

Phalangistæ.—The phalangers, *i. e.* the balantia of *Heiger*, contains the two great genera, the flying squirrel *(Petaurii)*, and opossums *(Didelphis)*.

Of the former, I have observed in Victoria six different species, but on account of insufficiency of leisure time, I am unavoidably prevented from making those observations which I should under other circumstances have desired.

The common flying squirrel (*Petaurus scuirens*) is very plentiful in the large gum trees near the banks of a creek or

river, and appears to entertain a peculiar aversion to the high lands. This animal is unquestionably one of the most beautiful animals in the country; and its fur, which is particularly fine and soft, will, no doubt, at some future time, become an article of commercial value. The petaurus flies with considerable facility from tree to tree, on which it is only detected by the motion of its long and bushy tail, and the peculiar shrieks which announce its desperate leaps. The general color is yellowish-grey, sometimes of a rusty hue.

Closely allied to the above species is the flying opossum, (*Petaurus taquanoides*,) black squirrel, which differs from it chiefly in the larger size which it attains, the blackness of its coat, and the greater length of the tail.

A third species is of a white colour, sometimes becoming of a yellowish-grey tint; but whether the specimens which came under my notice were albinos or not I am at present unable to decide.

A fourth variety, somewhat smaller than the preceding; color, ash-grey.

A fifth species, still smaller; grey colour.

The sixth and last variety is that known by the name of flying mouse (*Petaurus pygmœus*).

The Petaurii, I am inclined to believe, breed nearly two months later than the other branches of the marsupiala. The embryo remains blind during its second period.

Opossums (Didelphis).—The class of animals to which the term opossum was originally applied, and to which it is therefore with strict propriety limited, has no representatives whatever in Australia. The didelphis, however, familiarly recognised as opossum by the colonists, occurs in three different varieties.

a. Brush-tailed opossum.

b. A second variety, in which the tail is tipped white.

c. Ring-Tail Opossum.—The fœtus of this species is black, a distinction sufficiently great to make it rank as an independent group.

The young of the opossums are brought forth in the latter end of June; but do not obtain their full sight till the middle of August.

Phalangista.—To the family phalangista belong the flying squirrels (*Petaurii*), and opossums (*Didelphis*).

Chiroptera.—As yet only two species of chiroptera have been discovered in Victoria, viz., the vampyre bat, and the common small bat.

Vampyre Bat.—The former, which is familiarly known by the name of the "devil," or flying fox, is found in all the mountain ranges, but is especially numerous in those parts of the coast abounding in hollows and caverns. It sometimes measures three and a half feet across the wings.

Common Bat.—The common bat, like the less numerous species above mentioned, is found over the whole colony, but especially in rocky places along the coast.

IV.—The Aborigines of the Goulburn are few in number, of a peaceable disposition, and distinguished by a local language and characteristic habits. The whole of the tribes living in the same latitude towards Mount Gambier, are peaceably disposed, and in this respect differ most materially from the Fisher and the savage Murray tribes.

During my journey to Seymour, I met with a camp of Aborigines, by whom I was willingly accompanied to that place. Having observed an unusually large number of dead trees in a forest which we passed through, I was induced to inquire the cause of so peculiar a circumstance, and was informed, in reply, that it was the spot on which a once very numerous Goulburn tribe was overwhelmed by a still more powerful tribe, inhabiting the banks of the Murray. Each of the dead trees represent a member of the extinguished clan; and the custom is still maintained by those tribes neighbouring the Goulburn, and has its origin in the following superstitious ceremony.

Upon a youth arriving at manhood, he is conducted by three of the leaders of his tribe, into the recesses of the woods, where he remains *two days* and *one night.* Being furnished with a piece of wood, he knocks out two of the teeth of his upper front jaw; and on returning to the camp carefully consigns them to his mother. The youth then again retires into the forest, and remains absent *two nights* and *one day;* during which, his mother, having selected a young gum tree, inserts the teeth in the bark, in the fork of two of the topmost branches. This tree is made known only to certain persons of the tribe, and is strictly kept from the knowledge of the youth himself. In case the person to whom the tree is thus dedicated dies, the foot of it is stripped of its bark, and it is killed by the application of fire; thus becoming a monument of the deceased. Hence, we need no longer be surprised at so frequently finding groups of dead trees in healthy and verdant forests, and surrounded by luxuriant vegetation.

The three natives whom I have before-mentioned as having accompanied me to Seymour, having refused to stay with me so close to the lagoon where I had fixed my camp, I inquired the reason assigned for their refusal, and was informed, that an animal somewhat resembling an emu, but with much longer legs, and of so formidable a character as to threaten them with danger, usually makes its appearance during the commencement of the warmer season, and prowls about the lagoons; but whether this statement contained any degree of truth I will not now venture to say.

In the commencement of October the Goulburn river falls to its proper level, the winter rains having then subsided; and the multitudes of fish which appear in its waters attract hither the tribes inhabiting the surrounding districts. At that season too, they subsist upon eggs, which may then be obtained in abundance; and upon turtle and river mollusca. Hence the reason why they regard with indifference their employment by the settlers. At other times of the year, however, when the bounties of nature are not afforded on so liberal a scale, they avail themselves largely of ants' eggs, which are collected when travelling through the forest. For this purpose the hollow trees, in which it is likely the ants have deposited their eggs, are carefully inspected, and upon the discovery of one containing them it is opened with a tomahawk, and the ants and their eggs abstracted from it. These are promiscuously thrown together into a kangaroo skin and are roughly shaken, by which the eggs, on account of their greater specific gravity, are precipitated to the bottom, and the ants, particles of wood, and other impurities on the surface, being then removed, the eggs are eaten raw. I have myself tasted the eggs; they resemble sago, and possess a very peculiar aroma.

In the spring of the year marriages become frequent amongst the natives, no doubt on account of the profuseness with which the gifts of nature are then distributed. As it may be interesting to know the mode in which this family affair is conducted, I have thought fit to subjoin the following short account.

The young man who wishes to marry, has first to look out for a wife amongst the girls or *leubras* of some neighbouring tribe, and having fixed his choice, his next care is to obtain her consent. This being managed the happy couple straightway elope, and remain together in the bush for two nights and one day in order to elude the pretended search of

the tribe to whom the female belonged. This concludes the the ceremony, and the young man then returns with his wife to his own tribe. He is, however, laid under this peculiar injunction, that he must not see any more his mother-in-law; and the following circumstance in connection with this fact, has been related to me by Mr. Grant, an eye-witness. "A mother-in-law having been descried approaching, a number of leubras formed a circle around the young man, and he himself covered his face with his hands;—this, while it screened the old lady from his sight, served as a warning for her not to approach, as she must never be informed by a third party of the presence of her son-in-law."

The natives, however, of this, as of every other settled part of Australia, are fast disappearing before the rapid encroachments of the white man; in perfect accordance with that universal but mysterious law which governs civilization wherever the white man has planted its flag, sweeping the backward races from the face of the earth.

Art. VI.—*Original Rules and Tables adapted to Cases of Sidelong Ground in the Setting Out and Computation of Railway Earthworks. By* Clement Hodgkinson, C.E., District Surveyor.

Having originally investigated and computed the following formulæ and tables for my own use, I venture to submit them to those members of the Philosophical Society who belong to the Engineering Profession.

Before giving my tables for determining the side distances that define, on sidelong ground, the edges of railway cuttings and embankments on both sides of the central line of equidistant stakes, I will briefly state the methods that have been generally followed for determining side distances.

First.—Instrumentally; by means of the well known combination of graduated bars and arcs devised by Sir John Macneil, which, when the sidelong inclination on either side of any stake had been determined by a clinometer or other instrument, admitted of being adjusted so as to show by inspection, on a graduated bar, the required side distance. Sir John Macneil's instrument is not however applicable to those constantly recurring cases in which a

railway is partly in cutting and partly in embankment on the same side of a centre stake.

Second.—By successive approximations with the aid of the spirit-level. This method, which has been found well adapted for uneven ground, has been explained in detail in the work of Mr. Frederick Sims, C.E., lately Inspector of Railways for the Hon. East India Company; and has been very frequently employed by other engineers. I however noticed, some years ago, that his rule for determining the side distances, when the cross section showed both cutting and embankment on the same side of any centre stake, was totally wrong, and had occasioned errors of several feet in side distances set off for the South Eastern Railway. As Mr. Simm's work has passed through several editions, and as the erroneous rule alluded to has been since given in another work brought out by the well known publisher, Mr. Weale, I trust this passing allusion to it may not be considered uncalled for.*

Third.—By plotting the cross sections of the ground upon a large scale, and taking the side distances from the diagrams.

Fourth.—By various rules of thumb in vogue among contractors, and not admitting of mathematical demonstration.

Having considered it would be preferable to employ tabulated quantities for determining side distances, in lieu of employing Macneil's instrument, I have derived from the following formulæ the annexed tables of *multipliers*, and I have found that by using these multipliers (which are also applicable to those cases wherein Macneil's instrument fails to be of service), the required side distances can be computed and set off on the ground with more rapidity and certainty than by an instrument whose bars and arcs have to be adjusted at every stake.

Let A B C D (Fig. II.) represent a portion of the cross section of a railway cutting on one side of the centre stake at H: the ground, in this diagram, *converging* from the centre stake towards the plane of base at formation level. Draw

* A point being assumed as near the true position of the point D (Fig. I.) on the ground as can be determined by estimation, then the difference of level between that point and the central stake H, minus the height B H, would be the first approximate value of D N, which multiplied by ratios of slope for embankment, would give the first approximate value of C N; which should be added in order to obtain the first approximate value of the side distance, B N, to B C, *the half-width at formation level*, and not to H O, *the computed horizontal half-width for the height* B H, as in Mr. Simm's treatise.

H L, D O, parallel to base A C, and D K perpendicular to H L.

Now let $\frac{b}{2}$ denote half base or B C.

h the height B H at centre stake.

$m : 1$ rate of inclination of slopes.

δ angle of inclination of sidelong ground.

x the required horizontal side distance, or C D

Then D K $= x$ tang δ

$$\text{DK} = \frac{\text{K L}}{m} \quad \frac{\frac{b}{2} \; h + m - x}{m}$$

$$x \text{ tang } \delta = \frac{\frac{b}{2} + h\,m - x}{m}$$

$$x = \frac{b}{2} + h\,m \left(\frac{1}{1 + \text{tang } \delta.\, m}\right)$$

In Fig. III., in which the sidelong inclination *diverges* from the centre stake in reference to the plane of the base, we obtain, in a similar manner,

Side distance or $x = \frac{b}{2} + h\,m \left(\frac{1}{1 - \text{tang } \delta.\, m}\right)$

In Fig. IV. let the profile of the sidelong ground cross the half base, and occasion cutting and embankment on the same side of the centre stake.

Here D K + H L = H L tang δ.

$$\text{D K} = \text{H L tang } \delta - \text{K L} = x.\ \text{tang } \delta - h$$

$$\text{D K} = \frac{\text{C K}}{m} = \frac{x - b}{m}$$

$$x.\ \text{tang } \delta - h = \frac{x - b}{m}$$

$$x = b - h\,m \left(\frac{1}{1 - \text{tang } \delta.\, m}\right)$$

In Table No. I. I have given values of $\frac{1}{1 - \text{tang } \delta.\, m}$ for the more ordinary slopes, and in Table No. II. similar values of

$$\frac{1}{1 + \text{tang } \delta.\, m}$$

TABLE—No. I.

$$\frac{1}{1 - \text{tang } \delta . m}$$

INCLINATION.	SLOPES.			
	1 to 1	1½ to 1	2 to 1	2½ to 1
° ′				
0 — 0	1·000	1·000	1·000	1·000
0 10	1·003	1·004	1.006	1·009
20	1·006	1·009	1·011	1·014
30	1·009	1·013	1·017	1·021
40	1·012	1·017	1·023	1·028
50	1·015	1·022	1·029	1·036
1 — 0	1·018	1·027	1·036	1·044
10	1·021	1·031	1·042	1·052
20	1·024	1·035	1·048	1·060
30	1·027	1·039	1·054	1·068
40	1·030	1·044	1·061	1·077
50	1·033	1·049	1·068	1·086
2 — 0	1·036	1·054	1·075	1·096
10	1·039	1·059	1·081	1·105
20	1·042	1·064	1·088	1·114
30	1·045	1·069	1·095	1·123
40	1·048	1·074	1·102	1·132
50	1·051	1·079	1·109	1·141
3 — 0	1·055	1·085	1·117	1·151
10	1·058	1·090	1·124	1·161
20	1·061	1·095	1·131	1·171
30	1·064	1·100	1·139	1·181
40	1·068	1·105	1·147	1·191
50	1·071	1·111	1·155	1·201
4 — 0	1·075	1·117	1·163	1·212
10	1·078	1·122	1·171	1·223
20	1·081	1·127	1·179	1·234
30	1·084	1·133	1·187	1·245
40	1·088	1·139	1·195	1·256
50	1·092	1·145	1·203	1·268
5 — 0	1·096	1·151	1·212	1·280
10	1·100	1·157	1·221	1·292
20	1·103	1·163	1·230	1·304
30	1·106	1·169	1·239	1·317
40	1·110	1·175	1·248	1·330
50	1·114	1·181	1·257	1·343

TABLE—NO. I.—*continued.*

INCLINATION.	SLOPES.			
	1 to 1	1½ to 1	2 to 1	2½ to 1
° ′				
6 — 0	1·118	1·187	1·266	1·356
10	1·121	1·193	1·276	1·370
20	1·125	1·199	1·285	1·384
30	1·129	1·205	1·295	1·398
40	1·132	1·212	1·305	1·413
50	1·136	1·219	1·315	1·428
7 — 0	1·140	1·226	1·325	1·443
10	1·143	1·232	1·335	1·458
20	1·147	1·239	1·345	1·474
30	1·151	1·246	1·356	1·491
40	1·155	1·253	1·367	1·508
50	1·159	1·260	1·378	1·525
8 — 0	1·163	1·267	1·390	1·542
10	1·167	1·274	1·402	1·550
20	1·171	1·281	1·414	1·578
30	1·175	1·288	1·426	1·597
40	1·179	1·296	1·438	1·616
50	1·183	1·304	1·451	1·635
9 — 0	1·188	1·312	1·464	1·655
10	1·192	1·319	1·477	1·675
20	1·196	1·327	1·490	1·696
30	1·200	1·335	1·503	1·718
40	1·204	1·343	1·517	1·741
50	1·209	1·351	1·531	1·764
10 — 0	1·214	1·359	1·545	1·788
10	1·218	1·367	1·559	1·813
20	1·222	1·376	1·574	1·839
30	1·226	1·385	1·589	1·865
40	1·231	1·394	1·604	1·892
50	1·236	1.403	1·620	1·919
11 — 0	1·241	1·412	1·636	1·947
10	1·245	1·421	1·652	1·976
20	1·250	1·430	1·669	2·006
30	1·255	1·439	1·686	2·037
40	1·260	1·448	1·704	2·069
50	1·265	1·458	1·722	2·102
12 — 0	1·270	1·468	1·740	2·136
10	1·275	1·478	1·759	2·171
20	1·280	1·488	1·779	2·207
30	1·285	1·498	1·799	2·244
40	1·290	1·508	1·819	2·283
50	1·295	1·519	1·840	2·323

TABLE—NO. I.—*continued.*

INCLINATION.	SLOPES.			
	1 to 1	1½ to 1	2 to 1	2½ to 1
° ′				
13 — 0	1·300	1·530	1·860	2·365
10	1·305	1·541	1·881	2·408
20	1·310	1·552	1·902	2 453
30	1·315	1·563	1·924	2·500
40	1·320	1·574	1·947	2·549
50	1·326	1·575	1·971	2·601
14 — 0	1·332	1·597	1·997	2·655
10	1·337	1·609	2·022	2·711
20	1·342	1·621	2·048	2·769
30	1·348	1·633	2·074	2·830
40	1·354	1·645	2·101	2·893
50	1·360	1·658	2·128	2·960
15 — 0	1·366	1·671	2·156	3·030
10	1·372	1·684	2·185	3·104
20	1·378	1·698	2·215	3·182
30	1·384	1·712	2·246	3·264
40	1·390	1·726	2·278	3·350
50	1·396	1·740	2·310	3·440
16 — 0	1·400	1·754	2·344	3·534
10	1·407	1·769	2·380	3·633
20	1·414	1·784	2 417	3·740
30	1·420	1·799	2·455	3·855
40	1·426	1·814	2·494	3·978
50	1·433	1·830	2·534	4·109
17 — 0	1·440	1·846	2·575	4·250
10	1·447	1·863	2·617	4·402
20	1·454	1·880	2·661	4·565
30	1·461	1·897	2·707	4·739
40	1·468	1·914	2·755	4·924
50	1·475	1·932	2·805	5·120
18 — 0	1·482	1·950	2·856	5·328

TABLE—No. II.

$$\frac{1}{1 + \text{tang } \delta . m}$$

SIDELONG INCLINATION.	SLOPE 1 to 1	SLOPE 1½ to 1	SLOPE 2 to 1	SLOPE 2½ to 1
° ′				
0 — 0	1·000	1·000	1·000	1·000
10	·997	·996	·994	·993
20	·994	·991	·988	·986
30	991	·987	·982	·980
40	·988	·982	·977	·973
50	·985	·978	·971	·966
1 — 0	·982	·974	·966	·959
20	·977	·967	·956	·946
40	·972	·958	·945	·933
2 — 0	·966	·951	·935	·922
20	·961	·943	·924	·909
40	·956	·936	·915	·897
3 — 0	·950	·928	·905	·885
20	·945	·920	·896	·873
40	·940	·912	·887	·861
4 — 0	·935	·905	·878	·850
20	·930	·898	·869	·839
40	·925	·891	·860	·829
5 — 0	·920	·884	·851	·819
20	·915	·877	·842	·809
40	·910	870	·834	·800
6 — 0	·905	·863	·826	·791
20	·900	·857	·818	·782
40	·895	·851	·810	·773
7 — 0	·890	·846	·802	·764
20	·885	·839	·791	·756
40	·881	·833	·787	·748
8 — 0	·876	·826	·781	·740
20	·871	·820	·773	·732
40	·866	·813	·765	·724
9 — 0	·862	·808	·759	·717
20	·858	·802	·752	·709
40	·854	·796	·745	·701
10 — 0	·850	·790	·739	·694
20	·845	·784	·733	·687
40	·841	·778	·726	·680

TABLE—No. II.—*continued.*

SIDELONG INCLINATION.	SLOPE 1 to 1	SLOPE 1½ to 1	SLOPE 2 to 1	SLOPE 2½ to 1
° ′				
11 — 0	·836	·772	·719	·673
20	·832	·767	·713	·666
40	·828	·762	·707	·659
12 — 0	·824	·758	·701	·653
20	·820	·753	·695	·646
40	·816	·748	·689	·640
13 — 0	·812	·743	·683	·634
20	·808	·738	·677	·628
40	·804	·733	·672	·622
14 — 0	·800	·728	·667	·616
20	·796	·723	·661	·610
40	·792	·718	·656	·604
15 — 0	·788	·713	·650	·598
20	·784	·708	·645	·592
40	·780	·703	·640	·587
16 — 0	·777	·699	·635	·582
20	·773	·694	·630	·577
40	·769	·690	·625	·572
17 — 0	·765	·685	·620	·567
20	·761	·680	·615	·562
40	·757	·676	·610	·557
18 — 0	·754	·672	·606	·551

EXAMPLE OF APPLICATION OF TABLES.

Nature of earthwork.	No. of stake.	Base.	Slopes.	Heights.	Horizontal ½ widths corresponding to heights.	Sidelong Inclination.		Tabular multipliers.		Required side distances.	
						Left.	Right.	Left.	Right.	Left.	Right.
						Dep.	El.				
Cutting	46	30	1 to 1	10·2	25·2	6° 30′	6° 0′	·903	1·118	22·8	28·2
do	47	do	do	7	21	6 20	4 40	·900	1·088	18·9	22·8
do	48	do	do	3·4	18·4	6 0	6 0	·905	1·118	16·7	20·6
do	49	do	do	1·2	16·2	5 40	5 30	1·175 / ·910	1·106	15·5	17·9
Embank.	50	do	1½-1	3	19·5	5 20	5 20	1·163	·877	22·7	17·1

The tabular multipliers corresponding to angles of *elevation* for *cuttings*, and *depression* for *embankments*, are taken from Table No. I.; and those corresponding to angles of *depression* for *cuttings*, and *elevation* for *embankments*, are taken from Table No. II. Whenever the product of the horizontal half width (in column 6), by a tabular number, is *less* than the half base, it is an indication that there will be both cutting and embankment on the same side of the centre stake. This is the case on the left side of stake No. 49 of the given example; and the required side distance, in this instance, is obtained by deducting from the half base, or 15, the product of the height 1·2 by the slope of embankment $1\frac{1}{2}$, and then multiplying this difference by the corresponding tabular number 1·175, taken from Table II., in accordance with the Formula No. III.

Formula for occasional use in computing the volume of a portion of a Cutting or Embankment between two consecutive centre pegs, when the sidelong inclination differs considerably at each peg.

I VENTURE to submit the following investigation of the volume of earthwork having rapidly changing profiles; as any rule that would tend to the attainment of greater accuracy in the computation of cubic contents in such cases, might be sometimes applicable in this colony, where the great cost of earthworks renders precision in the estimated contents thereof a matter of very great importance.

The French have made long and complicated investigations in connexion with the subject of *deblais* and *remblais*, but their formulæ are too abstruse for any practical application, and their tables for facilitating ordinary computation of earthwork, are less convenient than Bidder's improved tables and some others in use by British engineers.

I am indebted to the French for the hypothesis of the mode in which the surface of the ground may be conceived to be generated in the following investigation; but the investigation itself, and comparatively simple formula obtained, are my own.

Let A B C D E F G H (Fig. V.) represent a portion of railway cutting between consecutive stakes, and let the sidelong angle of inclination H G H′ be not equal to the sidelong angle of inclination D C D′ at the other end of this earthwork. In the first place it is evident that the surface D C G H is not a plane surface, but a contorted surface, and it may be conceived to

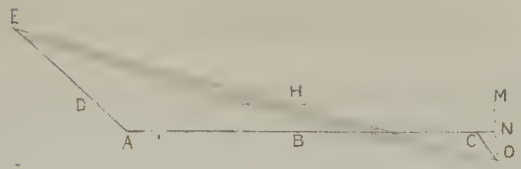


Fig. 1.

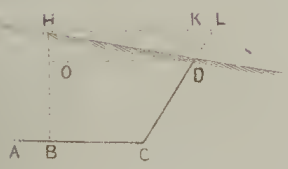


Fig. 2.

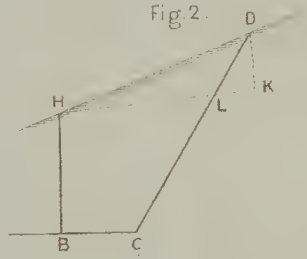


Fig. 3

Fig. 4.

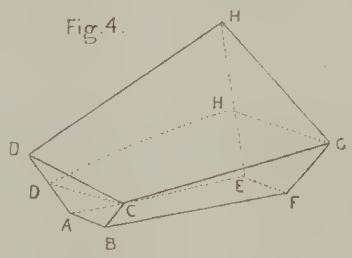


Fig. 5.

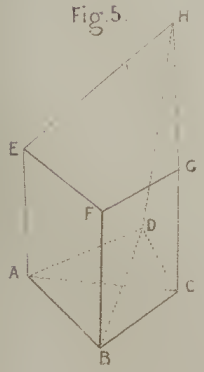
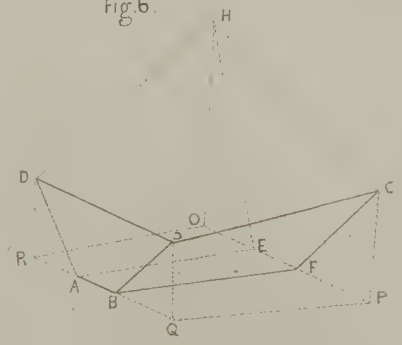


Fig. 6.



be generated as follows:—Let a line in the position C G slide along the lines C D, G H, in such a manner that it may pass over respective distances on each line continually proportional to C D, G H; then, when this moving line arrives at D it arrives simultaneously at H. This moving line would generate a contorted surface that might be, for several reasons, assumed to be equivalent to that of the railway cutting D C G H.

The volume of a solid founded on one side by a contorted surface generated in the manner just described can be mathematically determined. Thus, let A B C D E F G H (Fig. VI.) represent a solid whose base, A B C D, is a trapezoid, whose sides are planes perpendicular to the base, and which is bounded above by the contorted surface E F G H; now, if

s denote area of triangle A B C
s_1 ... area of triangle A C D
h_1 ... B F
h_2 ... C G
h_3 ... D H
h_4 ... A E

It can be demonstrated that volume of solid

$$\text{ABCDEFGH} = \frac{s\left(h_1 + h_2 + \frac{1}{2}\left(h_3 + h_4\right)\right) + s_1\left(h_3 + h_4 + \frac{1}{2}\left(h_1 + h_2\right)\right)}{3}$$

Reverting again to the prismoidal portion of cutting bounded above by the contorted surface assumed to be generated as described,

Let b denote the base A B
d ... the length B F
l ... ... D R
l' ... ... H O
r ... ... C Q
r' ... ... G P
m to l ... the slopes
V ... the required volume.

V = R Q P O D C G H — A D R E H O — B E Q F G P

of which

$$\text{RQPODCGH} = \tfrac{1}{2}\text{RQ QP}.\left(\text{DR} + \text{CQ} + \frac{\text{HO}}{2} + \frac{\text{GP}}{2}\right) + \tfrac{1}{2}\text{OP. QP}.\left(\text{HO} + \text{GP} + \frac{\text{DR}}{2} + \frac{\text{CQ}}{2}\right)$$

or,

$$\text{RQPODCGH} = \frac{d}{6}\left\{\left(b + lm + rm\right).\left(l + r + \frac{l'}{2} + \frac{r'}{2}\right) + \left(b + l'm + r'm\right).\left(l' + r' + \frac{l}{2} + \frac{r}{2}\right)\right\}$$

$$\text{ADREHO} = \frac{d}{6}\left(\overset{2}{l}\, m + \overset{2}{l'}\, m + l\, l'\, m\right)$$

$$b\, c\, q\, f\, g\, p = \frac{d}{6}\left(\overset{2}{r}\, m + \overset{2}{r'}\, m + r\, r'\, m\right)$$

Consequently,

$$V = \frac{d}{6}\left\{\left(b+l\,m+r\,m\right)\cdot\left(l+r+\frac{l'+r'}{2}\right)\cdot\left(b+l'\,m+r'\,m\right)\cdot\left(l'+r'+\frac{l+r}{2}\right)-\left(l^2 m+l'^2 m+l\,l'\,m+r^2 m+r'^2 m+r\,r'\,m\right)\right\}$$

Effecting the multiplication and reduction of the terms we obtain

$$V=\left\{\left(\frac{l+l'+r+r'}{4}\right)\cdot b+\left(\frac{+ll'}{2}.r+\frac{l'+l}{2}.r'\right)\frac{m}{3}\right\}d.$$

Example.

Let height to right at one end of cutting or	$r =$	20·5
height to left	$l =$	27·4
height to right at other end ...	$r' =$	32·1
height to left at other end ...	$l' =$	38·4
length	$d =$	100
base	$b =$	30
slopes	$m =$	2

```
 20·5          27·4          38·4
 27·4          19·2          13·7
 32·1          ----          ----
 38·4          46·6          52·1
 ----          20·5          32·1
4)118·4        ----          ----
 ----          2330           521
  29·6        9320          1042
     30       ----         1563
 ----        955·30        ----
  888        1672·41       1672·41
             ------
             2627·71
                   2
             ------
            3)5255·42
             ------
             1751·80
              888
             ------
             2639·8
                  100
             ------
```

263980· cubic feet = 9777 yards.

Reidaway & Sons Melbourne

Art. VII.—*On the Construction of an Instrument for Ascertaining the Mean Temperature of any Place. By* Dr. E. Davey.

To ascertain the *mean temperature* of the year, and especially of particular months of the year, in different regions of the world, is an object of prime importance in Meteorology. The mean temperature of particular days is also of interest, though much less important.

The mean temperature of the year may be pretty nearly inferred from observations on the heat of the earth, at a certain distance, say ten feet, from the surface, where it is almost beyond the reach of influence from the seasons; and the results thus obtained will probably be almost exact if taken at opposite seasons of the year. By this method, however, we are informed rather of the average temperature of a succession of years, than of any particular year, and we are by no means enlightened as to the differences of the seasons.

The mean temperature of particular days may be, of course, ascertained by hourly observations on the thermometer, and taking their mean; and the temperature of the month would be calculated from the mean of the days. This method is, however, obviously too troublesome to be carried into practice.

It was remarked by Humboldt, from observations made in France, that the temperature at sun-down, is in general pretty nearly the mean of the highest and lowest of the twenty-four hours: the lowest being at sun-rise, and the highest, about two hours after noon. He preferred, however, to take the actual mean of the two extremes. These extreme points may be very exactly ascertained by means of the instrument well known as Six's day and night or register thermometer, which leaves a mark of the highest and lowest points which the thermometer has attained since the last previous observation.

The description of my sensitive thermometer pendulum has reference to the drawing. It consists of a glass tube, fixed upon any suitable frame, A being the axis of oscillation. The glass tube is bent in the form of a reversed syphon, of which each limb, but necessarily the limb G E F, is upwards of thirty-two inches in length. It contains three bulbs, of which the bulb B and part of C D down to D with the intervening tube contains air.—The remaining portion of the bulb C D and part of the bulb E F and intervening tube,

from D to E is occupied by mercury, and the remainder of the bulb E F is a Torricellian vacuum, the tube being hermetically sealed at both ends to exclude barometric influence.

The effect of heat will be to expand the air in the bulb B, and by the increase of its pressure to force the mercury out of the bulb C D into E F, the upper part of which being vacuum will offer no resistance. The weight being thus removed nearer to the centre of oscillation, will be tantamount to a shortening of the pendulum, and will cause it to vibrate more rapidly, and in exact proportion to the temperature, as it is well known that the expansion of air is uniform with every increment of temperature.

A drop of oil on the surface of the mercury in C D, and the substitution of hydrogen gas for air in B would probably add to the perfection of the instrument;—the object of the oil being to prevent the transfer of air into the vacuum, and the hydrogen to obviate the action of common air on the oil.

By a slight and obvious modification of this instrument a sensitive air thermometer may be constructed.

It is, however, obvious that the true mean temperature is not necessarily the same as the mean of the two extremes of the twenty-four hours. The thermometer may have been for many hours near its highest point, and for a short time only near its lowest, or *vice versâ*. The force of this objection becomes considerable in a climate like this, where a change of temperature to the extent of thirty degrees is not unfrequently known to occur during a single hour. Admitting, therefore, the value of Six's thermometer, as registering in a most convenient manner the extremes of heat and cold, it cannot, I think, with propriety be depended upon, as an instrument affording data from which to calculate mean temperatures, except approximately; and this approximation may be seriously remote from the exactness which modern science demands.

I now proceed to describe the principle of the instrument which I propose for ascertaining mean temperatures. It is well known that the pendulum of a clock vibrates more or less rapidly according to its length; that the pendulum is elongated by heat and shortened by cold; and consequently, that an ordinary clock has a tendency to go slower or lose time in warm weather, and to gain time in cold. The effect of slight changes of temperature upon an ordinary pendulum is very inconsiderable; but, if we can succeed in constructing a pendulum, which shall be highly sensitive of heat and cold,

to such an extent, for instance, that the variation of one degree of Fahrenheit's thermometer shall cause the clock to gain or lose five minutes a day; we shall at once have an instrument which will register the temperature of the aggregate of every vibration it has made.

Art. VIII.—*Meteorological Observations at Bendigo. By* Ludwig Becker, Esq.

In the present paper I am desirous to give the result of my observations on the weather, at Bendigo, during a period of fifteen months, viz., from the 1st December, 1852, to the 28th February, 1854. During which period I have prepared complete meteorological tables.*

During my stay at Bendigo I was unable to procure either a barometer or a thermometer, and the stated grade of temperature met with in the tables was kindly furnished to me by a gentleman who was fortunate enough to have been in possession of the necessary instruments.

My especial object in preparing these meteorological tables is, that in connection with, and compared to, later observations, it should tend to fix the character of the seasons and their phenomena.

So far as I have had the opportunity of observing the character of the weather at Bendigo, I have come to the following conclusions :—

1. Prevailing winds come generally from N. W., most of the rain coming from the same quarter.

2. During the day there is more or less wind, followed by a calm and clear night.

3. Warm days and hot winds are generally succeeded in the evening by a cold southerly wind, as if the effect of the sea breeze extended as far inland as Bendigo.

4. The hot winds announce themselves in the morning by a thick hazy atmosphere, with a light south-easterly breeze; the wind, increasing in force, veers from south-east to east, and gradually wears round to the north-west, which ends in a cold south wind, *thus making a perfect circle;* the greatest heat is felt when the wind is blowing from the north-west; the hot wind is generally followed by rain.

5. The whirlwinds prevailing during fine weather and gentle breezes, but do not indicate rain.

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* The original meteorological tables are deposited in the Museum of Natural History.

6. During very hot and dry weather I have found my opossum rug discharging electric sparks, with a cracking noise, when rubbed with the hand; sometimes I observed a similar electric phenomenon, although in a less degree, on a common wool blanket.

7. There are few thunderstorms, compared to those in other countries, although the atmosphere seemed to be fully charged with electricity. Very vivid flashes of lightning, marked with the peculiarity of always taking a perpendicular direction, were accompanied by heavy showers.

8. The atmosphere is generally clear, and the stars visible, even close to the horizon, with but a very slight scintillating appearance. The firmament is more blue than that above Melbourne, but less brilliant than in Van Diemen's Land. Fogs I observed only twice or three times, early in the morning, lasting, however, but a very short time; nevertheless, the atmosphere is occasionally of a yellowish-grey colour, which is the effect of the large bush fires, which occasionally originate during hot winds. The opinions of the causes of bush fires are various; according to my observations, it may be attributed:—

To carelessness with camp fires, &c.

To a slumbering fire in a hollow tree, in places where the bush fires seem to be extinct. In such hollow trees, for several weeks, the fire is smouldering, and, during the hot winds, is fanned into flames, and thus communicates to the parched vegetation, sometimes at a very great distance, not only sparks, but burning charcoal of considerable size.

In places far in the interior, where no man could be supposed to have penetrated, the origin of bush fires can be attributed to lightning, and to the friction of dried branches, during the hot northerly winds. One could scarcely imagine, without having seen it, what power these winds exercise upon the branches of a tree, and what a peculiar noise is produced by the friction of the branches, during the prevalence of the gale. Considering the friction of thousands of branches in the forest, aided by a high temperature, scarcely endurable to animals, it sufficiently accounts for those fires in the interior, the origin of which could be attributed to no other agency, except, perhaps, lightning.

9. Frost is not unfrequent during the winter season; ice, however, is seldom seen, and rarely attains the thickness of a quarter of an inch. Snow I did not observe during the whole of my stay at Bendigo. Rain and storms are

prevalent in the winter season, which generally begins in May and ends with October. The days and nights are often very cold; sometimes, however, even in the winter season, I have experienced a warm calm day, followed by a clear starry night.

10. Of shooting stars or aerolites I have seen but few; and during the months of August and November, which it is well known are those in which they are most numerous, I did not observe a single one, although I looked for them on many nights.

11. The Zodiacal light appeared often so luminous as to be almost equal in brilliancy to that observed within the tropics.

12. At Bendigo I never observed any Aurora Australis; but in Tasmania, where this beautiful phenomenon is frequent, I have witnessed most brilliant displays.

13. One of the most striking peculiarities of Bendigo consists in the sudden and violent currents of wind from the north-west; these are of frequent occurrence, and of short duration. I will here avail myself of a few lines from my diary, descriptive of this remarkable phenomenon.

"Night. At a great distance, apparently of several miles, in a north-westerly direction, a peculiar rushing noise is heard, which approaches closer and closer, becomes more distinct, till at length it grows into the boisterous tumult of a hurricane. The inmates of the tents are alarmed, and cry out the well-known seaman's call, "stand by the royal halyards." It is a heavy squall approaching, and the warning voice serves to the inhabitants of the gullies as a hint to secure their tents against the violence of the approaching tempest. A few minutes later and we find ourselves in the midst of the storm; the air is filled with dust, intermixed with myriads of burning sparks, lifted from the numerous fire-places. The hurricane is so violent that it destroys and carries away tents, shakes substantial buildings, bends and breaks trees; and, after this storm of a most violent nature, a heavy shower follows, reminding one of an approaching deluge, and in a few minutes everything is again clear and calm. The dark cloud, charged with destruction, and which has imparted terror to every living being, is now to be seen far away on the horizon, wearing towards the south-east, and only a roaring noise is to be heard, something like as the receding sounds of the Niagara Falls, becoming fainter and fainter, until at a vast distance it dies away."

14. The beautiful constellation represented in the accompanying diagram I was fortunate enough to witness. It took place on the 4th November, 1853.

During the summer season the mining population suffers from inflammation of the eyes; the cause of this evil may be attributed to a small kind of fly, which, having gone into the eye, sucks the moisture of that delicate organ, and causes a peculiar itching sensation; to relieve this, the sufferer has recourse to rubbing the eye, which cannot fail to injure it. I believe that the great heat of the solar rays, reflected from the gold-fields and the numerous white tents, may be considered an additional source of injury to the eye. One of the chief causes of inflammation of the eyes may be the caterpillars. These creatures web themselves on trees in the months of January and February, the time when the blight is most frequent, leaving behind them a great number of small hairs, covering the web as well as the wood. If this is used for domestic purposes, the hairs, coming in contact with the eye, either by rubbing it with the hand that handled the wood, or by other means, produces inflammation, exactly similar to what is produced in Europe by the migrating caterpillars. I never suffered in the eyes, as I was careful to take the precaution of smearing oil over my face, this being the best remedy to keep off insects. The aborigines of different countries are well aware of the useful application of oil; they smear and grease the whole of their bodies, to provide against being bitten by musquitoes and other insects. It is desirable to avoid touching the eyes with the bare dry finger; and veils and coloured eye preservers are therefore used at the Diggings as a means of protection.

In the month of April, 1853, nearly all the dogs at Bendigo were afflicted with the distemper, and I was informed that a great number of native dogs perished by the same cause. At the same time, the Bendigo population suffered much from influenza and rheumatic pains. It is questionable whether man and beast did not suffer from the same cause.

One great principle should be observed by every one resident in this colony, viz., *to dress warm at night.* To this effect an example is furnished to man by various animals indigenous to Australia; amongst others the opossum, which feeds during the cool nights on lofty trees. The effects of the sudden change of temperature is mostly felt by new arrivals, and by the less cautious of the mining population. During the heat

L. Becker, Del. 8¾ PM. 7 PM Surveyor Generals Office

VENUS, LUNA, JUPITER.

Bendigo, Nov.r 4th 1853.

of the day, the diggers, as well as other working-men, are dressed in light apparel; and if they are not cautious to change their clothes, for warmer ones, during the night, they will soon experience the effect of their neglect. At the end of the day's work the tired man falls into a deep sleep, not awakened even by the effects of the cold, which penetrates through the tent, and injures his health. The man next day feels feverish, diarrhœa precedes the dysentery, and not unfrequently it is followed by typhus, which generally ends in the death of the suffering man.

The prevailing diseases are greatly assisted by the population not living according to their adopted climate. Most of them transfer to this colony the mode of living which they have been accustomed to in a climate lying twenty degrees further from the equator than Victoria, without allowing one degree of change in their habits. They drink here the same spirituous liquors as they did at home; they consume the same great quantity of animal food, washed down by a deluge of tea, as if the same misty sea air surrounded them here that did in England, and which allowed the consumption of of a greater quantity of animal food and strong drinks. To this effect I beg to quote Streletzki's remarks upon the subject, in his work on New South Wales and Tasmania:—

"No endemic disease, and seldom any epidemic of grave character, prevails; and if individual indisposition, or even partial deterioration of the progeny is sometimes seen, it is to be traced to the pertinacity with which the English race cling to their original mode of living, wherever they settle, and however different their adopted country may be to their native climate. It is to the abuse of strong wines, malt liquors, and spirits, and particularly to the excessive consumption of animal food of the richest description, and even to the mode of clothing and housing, that individual disease, such as dyspepsia, premature decay of teeth, and affection of the brain may be attributed."

The state of the health would be much improved in this country if the inhabitants, instead of the strong beverages used at present, would drink pure water, light beer, or native wine, which could be produced in this country, and consume more vegetable food and fruit. About the mode of living in Australia I shall have the opportunity of giving my opinion on a future occasion, it being here out of place to treat on this subject. I will, however, observe, that the climate of this country is healthy, though not so the men.

Art. IX.—*On the Influence of Gravity on the Physical Condition of the Moon's Surface. By* Balfour Stewart, Esq.

The great irregularities of the surface of our satillite, are discernible almost without the aid of a telescope, but, by means of this instrument they have been accurately measured; and their stupendous character impressed upon the mind, which is thus enabled to compare them with the irregularities of the Earth's surface. The appearance presented by the moon's disc, is thus described by the Rev. Josiah Crampton, in his work entitled *The Lunar World; its Scenery, Motions, &c.*

"Not only," he remarks, "are her mountains more numerous in proportion to her size than those of the earth, but they are much larger, rising to a much loftier elevation, composed apparently of a substance of a much harder texture than any thing terrestrial, and exhibiting bolder and sharper outlines, and more tremendous precipices, some of which project and overhang each other in such a manner as to lead many to suppose that the rocks composing them are of a harder and more solid nature than wrought iron."

And the *Dublin University Magazine,* for February, 1854, remarks on the same subject.

"Some important diversity must prevail, no doubt, for it cannot be by chance, that in the lesser body sheer cliffs of thousands of feet descend from mountain tops into the valleys or chasms, while in the larger, no search has yet succeeded in discovering a perpendicular descent of five hundred feet anywhere. The moon's craters cling to the sides of cliffs, cut into, encompass, and over-leap each other. In dimensions some of them measure one hundred miles."

With regard to the cause of this diversity I would venture an explanation. I do not look for it in any difference of material; for I am neither inclined to imagine with some that the moon's surface has more tenacity than wrought iron, nor with others that it resembles cork. I would rather look for its chief cause in the difference between terrestrial and lunar gravitation. A long rod of iron will bend, and a sufficiently long rod of any brittle substance will break by its own weight; but if these be placed in circumstances where they retain their tenacity and all their other qualities unchanged, with the exception of their gravity, which is lessened, the rod of iron will not bend so much, and it will require a greater length of the brittle substance in order to break it. Now the weight of the same body is much less on the moon's surface than on the earth's. For the attraction of a sphere of matter on any point, without its force and distance, is the

same as if all the matter of which the sphere is composed were collected in its centre. Now, if there be two spheres, of the same average density, the attraction of either for a point on its surface will be equal to that produced by the whole mass acting from the centre; and, since attraction varies inversely as the square of the distance, that on the point will vary as $\frac{\text{mass}}{\text{radius}^2}$ viz., it will vary altogether directly as the radius of the attracting sphere.

Now, according to Humboldt, the diameter of the moon is 1816 geographical miles, and the mean diameter of the earth is 6864 geographical miles; hence, supposing the density of these two bodies to be the same, these numbers will represent their proportional attraction for a point on their surface. But if the density of our earth be denoted by (1), that of the moon, (according to Humboldt), is only ·619; if, therefore, lunar gravitation be reckoned unity, terrestrial gravitation will be found from the following compound proportion:—

$$\begin{array}{ccccc} 1816 & : & 6864 & : : & 1 \\ \cdot 619 & : & 1000 & & \end{array}$$

The result of which is 6-1 for the value of terrestrial gravitation, or upwards of six times that of lunar gravitation. We need not therefore be surprised at matter remaining stable on the moon's surface, in a position from which it would be hurled by its own weight if on the earth's surface. And if we suppose that gravitation has exerted a direct influence in rounding the irregularities of the earth's surface, we need not be surprised if the moon's surface be less rounded, and more mountainous and irregular.

In like manner, were each square inch of the moon's surface charged with the same mass of atmosphere as the same extent of the earth's surface, its tension would be less, because its weight would be less. It would therefore be less condensed, and would not lie so closely to the surface as on our earth, but would spread to a greater distance from it.

Take a star near the edge of the moon. We may consider the star as a luminous point so distant that the rays which fall upon the eye form a parallel pencil in passing near the moon, and through its atmosphere, if there be any. But the mass of material particles which such a pencil will encounter in its passage through an atmosphere will vary, not only with the total mass of that atmosphere, but also with the manner in which the atmosphere is attached to the surface of the planet. The following approximate demonstration may serve to make my meaning plain.

Case 1st. Let the atmosphere (Fig. 1) be so closely attached to the surface, that its depth is very small compared with the radius of the planet. Let A B C be part of a great circle section of the planet, let A' B' be the boundary of the atmosphere, and by an alteration of circumstances suppose this atmosphere afterwards extended to A" B". By this latter supposition the same amount of atmospherical particles will be included in the solid, represented sectionally by A A" B" B, as was formerly included in A A' B' B. But the solid A A" B" B is to the solid A A' B' B nearly as A A" is to A A', that is the amount of atmospherical particles included in a given space varies *(cæteris paribus)* inversely with the depth of the atmosphere. But the length of the pencil of light exposed to the action of the atmosphere varies nearly in proportion to the square root of the depth of the atmosphere, therefore the closer the atmosphere lies upon the surface, the greater will be the mass of particles which the pencil has to encounter.

Case 2nd. Suppose (Fig. 2nd) that the depth of the atmosphere is very great in comparison with the radius of the planet. Here the solid A A' B' B is to A A" B" B very nearly as $(A\ A')^3 : (A\ A'')^3$ or as the cube of the depth of the atmosphere, but the length of a pencil of light passing near the planet immersed in the atmosphere will vary directly with the depth of atmosphere, hence in this case also, the deeper the atmosphere the fewer particles will the pencil encounter. These are the two extreme cases, and perhaps this demonstration is accurate enough to entitle us to conclude that when a given mass of atmosphere is closely attached to a planet, a pencil of light passing close to the surface will encounter a greater mass of particles, and probably deviate more from its direct course, or in some other manner indicate the existence of an atmosphere than when the same mass of atmosphere is more loosely attached. If, therefore, each square inch of the moon's surface were charged with the same mass of atmosphere as the same extent of the earth's, it would not *(cæteris paribus)* cause a star to deviate so much as the terrestrial atmosphere. It might also be shown (Fig. 3rd) that were the atmosphere in precisely the same state for both planets, the pencil would encounter more particles in the atmosphere of the larger body being immersed in it to a greater length. And, finally, if the amount of atmosphere be proportional to the mass of the planet, we cannot look for the same mass of atmosphere on each square inch of the moon's surface as on the same extent as our earth's. These

FIG 1

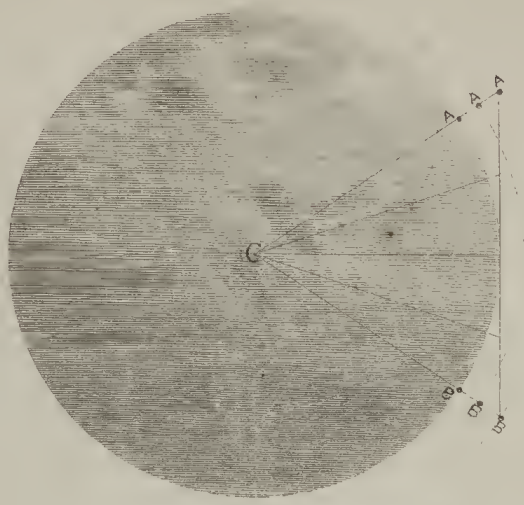


FIG:2

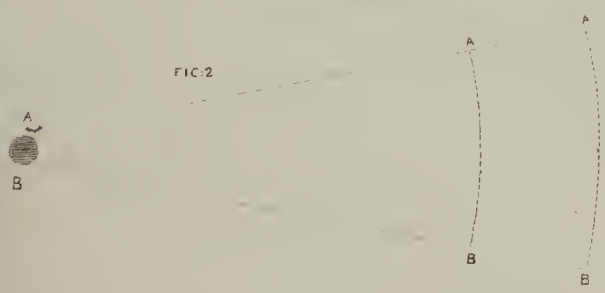
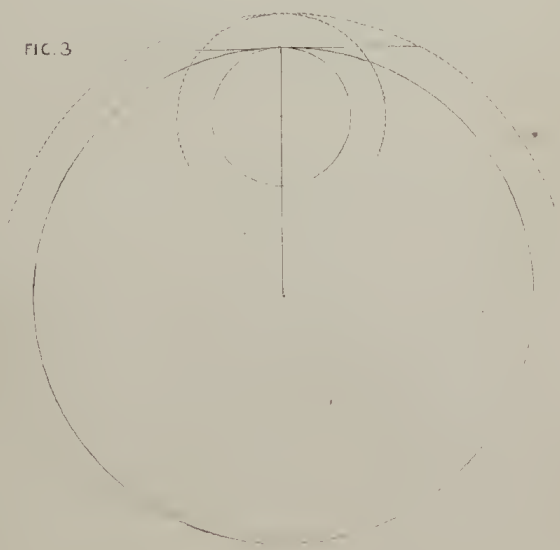


FIG. 3



Reducing to 1/10th size

three considerations taken jointly induce me to think that the moon may have an atmosphere, although such may not come within the range of our observation.

ART. X.—*On the Adaptation of the Eye to the Nature of the Rays which emanate from Bodies. By* BALFOUR STEWART, ESQ.

IN the following remarks I assume, along with Professor Provost, that bodies radiate at all temperatures, only the hotter bodies radiate more than they absorb, and the colder less, until a uniform temperature is at length attained. Now, in the spectrum formed by decomposing a ray of white light by means of a prism, the most refrangible rays are the violet and blue, and the least refrangible of the visible rays are the red; but there are yet a set of less refrangible rays, which though not visible to the eye, have the power of raising the thermometer. I conceive that all bodies at ordinary temperatures emit rays of this description, which are less refrangible than the extreme red of the visible spectrum, and that as the temperature of a body rises, the average refrangibility of the rays it emits rises also, and to the same extent for all bodies, until at almost 600° Fahr. The rays enter the visible spectrum by the extreme red, and the body is now said to be red-hot. And here I may remark, that with regard to the absolute identity of the heating and illuminating rays, I hold the opinion of Professor Powell, expressed in his report on Radiant Heat, in the Transactions of the British Association for 1840, where he says:—

"The question of the identity of the heating and illuminating radiators seems clearly negatived by many experiments, if we mean it to apply in the sense of one physical agent; but, if we refer to the possibility of accounting for the different effects by sets of undulations of the same ætherial medium differing their wave lengths, this probably presents fewer difficulties than any hypothesis of peculiar heat."

However this may be, if the temperature of a red-hot body be still further increased, the average refrangibility of the rays it emits is also increased to the same extent for all bodies; and it is now said to be white hot. If the heat be still further increased, it requires a greater number of the blue or more refrangible rays; such, for instance, as the lime-ball

light charcoal points in a galvanic battery, and the light of the sun.

Now, although we do not know by what property of the eye rays less refrangible than the extreme red become invisible, yet this will appear on inspection to be a wise arrangement of Providence.

For if the rays which emanate from bodies at ordinary temperatures were invisible they would overpower those exquisitely beautiful colours of nature which are produced by reflection of the solar light; besides which, there would be no such thing as darkness, even when the eye was closed, for light would still issue from the eyelids. And again, if rays did not become visible till at a much higher temperature than 600°, combustion would go on in darkness, and we should never be warned of the presence of fire.

Finally, if we suppose a number of bodies (for simplicity's sake spheres) to have been originally at the same temperature, it is clear, that since radiation will vary with the surface exposed, large spheres, the surface of which bears a less proportion to their solid contents than that of smaller ones, will cool more slowly than smaller ones; so that at any given time a large sphere would be at a much higher temperature than a small one, and would, consequently, emanate visible rays, while the rays of the other would be invisible.

Therefore, in a system of bodies, such as the solar system, the centre of attraction is also the centre of illumination which is a most wise and beneficial arrangement.

Art. XI.—*Descriptive Characters of New Alpine Plants, from Continental Australia. By* Dr. Ferdinand Mueller.

In offering this small, yet perhaps not unwelcome contribution towards the botany of Australia, I wished to conclude the precursory diagnostic notes on our Alpine flora, of which some scattered fragments appeared in this journal, and in the papers of the Victorian Institute.*

* The plants there enumerated and described are the following :—Eriostemon lancifolius, P. phylicifolium, Phebalium ozothamnoides, Ph. podocarpoides, Crowea exalata, Scleranthus miaroides, Kunzea ericifolia, Burtona subalpina, Oxylobium alpestre, Bossiæa distichoclada, Eurybia megalophylla, Eurybia alpicolo, Brachycome, multicaulis, Br. nivalis, Antennaria nubigena, Gnaphalium alpigenum, Agrostis nivalis, Agr. frigida, Agr. gelida, Danthonia robusta, Hierochloe submutica, and Astelia psychrocharis. A few as doubtful remained yet uncharacterized.

For further details on the position which the plants from our snowy mountains occupy in phyto-geography, showing how far they are endemic, how far connecting those of distant countries, and how far identical with those of other parts of the globe, and for information on their uses and peculiarities, I beg to refer to my published official reports. It remains here only to acknowledge, that without the use of the admirable Flora Antarctica of Dr. Jos. Hooker, and the yet unfinished Flora of New Zealand, from the pen of the same celebrated author, I should have been unable to analyze these plants regarding their distinctive characters with that precision which was earnestly desired, but perhaps not attained.

Ranunculacae.

1. *Ranunculus anemoneus.*

(Sect. Hecatonia.)

Glabrous or hirsute; root fasciculate; stem thick, simple, erect, one-three flowered, below leafless, at the base vaginate; leaves veined, the radical ones on long and strong petioles, orbicular, to the base divided into three or five lobes; these deeply three or five-cleft, covering each other, their lobules variously cut, acute; bracteal-leaves large, cordate-orbicular, dissected, sessile, clasping; peduncle naked or with a smaller bracteolar-leaf; sepals five-seven, ovate, appressed, slightly villose; petals large, white, generally numerous, twice or three times as long as the calyx, narrow oblong-cuneate, entire; nectar-pit solitary, margined; carpels turgid, even, glabrous, margined; their style at the extremity hooked.

On springs at the summit of the Munyang Mountains.

This charming and interesting species forms, next Grevillea Victoria, the greatest ornament to the Snowy Mountains of Continental Australia. It differs from similar showy ones in New Zealand already, in its white petals, and approaches rather to the European alpine type of the genus represented by R. aconitifolius, glacialis, &c.

2. *Ranunculus Millani.*

(Sect. Hecatonia.)

Dwarf, stemless; root fasciculate-fibrous; scape simple, one-flowered, solitary, spreading-downy, of the length of or

shorter than the petioles; leaves pinnatisected, glabrous or together with the upper part of the petioles scantily downy; segments few, linear, undivided or bi-trisected, terminated by a gland; sepals appressed, glabrous, nearly ovate, with membranous margin; petals five-ten, white, obovate or oblong-cuneate, almost twice as long as the calyx; nectar-pit distant from the base, margined, covered by a hardy perceptible scale; carpels few, glabrous, broad-ovate, compressed, margined, smooth, with a hooked style.

In gravelly places on most of the summits of the Australian Alps, irrigated by the melting snow.

I should have referred this neat little plant to the Tasmanian R. nanus, were the discrepancy in the colour of the petals, a character of such validity in this genus, not too manifest; for whilst to that species bright yellow petals are attributed, I found them always white in this, and assuming only a slight yellow tinge when drying.

In selecting the specific name, I desired to pay a slight scientific tribute to the merits of A. M'Millan, Esq., who not only forced, with skill and enterprise his way first into Gipps' Land, opening one of the finest districts of whole Australia to civilisation, but who also named and first ascended Mount Wellington, where I became originally acquainted with this plant.

3. *Caltha introloba.*

(Sect. Psychrophila.)

Dwarf, leaves on long petioles, hastate-ovate, notched at the summit, perfectly entire, enlarged at the base by two long lobes; these bend inward, oblong-linear, below dilated; scape with one flower, very short; sepals white, five-eight, deciduous, lanceolate-linear, acuminate; carpels five-nine, with three seeds, and a long straight style, reflexed at the top.

On gravelly places in the Australian Alps, irrigated during the summer months by the melting snow. Mount Hotham, Mount Latrobe, and Munyang Mountains.

To be distinguished from C. Novae Zeelandiæ principally by its white flowers, and longer leaf-lobes. It is the only species known from New Holland.

Diosmeae.

4. *Phebalium ovatifolium.*

Leaves coriaceous, ovate, above smooth and shining, beneath lepidote, their margin recurved; peduncles axillary, solitary, with a single flower and three or four bracts, compressed, twice or three times shorter than the leaves; teeths of the calyx triangular-lanceolate, glabrous; petals lanceolate-ovate, whitish, little longer than the stamens; anthers affixed with their back; filaments glabrous; stigma capitellate, club-shaped; carpels apiculate.

In the rocky or scrubby parts of the Australian Alps, at the sources of the Murray and Snowy River.

That the genera eriostemon and phebalium are not strictly defined by clear and natural characters has been observed previously in other instances. This handsome species again may be referred to either of the two genera, which I would propose to unite.

5 *Eriostemon trachyphyllus.*

Tall, smooth, covered with glandular warts; leaves herbaceous, flat, entire, oblong-lanceolate, pointed, sessile, on both sides green, above shining; pedicels axillary, solitary, shorter than the leaves; segments of the calyx subdeltoid, glabrous; filaments fringed; style smooth; stigma five-cleft; carpels blunt; seeds shining, black, grey-variegate.

On the mountains at the Snowy River, near the Pinch Range, on rocks.

A fine plant, as well allied to E. myoporoides as to E. intermedius.

I beg to subjoin another rare plant of the order, although not alpine.

6. *Eriostemon microphyllus.*

Dwarf; branches asperous; branchlets thinly covered with starry downs; leaves coriaceous, crowded, much spreading, ovate- or cordate-orbicular, scabrous, with recurved apex, on short petioles; flowers several together terminal, glandulose; segments of the calyx triangular-ovate, nearly smooth; filaments as long as the corolla, glabrous, gradually tapering into the apex; appendage of the anthers exceedingly small; style glabrous.

On the low coast ranges of Spencer's and St. Vincent's Gulf, but only rare.

Of unquestionable alliance with E. rotundifolius (All. Cunn. in enum. pl. Hueg. p. 15.)

7. *Boronia algida.*

Fruticose, much branched; branchlets spreading or divaricate, velutinous, somewhat compressed; leaves on very short petioles, with two pairs of leaflets and a terminal one; these small, coriaceous, glabrous, obcordate or cuneate-ovate, with entire hardly recurved margins; flowers solitary twin or rarely several together without a common pedunele; pedicels on the base bracteolate, of nearly equal length with the ovate-lanceolate acuminate glabrous sepals; petals much longer than the glabrous filaments; style smooth, very short; stigma depressed-capitate.

On the highest stony declivities of our Alps; for instance on Mount Hotham, Mount La Trobe, and Mount Koskiusko.

A charming bush, allied to B. rubiginosa.

Cruciferæ.

Blennodia. R. Brown.

(Sect. Drabastrum.)

Silique lanceolate, by its convex one-nerved valves almost tetragonal.

8. *Blennodia alpestris.*

Perennial, dwarf; stems erect, nearly naked, thinly pubescent, rarely branched; leaves lanceolate or ovate, toothed or nearly entire, gradually tapering into the petiole; flowers white, corymbose; style short; pedicels divaricate, of the length of the silique; valves distinctly one-nerved; seeds disposed in two rows, brown, minutely foveolate.

In subalpine grassy places on the sources of the Murray and Snowy River.

Erysimum brevipes, curvipes and blennodes (B. lasiocarpa mse.) are congeners of this plant, but as the cotyledons are at times slightly bent inward, I am uncertain whether the genus ought not to be united with Diplotaxtis or Moricandia.

Caryophylleae.

9. *Colobanthus pulvinatus.*

Perennial, glabrous; stems numerous, moos-like tufted; leaves densely crowded, rigid, squarrose, broad-subulate, channelled triquetrous, pungent, shining, with a slightly inflexed mucro; sheats close; flowers terminal, solitary, on very short and thick peduncles, pentamerous; sepals from a broad base lanceolate-subulate, hardly longer than the egg-shaped capsule, and nearly twice as long as the stamens.

On the highest, barest, and gravelly tops of the Munyang Mountains. (6,000—6,500 feet.)

This forms a near approach to C. Benthamianus, a native of Cape Horn and the Falkland Islands, and not yet found similarly presented either in New Zealand or Tasmania, but is apparently identical with the pentamerous form of C. Benthamianus from Campbell's Island. Since also my plant invariably shows a quinery division of the flowers, I have separated it from the South American one, following Dr. Hooker's suggestions in the Flor. Antarct., p. 247.

Stackhouseae.

10. *Stackhousia pulvinaris.*

Depressed, with numerous intricate rooting branches, perfectly smooth; leaves somewhat fleshy, oblong or spathulate-linear, nearly blunt; flowers solitary on the summit of very short branchlets; bracteoles twin, as long or longer than the pedicel; flowers yellow; three of the stamens longer than the two others; anthers glabrous; style deeply bi- or trifid.

On the highest summits of the Australian Alps, where saturated with moisture, the widely expanded tufts decorated with fragrant starry flowers, form a beautiful carpet. (5—7,000 feet.)

As a species it connects the Tasmanian S. flava with S. minima, from New Zealand.

Umbelliferae.

Dichopetalum.

A new genus of Hydrocotyleæ. Flowers hermaphrodite, equal. Lobes of the calyx white, membranous, petaloid, of

the shape of the petals, and with these deciduous. Petals sessile, ovate-elliptical, with a blunt not inflexed apex. Stamens shorter than the petals. Styles divergent, subulate, arising from thick stylopodia. Fruit laterally compressed, nearly ovate, glabrous. Carpels with five ribs, destitute of vittæ. Carpophor undivided.

A genus well defined by the perfect and constant equality of calyx and corolla, which unite to form a decapetalous flower, a structure without parallel in the wide order to which this fine genus belongs.

The alliance, in other respects, to Xanthosia and Oschatzia is obvious.

11. *Dichopetalum ranunculaceum.*

Stemless, prostrate, hispid; root thick; leaves on long petioles, nearly round, three- to five-lobed; the lobes incisocrenate; scapes numerous; umbels few-flowered, simple or somewhat compound; involucre large, with two or three leaflets, which are often connate at the base.

On wet gravelly places chiefly around the springs in the Munyang Mountains. at an altitude from 5000 to 6000 feet.

Pozoa; Lagasca.

(Sect. Schizeilema, J. Hooker.)

12. *Pozoa fragosea.*

(Fragosa hydrocotylea, Ferd. Mueller, Coll.)

Glabrous; rhizome thick, creeping, with numerous long fibres; stems very short, prostrate; leaves herbaceous, long-petiolate, orbicular-reniform, net-veined, divided scarcely to the middle into five to nine crenulate lobes; stipules broad, membranous, torn; umbels sessile on the base of the petiole, or pedunculate, capitate, generally many-flowered; leaflets of the involucre five to eight, connate, lanceolate, with a few setaceous lobes; teeth of the calyx deltoid-ovate, somewhat acuminate, nearly acute; petals greenish; carpels ovate, compressed on the back, with five hardly prominent ribs, strongly contracted at the axis.

Under the shade of rocks on the highest tops of the Munyang Mountains, but of rare occurrence; 6000 feet.

I assigned to this plant a place in the genus Pozoa, on account of the great resemblance with Pozoa reniformis, P.

Ranunculus and P. trifoliata, but cannot surpress my opinion, that Pozoa and Azorella, rank only as groups of one large and polymorphous genus, namely Fragosa.

(Sect. Sphagnosciadium.)

Umbels few flowered, paniculate; leaflets of the involucre few or reduced to one; flowers hermaphrodite; teeths of the calyx deciduous.

13. *Pozoa cuneifolia.*

Sphagnosciadium cuneifolium, Ferd. Mueller coll.

Glabrous; rhizome, thick; stems erect; leaves all radical, cuneate, tapering into a long petiole, three-nine nerved, in front with three-nine acute teeth or laciniæ; bracteoles lanceolate-subulate, entire; generally equal in number to the flowers of the umbels; flowers pedicellate, sometimes solitary; teeths of calyx small, nearly acute; petals white; fruit ovate, with a retuse base; carpels slightly compressed at the back, strongly five-ribbed.

At Mount Wellington, the Cobboras Mountains, and other localities of the Australian Alps, always in turf moss, (5,000 feet.)

It was not without hesitation that I referred this plant to Pozoa, differing from the rest so decidedly in its inflorcsence, yet hardly in other respects.

Gingidium; Forster.

Anisotome; J. Hooker, not of Entomologists. Calosciadium, Endlicher.

14. *Gingidium glaciale.*

Diœceous; stem robust; leaves rigid, in outline almost ovate, bi- or tripinnated; segments hardly spreading, broad-linear, undivided, acute, mucronate, streaked, as well the rachis channelled and traversely articulated; umbels, many-rayed; carpels equal, semiterete.

In the higher regions of the Australian Alps, not rare, (5-7,000 feet).

The strange rigid foliage attracts the notice of all travellers which yet penetrated into this mountain.

15. *Gingidium simplicifolium.*

Diœccous; leaves rigid, undivided, elongate-linear, articulated, perfectly blunt, somewhat channelled; lower umbels, few-rayed, supported by an undivided large vaginated leaf.

In moist, grassy, subalpine meadows, from Mount Wellington to the Munyang Mountains.

It is certainly very singular that the species of anisotome or gingidium should be all endemic. Their striking feature is highly developed by gigantic species in Campbell's and Auckland's Islands, reappears by numerous distinct forms in New Zealand, but is wanting in Tasmania.

16. *Seseli Harveyanum.*

(Sect. Euseseli.)

Glabrous; stems several, erect, herbaceous, simple, from a perennial root; petioles of the stem with an ample vagina; radical leaves pinnatisected; upper segments lanceolate- or broad-linear, undivided, gradually pointed; the lower ones to the middle or nearly to the base two- or three-cleft or again pinnatisected; leaves of the stem simply pinnatisected or undivided; umbel with 4-8 unequal angulate glabrous rays and with a solitary or without a bract; bracteoles 1-3, linear-setaceous, unmargined, sometimes wanting; fruit glabrous, oblong, somewhat compressed, with sharp prominent ribs and solitary vittae in the interstices.

In alpine and subalpine meadows from the Cobboras to the Munyang Mountains (4-5000').

Not dissimilar to Seseli Pallasii from Russia, offering with the following plant a new and unexpected connecting link between the Australian plants and those of northern countries since the genus was very scantily hitherto represented in the southern hemisphere, and quite unknown in Australia. The whole plant is of sweetish aromatic taste, reminding of Fennel and Garden Chervil, and might, I think, be cultivated to advantage.

17. *Seseli algens.*

(Sect. Euseseli.)

Glabrous, glaucous; stems several, generally decumbent, herbaceous, simple, from a perennial root; petioles with an ample vagina; radical leaves simply pinnatisected; segments

trapezoid, trifid, or the upper ones cuneate, all in front deeply and acutely toothed, often laciniated; leaves of the stem from one to three, pinnatisected; rays of the umbel 4-5, unequal, furrowed, glabrous; bracts 1-3, bracteoles several, both setaceous; fruit glabrous, truncate-ovate, with very prominent ribs.

On the gravelly borders of alpine rivulets and springs in the Munyang Mountains (5-6000').

The want of ripe fruit of this plant leaves some doubt about its true generic position. It is unquestionably allied to Seseli Harveyanum.

Compositae.

18. *Erigeron conyzoides.*

Perennial, smooth, somewhat glabrous; stem erect, herbaceous, leafy, below simple; lower leaves lanceolate, tri-nerved, tapering into a long petiole, remotely and sharply serrulate; upper ones broad-linear, acute, quite entire, sessile; flower-heads panicled, hemispherical or campanulate; scales of the involucre linear—subulate, somewhat scabrous on the back; female flowers extremely narrow, whitish, flat, little longer than the disk; achenes compressed, oblong, scantily hairy, hardly half as long as the pappus.

On the sources of the Murray and Snowy Rivers, (4000 to 5000 feet.)

19. *Trineuron nivigenum.*

Leaves linear, blunt, indistinctly three or five-nerved, on a clasping fimbriate petiole; heads many-flowered; scales of the involucre fourteen to sixteen, oblong, with three pellucid nerves; female flowers three-or four-toothed; their style very short bi-lobed; style of the sterile flowers undivided; achenes indistinctly tetragonous, oblong—cuneate, with but slightly thickened angules.

On grassy or gravelly places in the Munyang Mountains, irrigated by the melting glaciers, (5000 to 6000 feet.)

Intermediate between T. spathulatum from the Antarctic Islands, and T. pusillum from New Zealand.

20. *Antennaria uniceps.*

Depressed, rooting, densely foliate; leaves subcoriaceous,

somewhat rigid, channelled-linear, acute mucronulate, glabrous; petioles clasping, scarious, woolly fringed; flowerheads solitary, almost sessile; scales of the involucre glabrous, somewhat red, at the base green, the outer ones ovate, inner ones narrow-lanceolate, not radiating; pappus of the sterile flower-heads scabrous, very slightly thickened at the apex.

On gravelly places near springs, or such as are subject to nundations in the Munyang Mountains, (5000 to 6000 feet.)

A small tufted herb, somewhat resembling the Raoulia tenuicaulis. The fertile flowers are yet unknown.

Epacrideae.

21. *Decaspora Clarkei.*

Stems short, diffused; branchlets slightly downy; leaves thinly coriaceous, flat, oblong-lanceolate, acutish, three or five-nerved, without a mucro, very much longer than the petiole, in front scabrous; spikes few-flowered, corymbose, as long as or longer than the leaves; faux of the large corolla bearded.

In shady ravines at Mount Wellington, half buried in decaying leaves; very rare.

This elegant little shrub bears the name of Capt. Andrew Clarke, the worthy President of the Philosophical Society, to whom the author is under many-fold great obligation, for promoting his researches.

The four other species, are endemic Tasmanian ones. The large bleuish berries of this are eatable.

22. *Leucopogon Maccraei.*

(Sect. Brachystachys.)

Tall, much branched; branchlets very little spreading, firm, velvety; leaves spreading, ovate, or from a round base lanceolate, stalked, flat, not mucronate, glabrous, above shining in front ciliolate; spikes terminal or below the apex, few-flowered, soon erect; calyx and bracteoles blunt, ciliolated; tube of the corolla hardly longer than the calyx; anthers half exserted; style glabrous, enclosed; drupe globose, red, generally four-celled, nearly dry.

In vallies on the sources of the Mitta Mitta, near Mount Hotham and Mount La Trobe, as also along the torrents of the Cobboras Mountains. (5—6,000 feet.)

This fine species is dedicated to Andrew M'Crae, Esq., as an acknowledgment for much support received from him in my travels.

Scrophularinae.

23. *Euphrasia alsa.*

Dwarf, annual; glandulously downy; leaves sessile, in outline ovate-cuneate, laciniate or pinnatifid; lobes of the leaves oblong or linear, blunt; spikes very short, few-flowered; calyx tubulose-campanulate, the lobes blunt, about as long as the tube; tube of the corolla hardly exserted, of equal length with the limb; the lobes of the lower lip emarginate, of the upper retuse; anthers scantily bearded, the cells of all short and equally spurred; capsule orbicular-ovate, in front densely ciliated, inclosed, much compressed, few-seeded.

Gregarious on the highest stoney summits of the Munyang Mountains—(6,000 feet).

It differs by its annual root from all other Australian and Tasmanian species, by almost equally spurred anthers from the European, by the bearded anthers from the South American, and respectively by the same characters from the New Zealandian species. E. Antarctica and revoluta are nearest to it related.

24. *Pæderota densifolia.*

Stems procumbent, cespitose; leaves thick, perfectly entire, cymbiform-ovate, ciliolate, sessile, densely imbricated in four rows; flowers bibracteate, axillary and terminal, solitary, sessile; corolla twice as long as the calyx, glabrous, pink, their tube inside unbearded; capsule obcordate; seeds oblique ovate, convex at the back.

On the highest rocky summits of the Munyang Mountains (6—6,500 feet).

A most remarkable herb, variable in the number of divisions of the corolla, and in their form.

Since it does not agree in habit with the European species, it may become the type of a new genus (Cymbophyllum).

Proteaceae.

25. *Grevillea Victoriæ.*

(Sect. Calothyrsus.)

Tall; leaves sub-coriaceous, undivided, long-lanceolate,

rarely ovate, acute, short-mucronate, gradually tapering into the petiole, penninerved, veined, with slightly recurved margin, above smooth, beneath with branchlets and rachis grey-silky; racemes pedunculate, axillary and terminal, elongate, sometimes divided, drooping, their development centripetal; calyces three times longer than the pedicel; outside rutilous, silky; inside, below the middle, white-bearded; style long-exserted, glabrous or scantily hairy at the extremity; germen-stalked, glabrous; stigma sublateral, ovate, slightly umbonate; follicle ellipsoidal, thinly ribbed, glabrous.

Along the waters of the Buffalo Range, on the summits of Mount Buller and Mount Tambo, on the sources of the Mitta Mitta, at Mount Hotham and Mount Latrobe.

A truly majestic plant, when, by descending into the vallies, it assumes a height of twelve feet and more. In higher altitudes it becomes a dwarfer bush, with shorter, almost ovate leaves.

26. *Orites lancifolia.*

(Sect. Aeroderris.)

Leaves oblong-lanceolate, flat, glabrous, blunt, net-veined, perfectly entire; spikes axillary and terminal, sub-solitary; calyx smooth; germen silky-downy, follicle silky.

On the rocky summits of the the Australian Alps (5-6,000 feet high), for instance on Mount Wellington, Mount Hotham, Mount Latrobe, in the Munyang Mountains, in the upper valleys of the Mitta Mitta, &c.

This fine shrub is besides Grevillea Victoria the only real alpine species of this natural order indigenous to the Australian continent. But I am uncertain whether it may prove to be identical with O. Milligani, of which hitherto no description has been given.

Cyperoideae.

27. *Scirpus polystachyus.*

Stems tall, trigonous, foliate, glabrous; leaves flat, on the keel and margins scabrous; cyme terminal, many times compound, little shorter than the three or five bracts of the involucre; spikelets ovate-oblong, partially solitary stalked, par-

tially glomerate; bracteoles somewhat keeled, lanceolate-ovate, awnless, naked on the margin, blackish-green and somewhat scabrous at the back; style trifid; caryopsis roundish-ovate, plano-convex, slightly angulate at the back, short-mucronate, pallid, even; hypogynous bristles at the top puberulous, variously curved, much longer than the fruit.

Along the rivulets and streams of the lower part of the Australian Alps; for instance, at Mount Linster, Omeo, and Gibbo Creek, Snowy River, &c.

Spikelets of the size of Scirpus radicans, between which species and S. silvaticus it seems intermediate.

I add here the only new species of Scirpus, with which I am acquainted, although not alpine.

28. *Scirpus leptocarpus.*

Dwarf, annual; root fibrous; stems numerous, slender angulate, streaked, one-leaved at the base; spikelets one-three, spuriously lateral, ovate, sessile, many-flowered; one bract of the involucre elongate, erect, at last horizontal; the other of the length of the spikelet; bracteoles oblong, acuminate, slightly recurved at the apex, straw-yellow, with brownish margin and green keel; style trifid; caryopsis trigono-cylindrical, fine dotted; hypogynous bristles white, slightly scabrous.

On moist or sometimes inundated localities on the Murray, Ovens, and King, Rivers.

29. *Oreobolus distichus.*

Leaves long, distichous, laxly imbricating, somewhat spreading, incurved, channelled, subulate, flat towards the summit, dilated and equitant at the base, serrulate-scabrous on the margin; peduncles angulate, furrowed, at last tereti-compressed; bracteoles two or three, large, unequal; scales of the perigynium lanceolate, acuminate; caryopsis even, ovate, acuminate.

In peat-moss on the highest summits of the Australian Alps.

Allied to Oreobolus pectinatus.

The present species must be considered as an interesting addition to the genus. For a long time Oreobolus Pumilio, originally from Tasmania, now also observed in the Australian Alps, remained the only species. Gaudichaud added Oreobolus obtusangulus from the Hermite and Falkland Islands,

and J. Hooker Oreobolus pectinatus from Lord Auckland's Group, Campbell's Island and New Zealand. Thus, it appears, that all these islands possess only an isolated representant of the genus.

30. *Carex Polyantha.*

Tall; leaves broad-linear, nearly flat, keeled, with the erect triquetrous stem a little scabrous; male spikes 4—5, elongate-cylindrical, the lowest ramified by several short ones; female spikes 3—5, very long, cylindrical, the lowest long pedunculate with remote flowers at the base; lower bracts very long foliaceous, auriculate but not vaginate at the base; stigmas two; fruit brown, ovate, sessile, glabrous, dotted, on both sides convex and distinctly streaked, abruptly terminated into a very short bidentate beak, as long as the lanceolate-subulate black bracteoles; caryopsis compressed, round-ovate, straw-yellow, shining, even.

In the vallies of the Upper Mitta Mitta, near Mount Hotham.

More allied to Carex acuta and paludosa, than to any of the Australian, Antarctic and New Zealandian species.

31. *Carex cephatotes.*

(Sect. Psyllophora.)

Dwarf; root fibrous; leaves narrow-linear, channelled, scabrid, as long as the smooth thin triquetrous stem; spike terminal, solitary, androgynous, dense-flowered, roundish-ovate, generally bracteless, with male flowers at the summit; stigmas two; fruit spreading, lanceolate-ovate, very short stalked, terminated by a short undivided beak, nerveless, even, green with black-brown tip, slightly convex at the back, longer than the brown ovate acute persistent one-nerved bracteoles; basal arista wanting; caryopsis round-ovate, tapering into the base, brownish-yellow, even, shining.

On the grassy summits of the Munyang Mountains, moistened by the perpetual glaciers, or on the most elevated springs.

One of the handsomest species of a large cosmopolitan genus, allied to Carex capitata, from European and Asiatic Alps.

32. *Carpha nivicola.*

Rhizome creeping; stem very short, smooth; leaves and lower bracts broad-linear, blunt, with scabrous margin, flat towards the summit; spikelets one-flowered, fasciculate, greatly surpassed in length by the leaves; scales of the spikelets generally five, unequal, the outer ones twice or three times shorter than the rest; the innermost solitary, linear-setaceous, toothless, or wanting; bristles of the perigynium six, nearly to the top plumose, three times longer than the caryopsis; stamens three; style filiform, puberulous; stigmas three, capillary; caryopsis oblong-triangular.

On the highest summits of the Australian Alps, near swamps.

Closely allied to C. alpina. As a genus, I consider carpha as near allied to oreobolus as to cyathochate, rhynchospora or chætospora.

Gramineae.

Most of our new Alpine grasses are already published, but I avail myself of this opportunity to bring a kind of Ehrharta under notice, singular for its incomplete flowers.

33. *Ehrharta uniglumis.*

(Sect. Tetrarrhena.)

Stems branched, with the vaginæ and leaves scabrous, otherwise smooth; spikelets glabrous, distinct, perinath nerved, blunt; gimmella of the lower sterile flower a little longer than the solitary gluma, and as long as the hermaprodite flower.

In humid valleys on the Brodribb River.

It bears the greatest resemblance to Ehrharta (Tetrarrhena) contexta, but differs from this in the equal length of the sterile flowers, and like from all others in the want of the outer glume.

Art. XII.—*On the Failure of the Yan Yean Reservoir. Embracing an Examination of the Report of the Committee on the Yan Yean Scheme. By* David E. Wilkie. Esq., M.D.

Whether we regard the magnitude of the works now in progress at Yan Yean, for the supply of the City of Mel-

bourne with water, or the great importance of the interests involved in the probable success or failure of this undertaking, the subject, I think, is one which merits the attention of the members of the Philosophical Society.

The gravitation system has, of late years, been very much adopted wherever it has been found practicable; because, although the first cost may be great, it possesses the advantage of a constant supply of water, at a high pressure, and at a comparatively small annual expenditure.

It becomes a matter of important calculation, therefore, in every case, to determine whether it is better, in a pecuniary point of view, to obtain river water in the immediate neighbourhood of a town by steam power, or to bring it from a distant and higher level by gravitation.

Accordingly, about six years ago, the late Mr. Blackburn, at that time City Surveyor, directed his attention to the problem of procuring water for the city by gravitation, and it is to that gentleman that we are indebted for pointing out the natural adaptation of Yan Yean for a large reservoir.

In recommending his favourite scheme to the public, there is no doubt that Mr. Blackburn had satisfied himself that there would be an ample supply of water for the reservoir. In his calculations, however, he placed great dependence on the natural advantages of the Yan Yean basin, in supplying a large supplemental amount of water from surface drainage, and in storing the flood water of the Plenty, independently of its ordinary discharge.

He also calculated that his gravitation scheme in 1851 would cost, including distribution pipes for the city, only 84,700*l.* to supply a population of 70,000, at 40 gallons per head per day; while the lowest cost for supplying the same population at the same rate by steam power, from the Yarra, he estimated at 76,700*l.* The annual current expenses attending the gravitation scheme, he estimated at 858*l.*, against 3,894*l.*, as the expenses attending the pumping scheme.

It must be regarded as a singular fact in the history of Melbourne, that with the river Yarra so easy of access, and so peculiarly adapted by nature to furnish an unlimited supply of the purest water, no steps were taken to supply this large city until February, 1853.

At that date, four Commissioners of Sewerage and Water Supply, were appointed under an Act of Council, and their

engineer having reported very favourably of Mr. Blackburn's gravitation scheme, and having condemned all other plans for supplying the city from the Yarra, they determined forthwith to commence the works at Yan Yean.

I have always regretted the step taken by the Commissioners in adopting the Yan Yean scheme.

In the month of February, last year, I published a letter for the purpose of vindicating Professor Smith's preference of the Yarra scheme, and I endeavored to show that the Yarra water was necessarily purer than the Plenty water, and that the latter would be very much deteriorated by being transferred into the Yan Yean swamp, and, being there deprived of that constant and continuous motion which is its very life, that it would become incurably infected with microscopic animal and vegetable productions, which no filtration could remedy.

I described the plan adopted by the city of Edinburgh, which obtains its supply direct from the Crawley Springs, without subjecting the water to the injurious influences of exposure in a large open reservoir. And I urged the great advantage of possessing an unlimited supply of this necessary of life which the Plenty could not afford; and, as objections had been taken to all other Yarra schemes, on the ground of their impracticability, and the annual expenses attending them, I ventured to propose a simple scheme for bringing the Yarra water into Melbourne, on the gravitation principle, by means of a tunnel carried to the base of a shaft to be sunk alongside the Eastern Hill reservoir; which would thus have the effect of diminishing as far as possible the expense of pumping and management; and I showed that the annual expense of a pumping scheme for 100,000 inhabitants would cost a half-penny per week, per head; and that any expense was of trifling importance when the health and comfort of a populous city were involved.

I regret that I did not further prosecute my inquiries at that time, but the truth is that my letter having received no attention or sympathy in any quarter, I saw no prospect of warding off the evil which I believed to be impending over the city.

I still object to the Yan Yean scheme—1. Because of the enormous expense. In consequence of the discovery of the Gold-fields, labor is now at a much higher rate than when it was first projected by Mr. Blackburn. The Commissioners' estimate for the works is £650,000, of which £400,000 have

already been expended; but it is the opinion of many that they will more probably cost £1,000,000. 2. Because the Commissioners, in erecting temporary works for supplying the city from the Yarra, have shown that, for the comparatively small sum of £30,000, the same object can, to a certain extent, be accomplished; and, indeed, if they had erected their temporary works at the right place, viz., near the junction of the Merri Creek with the Yarra, about a mile and a half from the reservoir at St. Peter's Church, the temporary works being distant half a mile from the same reservoir, and, so as to have avoided the surface drainage and sewerage of Collingwood and Richmond, we could have dispensed with the Yan Yean Water Works altogether. The expense of the additional horse-power required for the increased distance of one mile, which would be about six horses added to forty, and the saving in the carriage of coal, are trifling advantages to be purchased at a sacrifice of the public health, in a populous and wealthy city, which this measure really involves, as it has been clearly shown, by chemical analysis, that the water at Prince's Bridge contains four times more of impurities and matters prejudicial to health than the water at the junction of the Merri Creek with the Yarra.

But let us suppose that it would have been necessary to expend £60,000 in the erection of permanent works for raising water from the Yarra into the reservoir at St. Peter's Church, this would have been decidedly preferable as a commercial enterprise, when we contrast the interest of £60,000 at 10 per cent. with that of £600,000.

The Commissioners have thus altogether sacrificed the pecuniary interests of the public in their selection of the gravitation scheme, and have ignored the principle upon which a selection of either scheme is always based, namely, its adaptation to afford an ample supply of water at the lowest possible cost.

3. I object to the Commissioners' scheme because I do not think that in this climate a large swamp covering 7,000,000 square yards of surface is a suitable place for storing water for the consumption of a large city. It has been the natural receptacle for the surface drainage of the surrounding ranges, with only a very small natural outlet or water course. The consequence has been a vast accumulation of green slimy mud, the result of decaying organic matters, which will greatly alter and deteriorate the water of the Plenty, which, within its own banks, is exceedingly pure. And I find, on

referring to the able report of the Select Committee of the Legislative Council on Sewerage and Water Supply, that those gentlemen who were best qualified to give an opinion on the subject were unanimous in describing the deterioration which the water would undergo by being stored in the Yan Yean reservoir. The language used by one physician was that the water would be almost incurably contaminated; by another, that he should not like to use the water himself.

As regards the purity of the water, therefore, I think the Commissioners have disregarded the best interests of the public in a sanitary point of view.

4. I object to the choice of the Commissioners, because it was based on insufficient data. The Select Committee, in their report, say "our meteorological experience in these colonies by no means justifies the sanguine anticipations of Mr. Blackburn, who himself admits that a continued drought for two years, or even eight months, would render the whole scheme a failure;" and they state the following very grave objections to the reservoir scheme.

1. "That it would seem to be against all experience that any of the sources of the Plenty should be constant in all seasons.

2. "That sufficient allowance has not been made for the effect of evaporation over so large a surface as 1,200 acres, the proposed superficies of the reservoir."

And, while they were of opinion that the advantages upon the whole preponderated in favor of the gravitation scheme, they preferred to adopt the course taken by Mr. Hodgkinson in his evidence, and declined giving a positive opinion on the subject.

It is difficult to see what peculiar advantages the Select Committee had in view, without referring to the estimates of the two rival schemes which they were contrasting. The advantages which one scheme of water supply possesses over another, are always reducible to a money value.

The following are the estimates for the two schemes, which were under the consideration of the Select Committee in January, 1853.

	First Cost.	Annual Expense.
Modified Gravitation Scheme	£162,713	£1,450
Mr. Hodgkinson's Yarra Scheme	99,689	7,600

The objections which, in the opinion of the Select Committee, applied to Mr. Hodgkinson's plan, had reference exclusively to the annual expenditure for coal and supervision,

amounting to £7,600. A singular objection, when it was admitted that the people of Melbourne had hitherto been compelled to pay at the rate of £150,000 a year for a miserable supply of water—£10,000 a year f r a population of 100,000 is a halfpenny per week for each individual. If we add to this £10,000 as interest for the first cost of Mr. Hodgkinson's scheme, the cost of an efficient water supply from the Yarra, with all the advantages of purity, certainty, and high service, would have been a penny a week per head.

It is a singular fact, and worthy of being recorded, that the modified gravitation scheme, under the patronage of the Commissioners, so expanded itself in less than twelve months, as to re-appear under the new estimate of £650,000.

A good deal has been said of the advantages that the Yan Yean scheme possesses over its rival in its powers of indefinite extension. Perhaps this remarkable increase in the estimated cost is to be regarded as an illustration of this principle.

4. My chief objection to the Yan Yean scheme is the very limited supply of water for so colossal an undertaking, and this serious objection did not escape the notice of the Select Committee, who admit that it is "accompanied with the drawbacks that the quality and quantity of water might by possibility fall short of the standard, and that in the execution of the work some unforeseen difficulties might have to be encountered." And the chief object of this paper is to place before you certain data by which you may be enabled to judge for yourselves on this all-important point.

Having long entertained the opinion that the Plenty, from its limited size, was quite unsuited to supply the city with water, I resolved, in December last, to visit the Yan Yean Water Works, and obtain all the information I could respecting them. And as Dr. Mackenna had expressed himself much interested in the result of my inquiries, I invited him to accompany me, which he very kindly did. Mr. Taylor, the resident overseer of the works, politely showed us every attention, and gave us every information we desired.

It is proper here to mention, that when I submitted my first paper to you last month, it was necessarily based upon very limited data; but I was so impressed with the importance of the subject, and the result of my own inquiries, that I suggested the appointment of a Committee for the purpose of investigating the whole subject in a scientific manner, and reporting to the Society. I should also add, that I had the honour of accompanying your Committee on their scientific

tour, and I shall not soon forget the pleasure and instruction it afforded me, and through their kindness in furnishing me with their measurements and calculations, I am enabled to submit to you this evening my opinions on the Yan Yean reservoir scheme, based on more correct data, and more extensive inquiry.

There is a considerable discrepancy in the published accounts of the amount of water consumed by different cities.

It appears that London and some other cities in England are supplied with 30 gallons per head per day, Glasgow is supplied with 30 gallons per head, by steam-power, Nottingham consumes 40 gallons per head, and the Croton aqueduct at New York is calculated to discharge 60,000,000 gallons in 24 hours, which for a population of 500,000 gives 120 gallons per head.

Great credit is due to the City Council for having from the first laid it down as a settled principle that Melbourne should be supplied at the rate of 40 gallons per head. At the same time I cannot regard this amount as adequate in a sanitary point of view to our actual requirements. Melbourne and New York are in similar latitudes, and considering the hot winds and dust storms, and the very dry atmosphere and long droughts that are peculiar to Australia, a more liberal supply of water would be required here than in New York.

For public baths and fountains, for thoroughly watering the streets, cleansing the gutters, and flushing the sewers, for extinguishing fires, and limiting their rapid and destructive progress, the water supply of this city should not be measured by so many gallons per head, the supply should at all times and under all circumstances be amply sufficient for any increased or unforeseen demand that might arise; but it will be shown in this inquiry that there is no such ample supply at Yan Yean to satisfy such luxurious anticipations, and we must be contented to limit our wants to the supply we can command. And in the event of a drought, to use the words of the Select Committee, "it is incontestible, that the most careful provisions would be necessary to guard against any unnecessary waste of water."

I shall, therefore, assume forty gallons per head as the amount that it will be necessary to provide for this city; and this is the amount upon which Mr. Blackburn and Mr. Hodgkinson based all their calculations, in their evidence before the Select Committee.

There is one important point in which I must differ from the Select Committee, and that is in limiting the amount of

population to be provided for. Mr. Blackburn declined giving an opinion on this head, and I think the Select Committee were wrong in limiting the number to 100,000 for the modified gravitation scheme that was to cost 162,000*l.*, but they are in no way identified with the more costly scheme of the Commissioners. A gravitation scheme, involving an outlay of 650,000*l.* of public money should not be limited to any amount of population short of 500,000. In other words, it should not be commenced at all until an ample supply of water for 500,000 be secured.

The population of Melbourne, with its suburban towns and villages, is little short of 100,000; and the amount required for this number, at the rate of 40 gallons per head, per day, would be equal to 8,690,476 cubic yards. Now, as the area of the reservoir is 7,000,000 square yards, this amount of water would give a depth of 3 feet 8 inches in the reservoir, and a population of 500,000 would require a depth of 18 feet 4 inches.

Let us now inquire what amount of water can be supplied to the reservoir.

The main feature of the Yan Yean scheme is the large reservoir, or natural basin, which has an area of about 1450 acres, and a surface of about 7,000,000 square yards, and into which it is intended to direct the greater part, if not the whole of the watershed of the Plenty basin.

For this purpose an aqueduct of about two miles in length is being now formed to lead the river into the reservoir, and a large embankment is being raised at the lower end to the height of thirty feet; and, as it is expected that the river will more than fill the reservoir, and that it will maintain a current through it, there is a waste wash at the height of twenty-five feet to lead back the surplus water to the Plenty. A tower well has also been erected within the embankment, and is so arranged as to admit the water into the main pipes by two openings, at ten and seventeen feet, from the bottom of the reservoir. The third opening at the bottom of the tower well, as explained by Mr. Taylor, is only intended to draw off the impurities that will be deposited from the water.

The Plenty takes its rise in Mount Disappointment by two main branches, the eastern and the western. The latter, according to Mr. Hodgkinson, takes its source from a considerable stream which gushes direct from a fissure in the granite. The eastern branch, as we had lately an opportunity of witnessing, takes its rise from the table land at the very top of the mountain, and, from the smallest possible begin-

ning, is gradually augmented by innumerable rills and streams issuing from the moist rotten soil and from the fissures and crevices of the rocks. Both branches, at the base of the mountain are discharged into large swamps; and it is not until they issue again from these that they unite to form the Plenty River, about four miles from Yan Yean. The area of the western swamp, according to the estimates of your Committee, is 787,000 square yards, that of the eastern, 3,808,000 square yards.

These streams have been measured at different times and under different circumstances, with the following results.

The late Mr. Blackburn, in his first report on the water supply of Melbourne, dated 9th January, 1851, states that he had measured two of the branches of the Plenty, above the marshes, and found them to discharge respectively 2,000 and 1,700 gallons per minute, and he estimated that the whole discharge of the tributaries amounted to 5,000 gallons per minute, which is equal to 6 feet 7 inches in the reservoir, while the united stream below the marshes scarcely gave 2,700 gallons per minute, or 3 feet 7 inches. There was thus a loss by evaporation of 2,300 gallons per minute, which would give 3 feet in the reservoir, in twelve months.

There being an unusual drought in the summer of 1851, Mr. Blackburn, on two separate occasions, revised his former measurements; on the latter occasion, the 14th February, he found the discharge of all streams above the swamps amount to 4,040 gallons per minute, which equals 5 feet 4 inches in the reservoir, and in the river below the swamps he found only 865 gallons per minute, or at the rate of 1 foot 1 inch in the reservoir, showing a loss by evaporation of 3,175 gallons per minute, which would give 4 feet 1½ inch in the reservoir.

Mr. Hodgkinson, on the 9th December, 1852, after fifteen hours' rain, measured the western arm, where it issues from the granite rock, and estimated the discharge at 1,180 gallons per minute, or 1 foot 7 inches in the reservoir; he also measured the same stream, where it enters the swamps, and found it to give 1,700 gallons per minute, or 2 feet 3 inches. On the following day he measured the eastern arm, below the first waterfall, and found it to discharge 1,980 gallons per minute, or at the rate of 2 feet 7½ inches in the reservoir.

The first of Mr. Hodgkinson's measurements is the one of most value in this inquiry, as we may presume that the stream, where it issued from the rocks, was little affected by the previous rain. The second measurement was taken at a

situation where it could not fail to be considerably augmented by the rainfall of fifteen hours. The measurement of the eastern arm, which was obtained the following day, could not give any certain result, as it was taken above the junction of three small tributaries. In one point of view, however, it is very important, as the object of the measurement was to illustrate the constancy of the supply. All the other tributaries of the Plenty have been known to fail on several occasions.

The measurement of the main eastern branch, therefore, shows an approximation to the amount of water supply that would be available above the swamps in a severe drought, but it is only an approximation, as it too may also fail; there is certainly no guarantee in the height of Mount Disappointment, which is only 1,500 feet, to warrant a more favourable opinion.

All the tributaries of the Plenty equally depend on the rainfall of the mountain ranges, and it is simply because the main eastern branch rises from the highest point, where there is most rain and least evaporation, that it holds out the longest when the ordinary supply of rain is cut off.

I come now to mention the measurements which were made by the Committee who were appointed to investigate this subject at the last meeting of the society.

The river, at its junction with the aqueduct, with a velocity of half a mile an hour, gave a discharge of 2,537 gallons per minute, or an equivalent to three feet four inches in the reservoir. The eastern arm above the swamps yielded 4,450 gallons per minute, or an equivalent to five feet eleven inches. If we take Mr. Hodgkinson's measurement of the western arm, where it issues from the rocks, namely, 1,180 gallons per minute, and add to it the Committee's measurement of the eastern arm, we shall have 5,630 gallons as the discharge of all the streams above the swamps; and if we take into consideration that one week before their visit to Yan Yean there were nearly three days of heavy rain, which is an unprecedented occurrence in January, the 630 gallons may be regarded as due to this source, and the balance of 5,000 gallons per minute will exactly correspond with Mr. Blackburn's estimate.

From these measurements, it would also appear that the eastern arm bears the proportion to the western arm of 4,450 to 1,180, or very nearly four to one. By this estimate we shall find that the discharge of the western arm was 1,340

gallons per minute, at the time when the committee measured the eastern arm. The whole discharge above the swamps was therefore 5,790 gallons per minute, and below the swamps 2,537 gallons.

In this manner we ascertain that the loss by evaporation in the swamps amounted to 3,253 gallons per minute, which is at the rate of 4 feet 4 inches in the reservoir; and as the area of the swamps is one half less than the area of the reservoir, 8 feet 8 inches will represent the rate of evaporation in the swamps during the summer months.

It is thus easy to understand why Mr. Blackburn and Mr. Hodgkinson so strongly urged the necessity of making artificial watercourses, in order to withdraw the two branches of the river from the influence of the swamps.

It does not appear that the Commissioners of Sewerage and Water Supply have any present intention of doing this, and I am not sufficiently acquainted with the levels and depths of the swamps to give any opinion as to the best mode, but it is quite clear that some steps must be taken to save the immense loss that is at present occasioned by them. And in estimating the quantity of water that will be available for the reservoir I shall assume that some effectual means will be adopted to accomplish this very desirable object, and that the whole of the 5,000 gallons may be transferred into the reservoir without loss.

The measurements would not be complete without mentioning, that Dr. Mackenna and myself, on our visit to Yan Yean, measured the Plenty where it passes under the bridge, about three miles below the reservoir, and obtained a discharge of 960 gallons per minute, which would give a depth in the reservoir of 1 foot 3 inches. The measurement of the committee at the same place, on their late visit, gave 475 gallons per minute, which is equal to 8 inches in 12 months.

These small results compared with the measurement above Yan Yean arise from the quantity of water that is abstracted by a cut for the purpose of puddling the embankment.

I have thus assumed Mr. Blackburn's highest estimate of 5,000 gallons per minute as the average of the whole discharge of the tributaries of the Plenty. In the drought of the summer of 1851, however, Mr. Blackburn found this amount reduced to 4,040 gallons; and therefore it is to be presumed that 5,000 gallons are only to be depended on in ordinary seasons.

The important question now arises, what proportion of the 5,000 gallons can be abstracted from the river without inflict-

ing serious or irreparable injury upon the inhabitants of the district through which the Plenty takes its course. One witness, who was examined before the Select Committee, gravely proposed that a half-inch pipe from the reservoir should be given to the inhabitants on the banks, in lieu of the river itself; but to be serious, I am most decidedly of opinion that it would inflict irreparable injury upon the inhabitants of the Plenty district to abstract more than two-thirds of their river from them. Even with this loss they will suffer enough in the permanent closing of all the mills; and I have no hesitation in saying that the good sense of the public of Melbourne would neither expect nor demand more. If the Yan Yean scheme cannot afford to do this it had better be abandoned at once. Nor do I think that the public interests would suffer much thereby.

In ordinary seasons, as already shown, the discharge of the Plenty above Yan Yean, is 2700 gallons per minute in December, and deducting one-third there will remain 1800 gallons, or an equivalent to 2 feet 5 inches; this, added to 2300 gallons, which is the amount at present lost in the swamps, but which I take for granted will be saved, gives 4100 gallons per minute as the average amount of water available from the river for the supply of the reservoir, and this will give a depth of 5 feet 6 inches.

It is more difficult to calculate the amount that might be obtained from the river in time of floods, from the uncertainty of their occurrence, volume, and duration. Had the reservoir been in close proximity to the river, with a sufficient fall, a large amount of flood water might easily have been secured; but in order to obtain 25 feet of depth for the reservoir, it is necessary to bring in the river from a higher level by means of an aqueduct of about 2 miles in length, which winds round the base of the range which separates the river from the reservoir, and which will enter the latter by a tunnel which is being cut through this dividing range. Unless, therefore, a very strong embankment be constructed for the purpose of damming the flood water, which would be a very difficult and expensive operation, owing to the level character of the right or opposite bank, it is difficult to see how the floods can be taken advantage of to any great extent. On such occasions the water is widely extended over a large surface, and will naturally prefer the lower level of the river to the higher level of the canal or aqueduct.

Assuming, however, that the aqueduct can be filled from

the river in time of floods, and assuming that the Plenty will be in a flooded condition for 60 hours in each year, the sectional area of the aqueduct, which is 127 feet, with a velocity of one mile per hour, will give 1,494,000 cubic yards, which would add a depth of seven and a-half inches to the reservoir, or at the rate of 3 inches each day. This result, however, could only be obtained with a dam, so constructed as to raise the surface of the flood water to the height of eight feet above the present level of the river, and at the entrance of the aqueduct the right bank is only one and a-half feet above this level.

In order to do every justice to the resources of the Yan Yean reservoir, I think, that during the three winter months, we may assume that the river is larger than in the summer months, during which season the above measurements have been all made; and I shall take this opportunity of urging how important it would have been to have had accurate measurements of all the tributaries of the Plenty for each month of the year. As there is one-third more rain in the winter months, I propose to allow two-thirds more watershed, independent of floods. This will be equal to one-sixth of 5,000 gallons per minute, or its equivalent, six feet seven inches, which will give an addition of one foot one inch to the reservoir.

It may appear to some that I have allowed too little for floods. It may be thought that sixty hours will not accurately represent their duration for twelve months. It must be remembered, however, that the entrance of the aqueduct is only eight miles from the source of the eastern or main branch of the Plenty. With such a short and limited watercourse, therefore, in a few hours after any heavy fall of rain, the river will have returned within its own banks. It must also be remembered that we may possibly have no floods at all in twelve months; and I feel quite certain that in the last twelve months the river has not been flooded for more than twelve hours at Yan Yean.

As a source of supply for the reservoir, the next in importance is the annual fall of rain. The meteorological tables which have been kept in Melbourne for a period of six years, give thirty inches as the fall of rain for twelve months, and eighteen inches for the six winter months; but as Yan Yean is 600 feet above the level of the sea, I propose to allow six inches on that account, and, therefore, thirty-six inches, or three feet, may be set down as an addition to the

reservoir from this source, and in the same proportion twenty-two inches represent the rainfall for the six winter months.

Having ascertained the rainfall of the Plenty basin it would be of great importance to determine the whole amount of the watershed. The only certain method of obtaining this result would be to take accurate measurements of all the tributaries, at least once in each month, and to make a careful survey of the floods that may occur during the year.

In the absence of such measurements it becomes important to estimate the amount from data that are recognised in England, making due allowance for the difference in the mean temperature, and the physical peculiarities of the drainage area.

If we could ascertain the amount of rain in any district, and the proportion of the rain that is evaporated from the surface of the ground, the difference would exactly equal the contents of the rivers.

On this principle, the late Dr. Thomson, the Professor of Chemistry in the University of Glasgow, estimated the watershed of Great Britain at four inches of the rainfall.

From the meteorological tables he calculated the rain, including four inches of dew at thirty-six inches, and from experiments and observations he calculated the amount of evaporation from the ground at thirty-two inches. He therefore computed the watershed at four inches, or one-ninth part of the rain.

Although Dr. Thomson considered his estimate of four inches too high, from a calculation which he made of the the contents of the river Clyde, compared with its drainage area, yet it differs so greatly from other estimates, which are as high as eleven and thirteen inches, that the only inference we can draw is that the whole subject is still enveloped in so much obscurity and uncertainty, that no correct practical results can be obtained by this method.

It would, therefore, be altogether a visionary speculation, to make the water supply of a large city depend upon the correctness of either of the higher estimates. It would be unworthy of modern engineering science, and could only lead to failure and disappointment.

The most correct view of the subject is probably that entertained by Dr. Prout, who thinks that the truth lies somewhere between the extremes, and I therefore feel disposed to determine the watershed of England, in accordance with the experiments of Messrs. Hoyle and Dalton, who

found, with a mean rain of 33.55 inches for three years, that the evaporation from the ground equalled 25·14 inches; therefore 8·41 inches, or one-fourth of the rain, may be presumed as the amount available for springs and rivers in England.

I am not aware that any experiments have yet been conducted in this colony to determine the proportion of the rain that is evaporated.

The physical character of the country, however, shows that there are comparatively few rivers, and that these are very scantily supplied with water, and that floods are not of frequent or regular occurrence. The absence of high mountains, and the arid and desert condition of the interior, while they greatly diminish the rainfall, contribute to render the atmosphere peculiarly dry, and evaporation very rapid.

In the summer months many rivers and creeks are dried up, and the ground becomes so parched that it is capable of quickly absorbing a large quantity of rain, so that it is rare to find rivers much increased during this season, and the watershed is very trifling indeed.

I think, therefore, that with nearly the same amount of rain as in England, and with a much smaller proportion of rivers and fewer floods, there must be a much larger proportion of rain evaporated from the surface.

I may thus, on very strong grounds, assume that the watershed in this colony is one half less in proportion than in England, and therefore amounts very nearly to Dr. Thomson's estimate, which is one-ninth of the rain.

But it is more satisfactory, and certainly more correct, to deduce the watershed of this colony, from that of England, by making adequate allowance for the difference in the force of evaporation due to our higher mean temperature; and, as it is admitted by scientific men here, that the evaporation from the surface of water is nearly double that of England, it is strictly correct to assume that the proportion of rain evaporated here will also be nearly double.

Thus, I think, no valid objections can be offered to my assuming four and a-half inches instead of eight and a-half, as the best approximation that can be made of the watershed of this colony, until the mean discharge of the different rivers is ascertained by actual measurement.

In mountainous districts the watershed is greater in proportion than in the low country, and the absorption and evaporation less; and therefore it might be thought that Dr.

Thomson's estimate cannot apply to the Plenty Ranges, but their geological formation, and the tropical vegetation with which they are covered, are singularly adapted to absorb and retain a large proportion of the rain that would otherwise flow direct into the watercourses; and it is to this beneficent provision of nature in this dry climate that all the rivers that take their rise in the primary and granitic formations owe their permanency, and not to springs of the ordinary kind, that are met with in the secondary and tertiary formations, which are almost entirely absent; and were it not for this provision the river Plenty, and other similar streams, would cease to flow altogether in the summer months. The winter rain which is now stored up in the spongy soil, and in the caverns and fissures of the rock, maintains a more or less constant stream during the whole summer, and it is in this manner that we explain the otherwise singular fact, that the river Plenty is so little increased in size, during the winter months, in ordinary seasons. In my estimate of the discharge of the the river I have allowed an increase of two-thirds.

But it is not to be supposed that the water thus stored is altogether removed from the influence of evaporation. On the contrary, from its universal tendency to find a lower level it is constantly oozing out over the whole surface of the ranges, and leading gullies, which is thus always in a wet condition, and always evaporating, and the surface is so wet even near the summit, that we found abundance of small leeches several hundred yards from the stream.

The watershed of the Plenty ranges, therefore, differs essentially from the watershed of ordinary mountainous country, and thus the evaporation from the ranges is, probably, fully equal to that from the plains, because while evaporation from the level country is one-third more rapid than from the ranges, it ceases nearly altogether for three months in the former, while in the latter it is constant throughout the year.

The drainage area of the river above the aqueduct, according to the Survey Maps, may be computed at about sixty square miles. The ratio of this surface to the surface of the reservoir is as 26 to 1, therefore the whole rainfall, including four inches of dew, would give a depth of eighty-eight feet in the reservoir, and one-ninth part of this, or nine feet nine inches, would give the watershed.

It may be interesting here to contrast the whole discharge of the Plenty, as I have already estimated it, with the

whole amount of the watershed as deducible by Dr. Thomson's method.

	Ft.	In.
5,000 gallons per minute -	6	7
60 hours' floods - -	0	7½
Two-thirds increase in winter months	1	1
Total - -	8	3½
Whole watershed - -	9	9
Balance unaccounted for	1	5½

The only other important source of supply is the drainage area of the reservoir itself. Mr. Hodgkinson was kind enough to measure this area for your committee, and his estimate is 3,000 acres, or about twice the surface of the reservoir.

During the winter months there has generally been more or less water in the reservoir; but during the summer it has almost always been quite dry.

In 1851 there was no water in it during the whole year; and this fact is not only important as regards the watershed of the reservoir, but it has a far more extensive and significant importance as regards the watershed of the Plenty. I have estimated the rainfall for the basin of the Plenty at thirty-six inches; but in 1851 there was so little rain in that district, that even during the winter months no water was collected in the reservoir, from a drainage area, including the reservoir, of nearly seven square miles, or one-eighth part of the drainage area of the Plenty.

It can hardly therefore be alleged that I have under-rated the average watershed of the Plenty.

After heavy rains and floods, the reservoir has sometimes had as much as two feet of water at the lower end, and then it overflows into a small watercourse or rather swamp, which skirts the ranges for about two miles, and then enters the river by a creek, which has a sectional area of about twelve feet. At the upper end, the reservoir receives a larger creek, which has a length of about three miles, and contains a large quantity of water after heavy rains; but when there is no rain it is quite dry.

According to the best information which I have received the reservoir has, on an average, been dry for six months in the year, evaporation, therefore, must be constant during

the six winter months; now from other data we can estimate the amount of water thus evaporated, which is equal to two feet five inches, and the rainfall, for the same period, is twenty-two inches, leaving a balance of seven inches to represent the surface drainage that is evaporated. If the watershed, therefore, exceeds seven inches it must escape by the small creek at the lower end, and may be approximately ascertained. This watercourse has been generally observed to run after heavy rain, but not otherwise. If, therefore, we assume that there are, during the winter months forty days of heavy rain, and that the creek is, on an average, half full, and that its velocity is about half a mile per hour, the contents would amount to 1,900,800 cubic yards, which would give seven inches in the reservoir. By this estimate the water shed cannot exceed fourteen inches.

It is important, also, in this enquiry, to estimate the watershed according to Dr. Thomson's method. The ratio of the drainage area to the reservoir being as two to one, the whole rainfall would give a depth of six feet, and one-ninth would give a watershed of eight inches; but as there is no watershed in the six summer months, and as the rainfall of these months is less than that of the winter months, in the proportion of two to three, the rainfall of the drainage area must be taken at three feet seven inches for the winter months; and as the area is chiefly composed of ranges of clay slate, which are much less favourable for absorption than the level country, three-ninths or one-third instead of one-ninth of the rainfall may be estimated as the watershed, and this will give fourteen inches, which exactly corresponds with the former estimate.

I shall here notice some considerations which would seem to prove the correctness of Dr. Thomson's estimate, in its application to the basin of the Plenty.

Mr. Blackburn's highest estimate of all the tributaries is 5,000 gallons per minute, or 6 feet 7 inches in the reservoir. One half of this amount, therefore, or 3 feet 3½ inches, will represent the absolute quantity of the watershed for the six summer months. Now, as there is one-third less rain, two-fifths of 88 feet, or 33 feet in the reservoir, will represent the whole of the rainfall for this period. Therefore, the watershed is equal to one-tenth of the rainfall, and the remaining nine-tenths are evaporated.

In the six winter months there is one-third more rain, and,

therefore, there will be one-third more water shed; but evaporation is also one-third less rapid, so that if we add two-thirds to Mr. Blackburn's estimate for the six winter months, we shall have the water shed for that period. To 3 feet $3\frac{1}{2}$ inches add 2 feet $2\frac{1}{3}$ inches, which give 5 feet 6 inches. Now, 55 feet represent the whole rainfall for the six winter months; therefore, 55 divided by $5\frac{1}{2}$, or one-tenth of the rain, gives the whole watershed.

This result may be regarded as a near approximation in ordinary seasons, with no heavy falls of rain, but on such occasions, there is too little time for absorption, and a much larger proportion of the rainfall is quickly conveyed to the rivers. But most people have very exaggerated notions respecting floods, and many people fancy that one flood would fill the Yan Yean reservoir, if it could be secured.

The following considerations will show the very small proportion of the rainfall that can be contained in any ordinary flood.

The velocity of the river, at its junction with the aqueduct, is half a mile per hour, and its present discharge gives 3 feet 4 inches in 12 months; therefore, 88 feet, or the whole rain fall of one year, would require 26 years to pass down the river. The aqueduct has $9\frac{1}{2}$ times the sectional area of the river, yet with this volume and the same velocity, the whole rainfall would require 985 days, or more than $2\frac{1}{2}$ years to be conveyed into the reservoir, while such floods as would fill the aqueduct, do not last more than 2 or 3 days.

The mean rainfall of the different months here is $2\frac{1}{2}$ inches, which can readily be disposed of by absorption and evaporation in mild seasons. The highest mean rainfall is four and one-fourth inches; and in November, 1849, there was a fall of twelve inches, in consequence of which we had a very high flood in the Yarra, which lasted about a week.

I possess no information with regard to the duration of the flood in the Plenty at Yan Yean, but with so short and limited a watercourse, I consider it impossible that the river could have been flooded at that time for more than three days. The sectional area of the highest flood line, as determined by your committee, is 200 feet. Now, with a velocity of two and one-half miles per hour, which is the velocity adopted by them, three days or seventy-two hours would give a discharge of 7,040,000 cubic yards, which is equal to three feet in the reservoir, or one foot per day; and such a flood as that of November, 1849, probably does not occur more than once in ten years.

But how could such a flood be secured for the reservoir? The same amount of water would take twelve days to pass through the aqueduct at one mile an hour, which is the highest velocity that it would be either safe or prudent to allow. A higher than this, in such a winding canal cut out of the clay-slate, would convert the water into mud, and break up the sides, and wash away the artificial banks; and for the sake of such a flood, which may possibly occur once in ten years, would it be reasonable to spend £30,000 in enlarging the aqueduct to four times its present size? and without suitable embankments raised at an enormous cost, to dam up such a flood, one half would not enter the aqueduct at all.

As twelve inches of rain fell during the month, instead of four, we may safely conclude that this flood resulted from a rainfall of at least six inches, which would give thirteen feet in the reservoir, so that out of thirteen feet of rainfall in one of the heaviest floods on record, only three feet reach the rivers, or less than one-fourth.

The only other source of supply to be noticed is dew. In England from four to five inches have been computed as the amount of dew deposited on the ground, but I am not aware of any experiments to show the amount deposited on water. I feel persuaded that the atmosphere is generally so dry here, that the amount of dew must be very small; and unless in the case of very shallow pools and lakes, there can be very little deposited on water. A depth of two or three feet will, in a great measure, prevent the formation of dew, because as the upper particles become cooled they at the same time descend, from their increased density, to make way for the warmer and lighter particles underneath, and until the whole depth of water has attained a considerably lower temperature than the atmosphere with which it is in contact, no deposition of dew can take place.

As it is possible that there may be some dew, when there is very little water in the reservoir, I shall on this account allow an increase of two inches for the whole surface, which is equal to sixteen and one-half days supply for the city.

The whole amount will stand thus:—

	5 ft.	6 in.
From the River Plenty - - -	0	7½
Floods in ditto - - - -	1	1
Increase from winter rain - - -	3	0
Rainfall in reservoir - - - -	1	2
Drainage area of ditto - - -	0	2
Dew - - - - - -	11	6½
Total amount		

I come next to determine the amount of loss from evaporation and absorption.

In large reservoirs the annual evaporation from the surface is a very important element to be considered, and, as it increases nearly in a geometrical ratio, with an arithmetical increase of temperature, a comparatively small difference in the mean temperature might give double the amount of evaporation. It is therefore especially important in warm climates that its actual amount should be ascertained by a careful series of experiments, before any work of magnitude is undertaken, whose success or failure might entirely depend on the result.

In my first paper, which I only regarded as a preliminary inquiry, I computed the evaporation for this colony from the tables of Dr. Dalton, who gives forty-four inches as the evaporation for England. I took the mean temperature of the different months in Melbourne, and assumed for each month the amount of evaporation corresponding to the month of the same mean temperature in England. I also estimated the increased evaporation proportionate to the increased mean temperature and to hot winds, to which I allowed a mean temperature of 87°, and a duration of fifteen days, and I thus determined the evaporation to be seventy-two inches or six feet. I stated, however, that I felt satisfied that a careful series of experiments would show a still higher result, as, independent altogether of the temperature, the much drier condition of the atmosphere in Australia exercises a powerful influence in promoting evaporation.

Since our last meeting I have ascertained that Mr. Glaisher, who is the highest authority on meteorological subjects, has estimated the evaporation at Greenwich at sixty inches, or five feet annually. Proceeding upon this higher estimate, the evaporation, calculated in the same way, would be equal to eight feet two inches; and, making due allowance for the dry condition of the atmosphere, nine feet may be safely assumed as the mean evaporation for this colony.

I have also learned that Dr. Davey, a member of this Society, has devoted a great deal of attention to this subject, and he has furnished me with the result of his experiments. He is quite confident that the mean evaporation is not under nine feet, but he is inclined to believe that it is more probably ten feet. This summer having been remarkably cool, with a great deal of rain, and few hot winds, is not to be regarded as an average season.

Being anxious to ascertain the rate of evaporation over a large surface, fully exposed to the influences of the weather, I lately selected a sheet of water of about 300 yards long, with an average depth of eighteen inches, and width of fourteen feet, and, by fixing a mark in a particular part of the bank, I made careful measurements several times during fourteen days, and found that the amount lost exactly equalled six inches in that time, which gives five lines per day, and, for the three summer months, three feet two inches. The weather throughout was cool, excepting one day, and the winds southerly and easterly, so that this may be regarded as the lowest rate at this season. By computing the evaporation of the other months according to their mean temperature, this rate would give nine feet for the twelve months.

In further illustration of this subject, I may mention that Mr. Laidlaw has computed the evaporation in Calcutta at fifteen feet, and he also found that it averaged nearly three-fourths of an inch a day, between the Cape of Good Hope and Calcutta, and between 10° and 20° in the Bay of Bengal, he found it to exceed one inch daily, or at the rate of thirty feet in the year.

Dr. Milner mentions that there are many lakes in the steppes of Northern Asia which have no natural outlet. Some of them are many miles in circumference, and have a depth of six and seven feet, from the winter rain, but are entirely evaporated during the summer months.

And, according to Irby and Mangles, who describe the effects of evaporation in the Dead Sea, it must be very rapid indeed, notwithstanding the strong saline impregnation of the water. During the rainy season, the increase of the Jordan and other streams is sufficient to raise the level ten or even fifteen feet; but under the influence of a burning sun and a dry atmosphere, the lake, in a few months, resumes its former level.

It remains to consider the loss from absorption.

At the last meeting of the Society I expressed great fears that a serious loss might be sustained in the reservoir from this cause; but I have since seen the evidence which Mr. Hodgkinson gave on the subject before the Select Committee, which I consider perfectly satisfactory.

To determine the exact amount of water, that will be available for the use of the city, I have now to deduct the loss from evaporation.

Total - - - - -	11 ft.	6½ in.
Deduct evaporation - - - -	9	0
Balance - - - - -	2	6½
Required for present wants - - -	3	8
Balance deficiency - - - -	1	1½

This is indeed an unfortunate result of the gigantic operations and large expenditure already incurred at Yan Yean. And it seems not a little extraordinary that such unlimited confidence should have been placed in the abundant supply of water; and it is no less extraordinary that Mr. Blackburn, with a knowledge of the immense loss sustained from evaporation in the marshes, should have urged the necessity of rescuing the river from this slough of despond only to plunge it into an abyss of greater magnitude, where it would be scattered, contaminated and rapidly dissipated.

But it will probably be said, that as I have only shown a deficiency of one foot and one and a half inches, which is rather less than one third of the amount required, I may be in error in my estimate, and perhaps the winter rains may furnish the amount. Now, I shall admit that in some seasons even double this amount may possibly be added to the reservoir from this source, but I do not think that this need be regarded as a subject of congratulation. With a stream of pure water, encircling this city like a horse shoe, the inhabitants will not willingly pay £650,000 to be subjected to the chances of the seasons, to be dependent on the casualities of rain for the first necessary of existence; and, if we must speculate on chances, how often do we have summers remarkable for droughts, and the prevalence of hot winds? And, what we gain by casualties of rain, we shall certainly lose by the casualties of evaporation. An inch a day, for hot winds, which as we have seen is a small allowance for a temperature of 96°, would make short work with two feet in the reservoir, and this is the greatest addition which could reasonably be expected from the ordinary rainfall of the winter months.

It will be readily admitted that in estimating the available discharge of a river for the supply of a large city, it is necessary to take a low average, instead of the mean for a number of years, because it is essential to know what amount can really be depended upon for each year, as the water supply of a city should be placed beyond the reach of casualties.

The late Mr. Blackburn was fully impressed with the importance of this principle, hence he assumed his measure-

ment of 5,000 gallons per minute in December as a reliable average.

My own estimate, on the same principle, is 5,833 gallons per minute, allowing two-thirds of increase for the three winter months; but this again is reduced by 900 gallons, which I allow as a minimum, and very scanty supply for the inhabitants of the district. The available discharge is, therefore, 4,933 gallons per minute, independent of the floods, or six feet seven inches in the reservoir.

I do not say that the discharge does not frequently exceed this; but I am strongly of opinion that in some seasons it does not do so.

I shall now, however, consider what may be regarded as the highest average, and I shall deduce the amount from the sectional measurements of the river.

It may be considered as an axiom, that when a river has defined banks, these indicate its ordinary limits, which it only exceeds in time of floods. In other words, every river may be regarded as having excavated for itself a bed sufficiently large to hold its ordinary stream. The ordinary stream, therefore, will be confined within the ordinary banks, and the highest average in the winter, unless in floods, will not overflow the banks.

Let us examine the sections of the bed of the river at the entrance of the aqueduct. The mean of the sections gives 28 feet within the banks, and 13·2 feet under the water line. Therefore, with the same velocity of half a mile per hour, the section could contain no more than 5,381 gallons per minute, without flooding the right bank. With double the volume, the velocity would not be increased, according to the usual formulæ, by one half. Therefore, I consider it to be demonstrated, that 8,071 gallons per minute, or three times the January measurement, is the highest discharge of the river, except in floods; and it is exceedingly rare to find any river in Australia level with its banks for six months in the year.

This discharge will give five feet four and a half inches in the reservoir for the six winter months; but it will be observed that it does not include the amount at present lost in the swamps, which I have calculated at 1,830 gallons per minute for the whole year, or two feet five inches in the reservoir.

The loss in January, as we have seen, is 3,253 gallons per minute, or at the rate of four feet four inches in the reservoir.

This estimate is of great importance, as showing the exact amount that may be saved by effectually withdrawing the tributaries from the evaporation, and it may be absorption, of the swamps.

If the two feet five inches, therefore, can be saved, it may be added to the five feet four and a half inches.

The highest ordinary discharge may be computed thus—the six summer months being taken at 2,537 gallons per minute, or three feet four inches, as measured by the committee in January.

	ft.	in.
Six summer months - - - -	1	8
Six winter months - - - -	5	4½
Amount lost in swamps - - -	2	5
Total - - - -	9	5½
Deduct 900 gallons for district - - -	1	2
Highest discharge of river - - -	8	3½
First estimate - - - - -	6	7
Balance in favour of 2nd estimate - -	1	8½

Thus my first estimate amounted to six feet seven inches as the ordinary discharge of the river, so that this second or highest estimate has an advantage of one foot eight and a half inches over the first. It will therefore be seen that, even allowing the river to be level with its banks for six months in the year, for which we have no measurements to guide us, still the result is very little more favourable than the first, and cannot with any certainty be depended on; and if one-third of the whole, instead of the scanty allowance of 900 gallons per minute, were left for the use of the district, this highest average discharge would be reduced below my former estimate.

The Committee, who were appointed by the Society to investigate the subject in a scientific manner, have arrived at results very different from my own. They do not base their conclusions on the measurements at all, which they profess to disregard, but on theoretical principles, and on certain calculations quite original, and apparently adapted to supply any amount of water that may be required in this dry climate; and they have determined that the discharge is three times greater than my estimate of eight feet.

Thus, although Mr. Blackburn, who was ignorant of the

enormous evaporation in this colony, supposing it to be about three feet, only calculated upon a certain supply for 150,000 individuals, they, admitting nine feet of evaporation, which is equal to an annual loss of water that would supply 327,000 at thirty gallons per head per day, find that there is still sufficient left for a population of 666,000, and very generously leaving one half of this enormous amount for the use of the district, they regard the reservoir scheme as adequate to supply 333,000. Had Mr. Blackburn been spared, how rejoiced he would have been to find his favourite scheme so singularly developed in so short a time. This appears to be another illustration of the wonderful powers of unlimited extension attributed to the Yan Yean scheme.

The proportion of the Committee's estimate would stand thus: 3,000 gallons per minute for the six summer months, 15,000 gallons per minute for three of the winter months, and 48,000 gallons per minute for the other three winter months.

These large amounts are of course intended to include floods, but as I have elsewhere shown that in some seasons we may have no floods at all, and that the very highest flood, supposing it to last seventy-two hours, would only amount to three feet in the reservoir, or less than one-eighth of the whole, the above figures may be regarded as substantially correct.

It is a source of great regret to me that my estimate is so much at variance with that of the Committee appointed by the Society, but a thorough conviction that they are in error compels me to call in question the result of their investigations, and to discuss at some length their mode of reasoning on the subject.

And here it is necessary to state that the Committee at present consists of only two members, Mr. Christy, civil engineer, and Mr. Acheson of the Survey Department.

As originally appointed, the Committee contained the names of Mr. Wekey, the honorary secretary of the Society, and Mr. Hodgkinson, of the Survey Department, who, from his great practical knowledge, and long experience in the colony, and having already devoted much attention to the whole subject of the water supply of the city, was peculiarly fitted to aid their labours.

The former withdrew on finding, after mature deliberation, that he could not reconcile his own opinions and calculations with those of his colleagues.

The latter writes to the Society, "that although precluded, from want of time, from affording his assistance in the calculations of the Committee, yet, if he could have agreed with the conclusions arrived at by them, he would have appended his name to their report, but he differed very materially from some of their views."

It is much to be regretted, that the Committee thus lost the co-operation of two of the members, and especially on the grounds above stated, as it is evident, that they, as originally constituted, would have arrived at very different conclusions, and although I entertain the highest opinion of the professional abilities of Messrs. Christy and Acheson, I have to state, on public grounds, that however competent they may be to draw up a report on the watershed of English rivers, with the aid of English tables, they cannot be supposed to have much practical knowledge of the rivers of this country, from their comparatively short colonial experience, and they have never actually seen the river Plenty in the winter months, although their calculations show that they expect nine-tenths of the whole supply from the winter rains. The report, therefore, has lost much of that practical value that would otherwise have attached to any document emanating from a Committee of the Philosophical Society.

Finding such an enormous difference between my estimate of the watershed of the Plenty basin, and that arrived at by the Committee, Mr. Hodgkinson was induced to read a very interesting and valuable paper on the subject before the Society; and the result at which he has arrived strongly corroborates all my calculations and conclusions with respect to the watershed, which is the fulcrum upon which the sufficiency of the supply for a rapidly increasing population will depend. At forty gallons, per head, per day, Mr. Hodgkinson calculates that there will be water for 190,000, so long as there is no drought like that of 1837-38; in such a contingency he thinks the supply of water would fail.

But, it is to be noticed, that this estimate for 190,000 is based on a very important consideration, about which there is at present some difference of opinion. He has taken measurements of the evaporation from a pond which supplies his house, and calculates that it does not amount to more than five feet six inches in the year. Dr. Davy, on the other hand, who is our highest meteorological authority, regards ten feet as the probable evaporation. Now, at forty gallons

per head, the difference between these estimates of evaporation would supply 123,000; deduct this from 190,000, and we have 67,000 as Mr. Hodgkinson's estimate, according to this higher rate of evaporation.

My own estimate, deducting the same evaporation, would supply 43,000.

Regarding these estimates as mere approximations, it will thus be seen that the difference between Mr. Hodgkinson's and my own is very small, being equal to only ten inches in the reservoir.

Now, while the greatest importance is to be attached to Mr. Hodgkinson's estimate of the watershed of the Plenty, as it is founded on a thorough knowledge of the river, and much practical experience both here and in England, I feel inclined to prefer Dr. Davy's estimate of the evaporation, and from measurements which I recently made on a larger sheet of water than Mr. Hodgkinson's pond, I found that in twenty-eight days the evaporation exactly equalled eleven inches, or 0·39 inches per day, which would give very nearly nine feet in twelve months.

But, after all, no scientific result can be obtained from ponds and waterholes, unless they are water-tight, which it is impossible to ascertain.

Thus, with Dr. Davy's lowest estimate of evaporation, Mr. Hodgkinson's estimate of the watershed would supply 94,000, so long as there are no droughts; but Dr. Davy gives us very little hope of escaping from such calamitous visitations.

Mr. Hodgkinson likewise expresses a very unfavourable opinion with respect to the quality of the water, when stored in the reservoir, and thinks that the Plenty is more likely to suffer deterioration from a resident population than the Yarra.

It is interesting and highly important in this inquiry to know that Mr. Hodgkinson's estimate of the watershed and my own are still further corroborated by the investigations of Dr. Davy.

He is not sufficiently acquainted with the geological character of the Plenty basin to give any exact estimate of the watershed, but, from observations and calculations which he has made respecting the force of evaporation from the surface of the ground, in this colony, he regards one-eighth of the rain, over any large area of surface, as the most that can reach the rivers, under any conditions of slope or geological formation, and he thinks that in many districts the

proportion of rain that reaches the rivers is much less than one-eighth.

Thus, Mr. Hodgkinson, Dr. Davy, and myself, seem to have all arrived, by different and independent modes of investigation, at very nearly the same result. For all practical purposes, our different estimates will produce the same result.

I attach very little importance to the determination, on theoretical principles, of the watershed of the Plenty.

The only certain way, as stated above, of finding the amount, is to measure the streams at least once a month, in order to get the mean discharge for the year. But, if the aqueduct could be finished within the next two months, we should then have the very best means of practically testing how much water can be obtained from the winter rains.

I have availed myself of all the measurements already made, and without deducting the immense loss from evaporation in the swamps, have allowed an increase of two-thirds for the greater watershed of the winter months.

The members of the Committee have disregarded all these measurements, because they were taken in the summer months, and have calculated the amount of watershed, in accordance with the evaporation tables of Mr. Dempsey, which profess to show the evaporation due to the mean temperature of the different months in England, and I should have thought that it required no great amount of scientific knowledge to see that if these tables give a correct result for the mean temperature of England, they are totally inapplicable to the mean temperature of this colony, and would give a very incorrect result.

The Committee, in their report, admit that the evaporation from the surface of water is nine feet, which is nearly double the evaporation in England. It seems, therefore, a singular oversight on their part, not to see that the force of evaporation from the surface of the ground here must bear at least the same increased proportion, and, in point of fact, the evaporation is far greater than double.

That portion of the drainage area of the Plenty which is of the clay slate formation, and which may be estimated at fifteen square miles, or one-fourth of the whole, is so much more destitute of vegetation than the cultivated soil in England, that the surface of the ground becomes intensely heated under the influence of the solar rays and evaporation is exceedingly rapid.

Thus, the reasoning upon which the Committee rely, to

account for their enormous watershed, is the same which has led all other scientific men to the very opposite conclusion.

If, according to their view, cultivation of the soil diminishes the rivers, England of all other countries ought to have the fewest and the smallest in proportion to the rainfall, and the extent of surface, whereas, it is exactly the reverse, and, in these respects Australia is the very antithesis of England.

A barren, uncultivated and impenetrable soil, absorbs no moisture from the atmosphere, and is very unfavourable for the deposition of dew.

Luxuriant vegetation absorbs large quantities of moisture during the day, and is most favourable for the deposition of dew in the night, and the surface, being protected from the direct rays of the sun, is always cool and moist, and the rain readily percolates through the soil to supply springs and rivers.

Mere surface water adds little to rivers, except in floods: it is that which percolates through the soil, and traverses either the superficial, or deep strata, that forms the principal and permanent supply of rivers.

A compact and impenetrable soil, such as the Committee believe to be most favourable for river supply, is in reality the worst adapted for that purpose, and it is only in the immediate vicinity of rivers that mere surface water can reach them.

The capillary attraction of the soil is too great to allow the rain water to travel over any extent of surface. The varying inclination of the surface also, and numerous other obstacles, oppose its motion.

Their illustration of the great watershed of the Dandenong ranges is worthy of notice. Because the surface soil is ankle deep with water in wet weather, they conclude that the watershed must be very abundant, whereas, the opposite conclusion is the more legitimate deduction. The rain, which is so firmly held in the surface soil as to convert it into swampy or boggy ground, cannot reach the rivers at all. It remains there only to be evaporated and lost. It is the geological formation of the ranges, and the close structure of the granite rocks, which prevents the rain from draining through the soil, and gives rise to swampy and marshy ground, even on the sides and summits of the mountain, and the same condition occurs in the slate formation, as for example in the swamps above Yan Yean, where the water cannot readily percolate through the fissures, or where there is a subsoil of heavy stiff clay.

Mr. Dempsey, himself, entertains the same views on this subject as I have now expressed, and thus the favourite authority of the Committee would be the first to detect their illogical reasoning, and he would be especially astonished, that on such reasoning they relied for justification of their unwarrantable adoption of his evaporation tables, to determine the very important question of the watershed of the Plenty basin, with a totally different temperature from that of England.

I have said that about one-fourth of the drainage area of the Plenty is clay slate, and I may add the whole of that of the reservoir, and it is the opinion of Mr. Blandowski, who has made a careful geological survey of the whole colony, that the clay slate formation is entirely destitute of rivers.

The rain water quickly disappears through the surface soil, which is composed of the detritus of the slate, and is lost chiefly by evaporation from the surface, which becomes intensely heated by the solar rays, and partly by absorption through the seams and fissures of the strata, to re-appear as springs, at some lower level, either in the ocean or in the beds of rivers; or, as frequently happens, in the waterholes of the dry creeks and watercourses which have no other permanent supply in the summer months; and this circumstance has led some to entertain very false notions with regard to the evaporation from the surface of water in this colony. Finding that their waterholes, on which they depend for their domestic consumption, suffer little diminution in the heat of summer, they conclude that the evaporation is very trifling.

Artificial waterholes, sunk in any locality, where the close structure of the underlying rocks prevents the escape of the surface water, will lead to the same erroneous conclusions.

With scarcely any exception, the slate strata are vertical, running north and south. Hence, they present the most favourable condition for absorption; and it is very common to find rivers originating in the granite formation, gradually losing themselves in the districts of the slate formation.

I have said that the Committee have calculated the amount of watershed, in accordance with Mr. Dempsey's tables. I do not say that their calculations are based on these tables; but, to use their own expression, they check their calculations with them. By a method which has never before been applied to determine the watershed of any other country, they find that 57·6 per cent. of the rain in the Plenty basin is evaporated, and 42·4 per cent. goes to the river, and then, in order

to check this result, they consult Mr. Dempsey's tables, and find that exactly 57·6 per cent. of the rain in England is evaporated, and 42·4 per cent. goes to the rivers; and, forgetting that this colony is not England, and that our temperature is much higher, and that the evaporation from the surface of our uncultivated lands is vastly greater, they regard this coincidence as a proof of the correctness of their theory, and forthwith apply Mr. Dempsey's English evaporation to determine the discharge of the Plenty river in the winter months.

This extraordinary coincidence between their calculations and Mr. Dempsey's tables, even to a decimal fraction, might at first sight, be supposed to prove the mathematical accuracy of both, but a mere coincidence is not to be regarded as a proof of the correctness of either, it is necessary that one or other should first be established on a firm scientific basis before such a coincidence could prove anything at all. I shall not attempt to explain this singular coincidence, though, doubtless, it would form an interesting subject in an essay on probabilities.

I have already shown that Mr. Dempsey's tables give three times the amount of watershed that Dr. Thomson calculated for Great Britain, and I am prepared to show that they give a very erroneous and incorrect result of the proportion of the rain that is evaporated here, for, when corrected for the difference of temperature, they give only one-fourth of the watershed calculated by the Committee, and therefore the data upon which they rely to check their own calculations will prove that they are altogether unworthy of confidence, and must be divided by four to give a truthful result.

It appears, from the report, that the Committee chiefly rely on the eastern arm of the Plenty, for the supply of the reservoir.

Taking their own measurements in January, as the summer discharge, although, in consequence of rain, it considerably exceeded Mr. Blackburn's measurement in December, with a velocity of one and one-third mile per hour, it only gives 4,450 gallons per minute, which for the six summer months is equal to three feet in the reservoir; their whole discharge for the Plenty they calculate at twenty-four feet eight inches in the reservoir, therefore the winter discharge for six months will be eight times the amount of the summer discharge; but the section of the river will only contain three times the volume, supposing the stream to be level with the banks, with the same velocity, and they do not calculate for an increased

velocity, as, according to the usual formulæ it would be very small or difficult to compute.

It is thus very important to notice that they assume the six winter months discharge at eight times the amount of the six summer months, while the river, when level with its banks, can only contain three times the amount.

They also assume that the river is really level with its banks, although they have never seen it in the winter months; but they are quite satisfied on this point from the evidence of a resident farmer.

This, it will be observed, is not very scientific or reliable evidence to check their calculations, or to justify the expenditure of £650,000 of public money, and accordingly the farmer's son, an intelligent lad of nineteen, in his father's absence, told Mr. Wekey and Mr. George Wilkie, that the river was only half full during the winter months, except in floods, which, with the same velocity, exactly accords with my own estimate of the winter discharge.

The principle upon which Mr. Dempsey's tables are based is precisely the same as that adopted by Dr. Dalton and Dr. Thomson, for ascertaining the watershed. He calculated that 57·6 per cent. of the rain is evaporated, and 42·4 remains to supply springs and rivers.

Whether Mr. Dempsey's tables are the result of his own experiments, or those of others, he does not say, but he clearly states that the evaporation mainly depends upon the temperature, heat promoting it, cold retarding it, and therefore I cannot conceive that he would commit such an egregious blunder as to apply his tables, without correction for the great difference of temperature, to determine the proportion of the rain evaporated in this colony.

In calculating the evaporation from the surface of water here from English tables, I assumed for each month the evaporation of a corresponding month in England, with the same or a less mean temperature, and I thus obtained eight feet two inches, which is sufficiently near to Dr. Davy's estimate of nine feet to show the correctness of the method.

I therefore hold it to be scientifically correct to adopt the same method with Mr. Dempsey's tables in order to determine the proportion of rain that is evaporated from the ground.

I have drawn up three tables for the purpose of illustrating the contrast between the proportion of rain evaporated here and in England, allowing the same proportion to the

same mean temperature in both countries, and the result is 2·51 inches, or one-twelfth as the proportion of the rain that reaches the rivers in this colony.

TABLE I.—Showing the Mean Rain, and the Mean Temperature, and the Proportion of Rain evaporated in the different months in England, according to Mr. Dempsey :—

	MEAN RAIN.	MEAN TEMP.	EVAPORATION.	
	Inches.	Degrees.	Per cent.	Inches.
January . .	1·847	36·1	29·3	0·540
February .	1·971	38 0	21·6	0·424
March . .	1·617	43·9	33·4	0·540
April . . .	1·456	49·9	79·0	1·150
May . . .	1·856	54·0	94·2	1·748
June . . .	2·213	58·7	98·3	2·174
July . . .	2·287	61·0	98·2	2·245
August . .	2·427	61·6	98·6	2·391
September .	2·639	57·8	80·1	2·270
October . .	2·823	48·9	50·5	1·423
November .	3·837	42·9	15·1	0·579
December .	1·641	39·3	04·3	0·164
Total rain	26·616		Total evaporated	17·648

TABLE II.—Showing the Mean Rain and the Mean Temperature of the different months in Victoria, and the Proportion of the Rain evaporated, allowing the same per centage to the same Mean Temperature in both countries :—

	MEAN RAIN.	MEAN TEMP.	EVAPORATION.	
	Inches.	Degrees.	Per cent.	Inches.
January .	1·36	67·94	98·6	1·34
February .	0·95	67·31	98·6	0·93
March . .	1·60	63·92	98·6	1·57
April . .	3·13	60·56	98·3	3·07
May . .	3·67	54·91	94·2	3·45
June . .	2·41	51·00	79·0	1·90
July . .	2·18	49·34	79·0	1·71
August . .	3·61	50·66	79·0	2·85
September .	3·27	55·08	94·2	3·08
October .	2·59	58·97	98·3	2·36
November .	4·27	62·25	98·6	4·21
December .	1·86	66·29	98·6	1·83
Total	30·81		Total evaporated	28·30

TABLE III.—Showing the Mean Rain and the amount of Rain evaporated, and the Watershed, or that portion of the Rain that escapes evaporation in Victoria, deduced from Mr. Dempsey's Tables:—

	MEAN RAIN.	EVAPORATION.	WATERSHED.
January .	1·36	1·34	0·02
February .	0·95	0·93	0·02
March . .	1·60	1·57	0·03
April . .	3·13	3·07	0·06
May . .	3·67	3·45	0·22
June . .	2·41	1·90	0·51
July . .	2·18	1·71	0·47
August . .	3·61	2·85	0·76
September .	3·27	3·08	0·19
October .	2·54	2·36	0·18
November .	4·27	4·21	0·06
December .	1·86	1·83	0·03
Total	30·85	28·30	2·51

In illustration of this method I shall take our month of January, which has a mean temperature of 67° 94. On referring to Mr. Dempsey's tables I find that August in England has a mean temperature of 61° 6. Now, what can be more just or more in accordance with scientific accuracy, than to conclude that the proportion of the rain evaporated in our January is at least as great as that in the August of England?

In the same way I shall take our July, which has a mean temperature of 49° 34, and I find that April in England has a mean temperature of 49° 9. Am I not then warranted on scientific grounds to assume that the proportion of the rain evaporated here in July is equal to that of April in England? Now it is precisely in this way that I have deduced from Mr. Dempsey's tables that 2·51 inches, or one-twelfth of the rainfall adopted by the Committee, represents the proportion that reaches the Plenty.

I do not insist that Mr. Dempsey's tables are correct; but if they are so, then it would appear that the watershed of the Plenty is much less than I made it. His tables give 2·51 inches; I estimated 4·50 inches as the nearest approximation, and there is a vast difference between 2·51 inches and 10·69 inches when multiplied by sixty square miles of surface; and this is the watershed adopted by your Committee for eight months of the year. And as every point is

of importance in this inquiry, it may be asked why the Committee allow no watershed for the four summer months; their own reason is, that they think there is none; this admission, therefore, is not to be regarded as a set-off for their assuming 10·69 inches as the watershed of the eight months.

According to Mr. Dempsey's tables, the proportion of the rain that reaches the rivers in the four summer months in England is equal only to one-fifth of an inch. Now, without any correction for the higher mean temperature here, one-fifth of an inch for our four summer months is too trifling to be noticed.

This extraordinary error of the Committee in their misapplication of Mr. Dempsey's tables, leads, as might be expected, to very extraordinary results, and it is necessary to follow out their reasoning to its legitimate conclusion.

Above Yan Yean, in January, the river gave three feet four inches in the reservoir in twelve months, and one foot one and a third inches in four months, or two feet two and two-third inches in eight months. The whole rainfall for twelve months, at thirty-one inches, is 68·2 feet in the reservoir. Deduct the rain for the four summer months, which is equal to 5·77 inches, or twelve feet six inches in the reservoir, and we have fifty-five feet eight inches as the rainfall of eight winter months. Take 42·4 per cent. of this which gives twenty-three and a half feet in the reservoir as the watershed of the Plenty in eight winter months, according to the calculations of the Committee. Add to this one foot two inches, or one-third of three feet four inches, to represent the discharge of the river for four summer months, and we have twenty-four feet eight inches as the total amount that comes down the river.

Of this enormous amount of water, they generously propose to bestow one-half on the district, which will be sufficient, as we shall presently see, to flood the river during the whole year, and may therefore prove a source of great inconvenience to the inhabitants. And it is their intention to appropriate the other half for the reservoir.

Their calculations may be represented as follows:—

		Ft.	In.
From the river during eight months	-	23	6
Do. four summer months	-	1	2
Total - - -		24	8

	Ft.	In.
Total - - - -	24	8
Deduct one-half for district - - -	12	4
Balance for reservoir - - -	12	4
Rain in reservoir - - - -	2	7
42·4 per cent. of rain over drainage area of ditto - -	2	4
Total in reservoir - - - -	17	3
Deduct evaporation - - - -	9	0
Total for the use of the city - -	8	3

This amount will exactly supply, at thirty gallons per head, 333,000; at 100 gallons per head, 100,000.

Now, let us contrast twenty-three feet six inches, with two feet two and two-third inches, the discharge for eight months according to the measurement of the Committee. Thus they make the Plenty for the eight winter months contain ten times the volume of water that it does in January, or, according to Mr. Blackburn's measurement, in December.

It will perhaps be said that this actually takes place in the Merri Creek; but such reasoning, if it proves anything, proves too much. This creek is not a river, and only runs after wet weather, and does not always run in winter; or the stream is so small that it can scarcely be said to run in very dry winters. After a heavy fall of rain, the creek is flooded for two or three days, but if the flood water were divided over 365 days, it would be a miserably small amount.

If any argument could be extracted from this, it would prove that, because the Merri Creek is at one season many million times larger than it is at another, therefore the Plenty may be so also, which is absurd; besides, this sort of reasoning has its inconveniences as well as its advantages. If we take the highest flood in the Plenty, and reduce it by a few million times, it would cease running altogether like the Merri Creek, and the City would stand a poor chance of a permanent supply of water from this source.

Perhaps it may be thought that the Yarra is an analagous case, and if it can be shown that it contains ten times the volume of water during the eight winter months that it does in December, so may the Plenty. The Yarra differs in many essential points from the Plenty, and chiefly in this important particular, that it takes its rise in very high mountains

compared with Mount Disappointment, and these are covered with snow during the winter months. But it has yet to be proved that the Yarra undergoes so remarkable an increase in volume for a period of eight months in the year. This river has an average depth of thirty feet, for a distance of two miles above Prince's Bridge, and I need scarcely say that it only overflows its banks in floods, which may not occur once in two years. Its level, in the beginning of December, is not more than two or three feet below the average of the winter months, or below the level of many portions of the banks; with any reasonable increase in the velocity, therefore, how is it possible for the Yarra, with an increase of only one-tenth in its depth or sectional measurement, to carry ten times the volume of water for eight months?

We have only then to compare, in the drawings furnished by the Committee, the sectional area of the Plenty, at one or more points, in order to see how impossible it is to believe that the river, during eight months of the year, could contain ten times the volume of water that it does in December. The drawings show that the stream occupies in January one-half of the sectional measurement, that is, one-half of the depth where the banks are perpendicular.

Now, as above stated, it may be regarded as an axiom, that when a river has defined banks these indicate its ordinary limits, which it only exceeds in time of floods. Thus, without actual measurements for the winter months, important information as to the volume of water may be gathered from those that are resident on the spot. Dr. M'Kenna and myself put the question to Mr. Bear, who has long resided on his own property at Yan Yean, if a measurement of the Plenty, on the 12th of December, would give a fair average for the year. He replied, that he thought it would. Now, the meteorological tables show that November is our wettest month, and Mr. Blackburn's measurement of 2,700 gallons per minute was taken in December; therefore, it is not unreasonable to suppose, that Mr. Bear's opinion may be very nearly correct.

But let us examine the section of the river, at the entrance of the aqueduct, not very far distant from Mr. Bear's house. With a discharge in January of 2,537 gallons per minute, and a velocity of half a mile per hour, the section could not contain more than twice the present volume, with the same velocity, without spreading widely over its right bank, which is nearly level. With double the volume the velocity

would be very little increased. Thus the section could not carry three times its present volume without flooding its right bank.

Such a state of things could scarcely escape the notice of an intelligent resident gentleman, if it were to go on for eight months in every year, and yet the Committee of the Society tell us that there is not only three times but ten times the above measurement during eight months in the year. Nor is there the slightest water-worn appearance on the banks to indicate that they form the ordinary channel of the river for any portion of the year.

I cannot at present furnish, on reliable authority, the average increase of rivers in floods; besides, this increase must bear a constant relation to the rainfall, and therefore to the latitude.

The Committee entertain the opinion that, during the eight winter months, the rain falls very heavily here, and that, in consequence, the watershed is very great. I am not aware of this fact, but, on the contrary, during the four summer months, when they say there is no watershed, we have sometimes, in consequence of the tropical heat, very sudden and tropical rains.

The increase of our Australian rivers during floods probably ranges from 50 to 100 times the volume of the ordinary streams, and this accords with the opinion of Mr. Blandowski, who possesses a great practical knowledge of the physical peculiarities of the colony. The highest flood lines of the Plenty, with the velocity assumed by the Committee of two-and-a-half miles per hour, give seventy-five times the volume of water that passes Yan Yean in December.

How very difficult is the result of their singular and elaborate calculations. Having found according to these, aided by the evaporation tables of Mr. Dempsey, that the ordinary stream of the Plenty for eight months out of the twelve, is ten times larger than it is in December, the highest flood lines which they themselves could discover will only permit of a remarkably small increase during floods, the greatest being seven-and-a-half times the volume of the ordinary stream.

Such a result is so startling and incredible, that it is sufficient, in my opinion, to warrant the rejection, by the Philosophical Society, both of their calculations and Mr. Dempsey's tables.

Nor is this result more incredible than that the ordinary

stream of the Plenty is not confined within its ordinary banks, but for eight months of the year is widely extended over their level surface; a condition of things which was never witnessed by any of the settlers or residents on the river with whom I have conversed.

How much better would it have been for the Committee of a Philosophical Society to have disregarded theory altogether, and to have rigidly adhered to their own measurements, as well as those of Mr. Blackburn and Mr. Hodgkinson, and to have made these the basis of their calculations.

Theory, based upon experiments conducted in this colony, would possess a scientific interest and value, but otherwise it is practically valueless.

Speculative philosophers, who embark in abstruse scientific investigations with incorrect or inapplicable data for their guide, will soon find themselves lost in a pathless ocean, without a compass and without a chart.

Dr. Prout, one of the ablest writers on Meteorology, thus expresses himself with reference to the different estimates that have been made of the watershed of England:—

> These statements of the water that is condensed and evaporated in Great Britain, can only be viewed as rude approximations; and even admitting them to be correct, they could scarcely be applied with any advantage to an inquiry into the actual condensation and evaporation in other countries or climates, which in all instances must be determined by observation and experiment.

Before taking leave of Mr. Dempsey, I wish to state my entire concurrence in the liberal views he expresses with reference to the amount of water required for a city of 100,000 inhabitants.

Although, he says, twenty gallons per head might be sufficient for domestic and manufacturing purposes, and for the extinction of fires, yet he advocates a constant service of thirty gallons per head, and is of opinion that extravagance in water should always be permitted; and for the purpose of cleansing and watering the streets and thoroughfares, for the supply of fountains, public gardens, and pleasure grounds, and other miscellaneous and occasional purposes, he considers that one-tenth of an inch per day, should be allowed for the whole area. Part of this is supplied from rain, so that for a city covering one thousand acres, he allows fifteen gallons per head additional, making in all forty-five gallons, and if he were consulted about the proper supply for Melbourne, he

would allow thirty gallons instead of fifteen, as it covers more than two thousand acres; and as the evaporation from the surface is more than double that of England, I am satisfied that he would on this account allow another thirty gallons, or ninety gallons in all, and this is precisely what is frequently used in New York on the constant service principle.

The Committee, it appears, hold Mr. Dempsey in high estimation as an authority. I am surprised, therefore, that they do not follow him in his liberal views on the water supply of cities. They only allow thirty gallons, but if his views are correct, this amount will leave no water for the numerous important purposes which he enumerates; so that we shall have carefully to guard against any unnecessary waste in order that a little may be saved to allay the dust in our streets and thoroughfares.

When the object is to obtain a very large watershed from the Plenty basin, they adopt Mr. Dempsey's evaporation tables, which give nearly the highest theoretical estimate of the watershed for the mean temperature of England, or about three times the amount of Dr. Thomson's estimate, who was at least equally well qualified with Mr. Dempsey to prosecute any scientific investigation; but when the object is to make the most of the limited supply at Yan Yean, they forget Mr. Dempsey and his water-tables, and, knowing that New York frequently consumes ninety gallons per head, they tell us that Melbourne, which is nearly in the same latitude, and has much more need of a plentiful supply, ought only to have thirty gallons.

It is singularly illustrative of the peculiarities of this reservoir scheme to glance at the results arrived at by the Committee.

At thirty gallons per head per day, one foot eleven inches in the reservoir will suffice for the city for twelve months. Taking their own estimate of the evaporation at nine feet, it will thus be necessary, in order to store and preserve one foot eleven inches for the city, to put into the reservoir each year ten feet eleven inches, or about six times the amount required.

Thus, for every gallon of water that will be consumed by the citizens for domestic purposes, and for watering the streets, five will be consumed by evaporation at Yan Yean.

The contents of the river Plenty represent that small fraction of the rain that nature has rescued for the use of man from the powerful influence of evaporation, under an

Australian sun. It does seem extraordinary, therefore, with so little to lose, that we should be solicitous, at an immense sacrifice of money, to provide an evaporating basin in the vicinity of the river, sufficiently large to swallow up nine-tenths of the small supply which nature has thus provided for our use.

I confess to have some impatience for the publication of the full report of the Committee, in order to learn what they recommend to be done with this evaporating basin. A few more such basins, of a size proportioned to our larger rivers, would effectually secure the loss of all our river water, and convert this beautiful province of Australia Felix into an Australian desert.

It may be said that, in commenting upon the opinions of the two civil engineers who form the Committee, it is very unlikely that I should be right, as such questions belong to engineering, and are therefore strictly professional. An attentive consideration of this paper, however, will show that there are no questions involved which any person of ordinary education may not clearly understand and appreciate; and therefore, simply as a member of the Philosophical Society, it is perfectly competent for me to call in question any novel methods of investigation adopted by the Committee, and to say whether, in my opinion, these are legitimate and scientific, or the reverse.

But the great and important points upon which the success or failure of the Yan Yean scheme depends do not belong more to the province of the civil engineer than to the medical profession.

I have heard of civil engineers bridging the Menai Straits with a stupendous tube of iron, and tunnelling the river Thames, and building a leviathan steam ship of 25,000 tons, to perform the voyage to Australia in thirty days; and if the Goulburn River and the King Parrot Creek are to be brought through granite mountains into the Yan Yean reservoir there are still higher and greater laurels in store for our colonial engineers. But I am not aware of any civil engineer who has published original researches on the subject of Heat and Evaporation. Hitherto this department of science has been chiefly cultivated by members of the medical profession.

I never heard of any civil engineer who had published original investigations on Meteorology. This subject also owes more to the medical profession than to the civil engineer.

I know of no civil engineer who has added anything to our knowledge of the watershed of different countries. Original experiments and observations on this subject have been principally contributed by medical men. Perhaps Mr. Dempsey may be cited as an exception; but I think the less that is said about his evaporation tables the better.

I need scarcely add that it is not to civil engineers, but to members of the medical profession that we owe all our knowledge of the impurities of water, and their injurious effects on health, as well as the best and most effectual means of removing and counteracting them. And we are especially indebted to Dr. Hassall, of London, for his laborious microscopic examination of the impurities of all kinds that abound in the water that is supplied to the city.

Dr. Clarke, Professor of Chemistry in the Marischal College, Aberdeen, is acknowledged to be the highest authority in England, in all questions connected with the water supply of cities; and Dr. Smith, Professor of Chemistry in the University of Sydney, who for some years conducted all Dr. Clarke's practical investigations, is the highest authority on such questions in the Australian Colonies.

I think it will be admitted, therefore, that the scientific subjects considered in this paper come strictly within my own province, as a member of the medical profession, and that there is no reason why I should be disqualified to discuss them in a scientific manner; and I think I have sufficiently demonstrated, by legitimate reasoning, that the calculations of the Committee are not based on any correct or scientific data at all, but purely on speculations and assumptions of their own, and that the results to which they lead, when thoroughly investigated, are so incredible, as to carry with them their own condemnation.

In my estimate of the water available for the reservoir, I consider that ample justice has been done to all the sources of supply.

I have shown that, at the time of our late visit to Yan Yean, the whole discharge above the swamps was 5,790 gallons per minute, and, that of this amount, 3,253 gallons per minute were lost by evaporation in the swamps, or at the rate of four feet four inches in the reservoir; and I have taken for granted that effectual means will be adopted to prevent this loss, which, I have before stated, amounts to two feet five inches in the reservoir in twelve months. The total amount of supply for the reservoir I have estimated at eleven feet six

and a half inches: so that, deducting two feet five inches, there will only remain nine feet one and a half inch, or just sufficient to cover the evaporation from the surface.

In the meantime, therefore, until such means are adopted, it may safely be asserted, that there will be no water for the city at all: and it is rather a singular circumstance, that if we are to get any supply for the city, it must be by saving the two feet five inches that are at present lost by evaporation, and very probably also by absorption in the swamps, and if this can be done, there will be a supply for 71,500, at forty gallons per head per day.

To bring both arms of the Plenty to Yan Yean, clear of all loss from the swamps, would be a very difficult undertaking. The swamps are only to be likened to large sponges, and simply to cut a watercourse through them, and lower their level, would have very little effect in withdrawing the stream from their influence.

The evaporation would continue nearly the same, and would be fed from the current. The eastern swamps are about three miles in length, the western five miles; and I am strongly of opinion, that the loss from evaporation and absorption, could be saved in no other way than by conveying both branches in iron pipes.

Mr. Christy has kindly favored me with an estimate of the cost of laying suitable pipes for this purpose, which would amount to £14,000 per mile, or to £42,000 for the eastern branch, and £74,000 for the western. So that, after all, it may become a grave question, whether it be really worth while to go to any expense at all to save either branch from the evaporation of the swamps.

I have also taken for granted that we shall have sixty hours of floods each year at Yan Yean, while it is not unusual to have no floods at all; and I have allowed an increase in the Plenty of two-thirds, during the three winter months, for rain; although we sometimes, as last year, have very little rain in winter, and I have allowed a rainfall of thirty-six inches for the reservoir, although it is very doubtful whether there really is that average at Yan Yean. And, I may well ask, what became of the thirty-six inches of rainfall in 1851? I have no doubt that there is a larger and more constant rainfall at the Dandenong Ranges; but they are much nearer the Bay than Mount Disappointment, and therefore attract and intercept the rain-clouds, and it is well known that there is a greater rainfall near the coast than further in-

land. This is well exemplified in Melbourne, where we have many showers of rain which do not extend ten miles out of town.

I have allowed four inches for dew over the whole basin of the Plenty, an amount of water which would give eight feet eight inches in the reservoir; although it is very probable, in this dry climate; that there may not be two inches; and I have allowed two inches for the reservoir, without any scientific data to show that dew would be deposited at all; and, from an estimate which I have made of the whole watershed of the Plenty, based on scientific data, it appears that I have given the reservoir the advantage of nearly the whole amount.

And, what is of greater importance than all else, I have deducted nothing from the supply of ordinary seasons on account of droughts, of which we have had ample and painful experience in other parts of Australia; and a gentleman, who has recently returned from Adelaide, has told me that they have scarcely had any rain there for the last eighteen months.

I must not omit to mention here, that it is intended to have two intermediate reservoirs betwixt Melbourne and Yan Yean,—the one at Pentridge, the other near the Plough Inn. Your Committee requested information respecting their extent of surface, with a view to determine the amount of loss from evaporation, but they were refused all information on the subject. I have, therefore, been unable in my estimate to make the necessary deduction for their evaporation.

I shall only further add, in support of my statement that ample justice has been done to all the sources of supply, that while I place implicit confidence in Mr. Hodgkinson's opinion respecting the retentive nature of the bottom of the reservoir, there are not wanting others, who have had great experience in this colony, who think that the chances are very great indeed that in some parts of the vast extent of the reservoir, the water will find its way through the fissures of the clay slate to a lower level. I need not say there is no remedy in such a case. £2,000,000 would not suffice to puddle a surface of 7,000,000 square yards.

When this scheme was first proposed, I felt astonished to think that the Plenty could supply so much water as was alleged. I imagined, however, that the deficiency might probably be made up by the winter rains over an extensive district. And although I considered this a very objectionable source, I entertained the hope, that with a depth of 25 feet, and a current established through the reservoir by means of the river, and with a perfect system of filtration, the water

might be rendered comparatively pure, and that its inferiority might, to a certain extent, be compensated for by its superabundance.

It was only lately, in consequence of my visit to Yan Yean in company with Dr. Mackenna, that I was enabled to obtain the information necessary to arrive at more correct conclusions, and our astonishment and surprise can be better imagined than described, when we compared the diminutive stream of the Plenty with the wide extent of the reservoir intended for its reception; and, indeed, while contemplating from one of the heights the grandeur and singular beauty of this vast plain, the conviction forced itself upon our minds that the whole volume of the river would not suffice during the heat of summer, to wet the surface; and this my subsequent investigations have proved to be literally true.

The evaporation from the surface of the reservoir is equal to one foot per month for the three summer months. Now, the river, at the entrance of the aqueduct, gave 2,537 gallons per minute in January, or three feet four inches in twelve months; and this is above the average for the summer months, as Mr. Blackburn, in the dry summer of 1851, found it reduced in February to 865 gallons per minute, or to nearly one-third. Let us, however, take three feet to represent the discharge; this would give three inches for each of the summer months. Thus, with twelve inches of evaporation, it would take four rivers equal in size to the Plenty, to keep the reservoir wet. And if we take Mr. Blackburn's lowest measurement of 865 gallons per minute, it would require exactly eleven such rivers to give even an appearance of moisture to the surface of the reservoir.

According to the data which I have submitted to you, there is no difficulty in predicting the complete failure of the Yan Yean Waterworks for want of water; and it is important to notice here, that the amount of water in the reservoir, after deducting the evaporation, is far short of the amount that seems confidently to have been calculated upon. Two feet six and half inches, as measured for the whole surface, would give six feet of depth at the lower end, and this is the very lowest point at which it would be practicable to draw off the water. Below this point I consider that it would be altogether unfit for use, and it has never been contemplated to draw it off at so low a level for the use of the City, as the main pipes are intended to be supplied through two openings in the Tower Well, at ten and seventeen feet from the bottom.

It also appears that the immense extent of the reservoir, which has always been regarded as its greatest advantage, is in reality so serious an evil as to involve the failure of the whole scheme.

It is quite clear that the difference between the amount of rain and evaporation will represent the amount of loss depending upon the wide extent of the surface exposed. This difference is six feet, and is equal to nearly twice the whole discharge of the river, as measured by your Committee, above Yan Yean, and is nearly equal to Mr. Blackburn's estimate of all the tributaries above the swamps. The whole amount thus lost by evaporation in the reservoir, or nine feet, being sufficient to supply a population of 245,500, at the rate of forty gallons per head per day, or 491,000 at twenty gallons, which is equal to a loss of 9,820,000 gallons of water per day.

With an unlimited supply of water this immense loss would have signified little, but when the sources of supply are so remarkably inadequate, the case presents a very different aspect.

The foregoing considerations afford no prospect whatever of success to the Yan Yean scheme with the existing sources of supply, but it has always been regarded as capable of indefinite extension from other sources. It becomes necessary, therefore, to consider this part of the subject, in order to ascertain how far it may be possible, or practicable, to supplement the reservoir, and thus render it equal to supply, not only the present wants of the City, but a large prospective increase of population.

For this purpose it has been proposed to bring the Merri Creek, the Diamond Creek, the King Parrot Creek, and even the Goulburn River itself, into the reservoir.

With regard to the Goulburn River, if it were practicable to bring it into the reservoir, by means of an aqueduct, and if the expense of such an undertaking would not be beyond the means of the colony, there cannot be a doubt that this would render the Yan Yean scheme eminently successful, and Melbourne might then boast of being better supplied on the gravitation principle than any other city in the world.

I feel incompetent to give an opinion in a case involving so many difficult questions, and that could only be determined by experienced engineers, after complete surveys of the intermediate country; but it appears to me, independently of the expense, which would be enormous, to be altogether chimerical. The great dividing granite ranges, which must

have a very considerable elevation above the bed of the Goulburn, without mentioning other difficulties, would render such an amount of cutting and tunnelling necessary, that I fear the idea must be altogether abandoned.

Similar difficulties would attend the proposal to bring the King Parrot Creek, which is a tributary of the Goulburn, into the reservoir. The same dividing ranges would have to be tunnelled, and much broken country bridged by aqueducts; but a scientific survey by competent engineers could alone determine the question of its practicability and cost. And after all, would it be worth while to expend a very large sum in conveying so small a stream from so great a distance? Such a scheme, I apprehend, must be entirely laid aside until it is shown that there is no other cheaper plan of supplying the City with water.

The Diamond Creek claims our next consideration. It is a tributary of the Yarra, and, in its upper course, is not more than six miles distant from Yan Yean. It is more easy, therefore, to form an estimate of the probable cost of bringing this creek into the reservoir. An engineer, of great practical knowledge, assured me that he would not undertake the work for 50,000*l*. Besides, unfortunately it is a very diminutive stream, even compared with the Plenty; and, according to my judgment, is barely sufficient to supply the wants of the village of Eltham and the increasing population of this important district.

This proposal, therefore, merits no further notice.

It only remains to consider the Merri Creek as a source of supply, It rises in a swamp of 1,280 acres, which is said to have 30 square miles of drainage area, but there is not a single creek or watercourse of any description, leading into it, which shows the very small proportion of the rain that drains into it from an area of surface equal to one-half of the Plenty basin. It is proposed to dam up this marsh, and to lead the water by an aqueduct into the reservoir. Let us suppose, therefore, that this marsh really does receive the watershed of thirty square miles, the area of the swamp being two square miles, a rainfall of thirty inches would give a depth of thirty-seven feet six inches, and one-ninth, or four feet two inches would represent the watershed. This, added to the rainfall of the swamp, would give altogether six feet eight inches, which is not sufficient to cover the evaporation; and it would, therefore, be dry for two months in the year.

It is useless, therefore, to look to this marsh as a source of

supply; and, even were it otherwise, I could never sanction the principle of robbing a thickly-settled district of the fountain-head on which they chiefly depend for their supply of water, which at best is very small in ordinary seasons.

So much importance has always been attached to the supposed facilities that existed for indefinitely extending the reservoir, when occasion should require, that I have thought it necessary to consider the subject under its different heads; and I think I have said enough to show that the Yan Yean scheme has nothing to hope for from the principle of indefinite extension; that, indeed, it cannot be extended at all.

I forget, however, that there is one direction in which it can be extended, and I owe it to Mr. Hodgkinson for pointing it out. He has given his attention to all the different methods proposed for extending the reservoir scheme, and he has come to the conclusion that by far the cheapest plan of doing so is by pumping from the Yarra; and I readily admit that there is no limit to the amount that may be obtained in this direction.

I have thus shown that the sources of supply for the Yan Yean Reservoir are insufficient to make up for the immense loss sustained from evaporation. I have also shown that there is no hope whatever of extending the resources of the reservoir in any direction, unless by pumping from the Yarra. I have also shown that if the two feet five inches that are now lost in the swamps could be saved, this would only supply 71,500, whereas we require a supply at present for at least 100,000.

I have also shown that the medical profession here are strongly opposed to the principle of storing water in a large swamp in this climate; and they entertain the worst fears that the pure waters of the Plenty will be rendered perfectly unfit for use by being transferred into the reservoir. And I may add, that while it is found necessary in England to clean out such reservoirs once in five years, on account of the immense quantities of decaying organic matters that accumulate in them, and render the water offensive and unwholesome, it will be utterly impossible to clean out the Yan Yean Reservoir. At 5s. per square yard, it would cost 1,750,000*l.*; and how would the city be supplied during the twelve months that would be required for cleaning and refilling the reservoir? It remains to be considered what steps are now to be adopted. It is quite clear that the reservoir must be abandoned altogether.

From the data which I have presented to you, it will be observed that there is a sufficient supply in the eastern arm of the Plenty for the present population of the city. The discharge of this main branch in January, was 4,450 gallons per minute, and deducting 630 gallons, which I have done to compensate for the previous heavy rains, and to assimilate the amount to Mr. Blackburn's estimate for ordinary seasons, we have 3,820 gallons per minute, which is equal to five feet one inch in the reservoir, and would, therefore, suffice for a population of 138,600, supposing the whole to be conveyed in iron pipes without loss. Here, then, is one source of supply, and the water is pure and unexceptionable.

But there are certain considerations of great moment connected with this source.

In a dry summer, such as that of 1851, the supply would, according to the measurements of Mr. Blackburn, be reduced by one-fifth, therefore this source can only be depended on to afford a constant supply for a population of 110,000. And, according to Mr. Blackburn and Mr. Hodgkinson, a drought of eight months, or of one year's duration would diminish it still further, if not dry it up altogether, as the western arm has been more than once.

Another very weighty consideration is, that the present stream of the Plenty is entirely dependent on the eastern branch for its supply, the western being evaporated and lost in the marshes. If this supply therefore is cut off, the Plenty will cease to run altogether, unless the western arm be conveyed for a distance of five miles clear of the swamps, which I fear will be found a difficult and expensive operation. It could be done without any loss by laying a thirty-six inch pipe; but the cost, according to Mr. Christy's estimate, would be 70,000*l.*

By adopting efficient means to save the western arm from evaporation, and to restore it to the natural channel below the swamps, the stream might be maintained, notwithstanding the appropriation of the eastern arm for the use of the City.

The Government and Legislative Council have therefore seriously to consider if it be right or proper that this rapidly increasing City should be dependent on a source which is only equal to supply a population of 138,500 in ordinary seasons, and 110,000 in very dry summers, and in severe droughts perhaps nothing at all. And it is very important to bear in mind, that if we are to pay for bringing water by gravitation from a distance of twenty-five miles, we are not

necessarily restricted to the eastern arm of the Plenty, even supposing this source to be one on which we could at all times depend.

In the report of the Select Committee already referred to, I find that Mr. Blackburn, after a careful survey of the Yarra, ascertained that at a distance of twenty-five miles from Melbourne there is a sufficient head in the river to supply the City on the gravitation principle. Mr. Christy has kindly estimated for me the cost of laying a thirty-six inch pipe for a distance of twenty-five miles, and it amounts to the enormous sum of £369,900. If therefore we are to bring our water into the City from this great distance, I think it will not be denied that it is far better to leave the eastern arm of the Plenty altogether, and go at once to the Yarra, where we shall have as much water as a thirty-six inch pipe can deliver, which I have no doubt would suffice for a population of at least 500,000.

And it is also most important to bear in mind that a work of such magnitude would never have been thought of for a moment if it could have reached no further than the present wants of the City. The preference of the gravitation scheme was entirely based by the Commissioners on its supposed capability of supplying at least four times the present population of Melbourne, and on the facility with which it was believed that the works could at any time be indefinitely extended; and it was only very lately that Mr. Jackson, the engineer of the works, is reported to have made similar statements in a paper which he read before the Victorian Institute of Science. I shall take the liberty of quoting a paragraph from the newspaper report:—"The numerous advantages of the Yan Yean Reservoir Scheme were pointed out; several interesting particulars were stated in the paper. The Yan Yean scheme it appears can be extended indefinitely, without any addition to the reservoir, so as to supply Melbourne with water even if it attained the population of London. It was suggested that the cheapest plan of supplying Geelong might be from the same source which is intended to supply Melbourne."

It is foreign to my purpose to discuss, in this paper, the opinions which Mr. Jackson has published on the subjects of which I have treated; but, as it eminently concerns the public to know the kind of data upon which the Commissioners base their extraordinary expectations of success, I shall add a few illustrations of the scientific views entertained by their engineer.

Having disposed of Mr. Hodgkinson's pumping scheme, and all other plans for supplying Melbourne and Williamstown

from the Yarra, as impracticable and absurd, Mr. Jackson considers that the Merri Creek swamp, were it not for its distance, would be a very eligible site for a store reservoir for the City; and says, that it receives the drainage of about thirty square miles.

He says, also, "the necessity of constructing a store reservoir would not be manifest to a casual observer, but, as it would appear from the evidence of those settlers who have been established on the banks of the River Plenty for the longest period of time, that at a ford known as the Bridge Inn Ford, the Plenty has been known, on several occasions, to cease to flow, the necessity becomes more obvious."

He further says, "I found that the Yan Yean reservoir would receive the drainage of eighteen square miles. (Mr. Hodgkinson's measurement is four and half square miles) an area which, in my belief, is sufficient in itself to afford an ample supply of water for the City, without looking to any other source; but, as droughts of two or three years' standing have been known to occur, I consider it advisable to lead in the Plenty River."

He further adds, "that the reservoir can be made to receive, in addition to the Plenty River, the drainage of upwards of 120 square miles of surface." The Survey maps give sixty square miles as the area of the Plenty basin.

It needs no additional arguments, as it appears to me, to show the great advantages which a Yarra gravitation scheme would possess over a gravitation scheme having the eastern arm of the Plenty as its only source of supply; but if these are wanted, they will be found in the fact that if we are to be satisfied with the supply of our present wants only, at the enormous cost of 369,900*l.*, and if we are to depend upon the eastern arm of the Plenty for this supply on the constant service principle, we have no guarantee whatever that our wants will really be supplied after all, or that the supply will be equal to the actual demand. At forty gallons per head per day, the eastern arm is no doubt fitted to supply 100,000 inhabitants, if we are prepared to chance the droughts; but it has been practically found that there is no way of limiting each individual to his forty gallons, if the distribution is on the constant service principle. And the Comissioners of Sewerage and Water Supply, backed by the opinion of the Select Committee, have, very properly, from the first, determined to supply the City on this principle, and it would be a sad retrogression in sanitary economy to revert to the antiquated method of inter-

mittent supply, with its cumbrous machinery of dirty and ill-conditioned cisterns.

The constant-service principle, therefore, is not at all adapted for a limited supply of water, and this important fact has been clearly demonstrated by the experience of other cities. Croydon, which is supplied on this principle, consumes 500 gallons per house per day, which, making the usual allowance of five individuals to each house, is equal to 100 gallons per head instead of forty. Hitchin consumes 235 gallons per house, or forty-seven gallons per head. Whitchaven 250 gallons, or fifty gallons per head; and New York, which is nearly in the same latitude as Melbourne, and is therefore our best guide in regard to the amount that may probably be required, on some days consumes ninety gallons per head instead of forty.

At Rugby, Sandgate, and Barnard Castle, the supplies have been found inadequate from waste; and the Bristol company have been forced to abandon the constant-service principle altogether.

With such important facts before us, can we look with any confidence to a source which, under the most favourable circumstances, is only fitted to supply the present population of Melbourne, with its suburban towns and villages. And what is there so very repulsive in the Yarra that we should not at once resort to it for our water supply?

After giving my best attention to the whole subject, I would in the strongest manner recommend that we should abandon all hopes of supplying the City from any other source than the Yarra, where, at all times, and under all circumstances, we shall obtain an unlimited supply of the purest water.

I am aware that there is a very strong feeling on the part of the public that the works ought to be completed now, as the money is nearly all expended. But more mature consideration will show that if any confidence is to be placed in the estimates of Mr. Hodgkinson, Dr. Davy, and myself, the available amount of water, after deducting the evaporation, will not suffice even for the present wants of the City; and with so limited a supply, the water would be unfit for use, were it possible to run it into the pipes,

Where is the object, then, in laying twenty miles of pipes, even under existing contracts?

If the pipes had been laid, it might have been argued that it would be cheaper to carry them five miles further to the eastern arm, at an additional cost of 70,000*l.*, than to remove

them to the Yarra. But the main pipes are not yet laid, exeept for a very short distanee; and, therefore, I do not see that it is too late to lay them in another direetion, where we shall find at all times the purest water in the most unlimited abundanee.

But, while I am of opinion that the pipes ought not to be laid, I am most anxious that the eapabilities of the reservoir should be tested before finally abandoning it; and, for this purpose, I hope that the aqueduet will be completed in time to take advantage of the winter rains.

I may also notiee that no steps have yet been taken to convey the two branches of the river through the swamps. This will eost a very large sum, and of eourse is not yet contracted for.

It is deeply to be regretted that a work of such magnitude and importance as that which forms the subject of this paper should be found to be based on incorrect scientific prineiples; and it shows the vast importanee of eultivating the seienees, even in this remote eorner of the globe.

Had there been a seientific soeiety in this eity two years ago, the Commissioners might have obtained more correet information respecting the rate of evaporation in this colony, and more certain and reliable data with respect to the watershed of the Plenty basin; whieh were so neeessary to ensure the suceess of their scheme.

It was purely on scientific grounds that I was induced to undertake the investigation of this subject; and it was the conviction of its great importance, in a scientific as well as in a sanitary point of view, that has led me to submit to you the result of my inquiries.

If there is any probability of the Yan Yean Reservoir scheme failing for want of water, the sooner this unfortunate result is diseovered the better.

It would surely add little to the seientific reputation of Vietoria, that a work of sueh magnitude should be allowed to be eompleted, at a ruinous saerifiee of public money, before its failure is even suspeeted.

Art. XIII.—*The Meteorology of Melbourne. By* Dr. E. Davy.

My attention during a part of the last four months having been direeted to the meteorology of this place, I propose to lay before this Society the result of the observations I have

made, the inferences which appear to be deduceable from them, and particularly in regard to the nature of the hot winds.

Referring to the journal which I have kept since the 1st of December, I must first briefly advert to the thermometric observations. It will be seen that the highest point reached by the thermometer has been 112°, in the shade, and the lowest 45° in the night. There has been no night on which the thermometer has not sunk to 74°. We have therefore had none of those very hot or very cold nights, such as are not uncommon in the summers of South Australia:—and the heat, though on some occasions very intense, has in no instance been very continuous.

The mean monthly temperature has been estimated in two different ways:—First, by averaging the sum of the daily highest and lowest readings of a Sike's thermometer. Secondly, by exposing to the air in the shade a copper vessel, containing ten gallons or more of water, closely covered to prevent evaporation, and taking the temperature of this water twice a day, viz. at 6 a.m. and 6 p.m. The results of these two methods of observation have been found during December and January to correspond within a single degree. The mean temperature of December was 68°, and that of January 70°, and that of February 69°, and of March 68°; being ten degrees above the mean of the corresponding summer months in London in 1844. On the two days when the thermometer stood about an hour after noon at the highest point, 112°; viz., on the 28th and 29th January, it sunk in the course of the night to 66½° and 66°; thus showing a range of 46° during the twenty-four hours.

My observations on the barometer have not been sufficiently complete to admit of calculating with precision its mean height. I have recorded the reading of the barometer every day about noon; and during changes of weather, I have observed it at all hours; but not at other times. Approximatively, the reading was for December, 29·82; January, 29·88; February, 30·0.

The hygrometric observations are of more immediate interest and practical importance. They have been made principally with a Mason's hygrometer, the accuracy and convenience of which is now generally admitted. It appears that the mean dew point of December was 50·0; that of January, 49·5; and that of February, 50·3; having thus been practically the same during the three months. I have

made these observations on numerous occasions at all hours, from six in the morning till late in the evening, and have not found them to differ materially from those made daily about noon, the dew point having been nearly the same during the continuance of brisk wind in the same direction. Deducting the dew point from the mean temperature, gives the dryness of December 18°; that of January, 20·5°; and that of February, 18·7°. The mean of the three is 19·0°, while that of England is 8·0°. Thus the dryness of summer in Melbourne is to that of London, as more than $2\frac{1}{4}$ to 1; as far as the present season only is concerned.

The total rain fallen during the four summer months,—December, January, February, and March, was 4·67 inches. I may here be permitted to suggest a caution against any deductions from the annual rain-fall of Melbourne being applied to places even at twenty or thirty miles distance. It is well known that in England the annual rain-fall in some places is more than double of that which occurs in London.

During the four months in question there has been no appreciable deposit of dew in Melbourne. While on this subject, I may refer to the fallacy of supposing that dew is ordinarily deposited on the surface of water as it is upon that of the land. To attract dew, the surface must be cooled down to the dew point. This on the land is effected by *radiation*, but not so with the water surface. The cooling effect of evaporation will never reduce the temperature more than half way down to the dew point. A careful consideration of circumstances will convince us, that a deposition of dew upon the surface of deep unfrozen water must be a very rare, and almost inconceivable event in this colony.

The rate at which evaporation will take place from the surface of water depends essentially upon three circumstances,—

1st. The actual temperature.

2nd. The degree of dryness of the air.

3rd. The velocity of the wind.

It will, however, be difficult from these data alone, to calculate otherwise than approximatively the true rate of evaporation. Nothing short of direct experiment is to be depended upon; and even direct experiment upon a small scale is liable to a slight degree of fallacy.

With respect to the temperature there are two observations to be made:—1st. It is the temperature of the air rather than that of the water which affects the result. The air, on coming in contact with the water, raises or depresses as the

case may be, almost instantly to a certain temperature, an infinitesimally thin film of water, and it is from this surface film that the evaporation takes place, however cold the water below may be. This certain temperature will be nearly midway between the actual temperature of the air and its dew point. It is true that the air itself may not only become cooled, but also partially saturated with moisture on passing over a very large surface of water, but in this case, the thermometer and hygrometer ought to indicate a notable difference on the windward and lee sides of the sheet of water. 2nd. The rate of evaporation, as far as it depends on temperature, will be affected rather by the range of the thermometer than by its mean. Inasmuch as the tension of vapour increases almost in a geometrical ratio to the increase of temperature, it is easy to see that if a surface of water were exposed for twelve hours to a temperature of 50° and for another twelve hours to 90° it would evaporate more rapidly than if exposed for the whole twenty-four hours to the mean of 70°. Hence I suppose that evaporation will be more rapid in Melbourne, as compared with London, than the mean temperature alone would indicate. 3rd. The evaporation from any given area of *wet land*, will be greater in proportion than from a similar area of a sheet of water, because it exposes a greater surface.

By direct experiments upon water in different vessels and under different circumstances, exposed to the air during the months of January, February, and March, and comparing these with the hygrometric observations made also in December, I am led to estimate the mean evaporation of the three summer months of December, January, and February, as 0·55 per day, or four feet one and half inches. I have no certain data from which to infer what it may be during the remaining nine months of the year; and would not, therefore, except in the absence of precise information, presume to offer an estimate as a matter of opinion founded upon general observation. I cannot suppose that the evaporation during the six months of spring and autumn, viz:—March, April, May, September, October, and November, is less than half of that which occurs in summer; and I assume that of the three winter months, viz:—June, July, and August, to be one-fifth. We shall thus have

Summer	4	1½	
Spring and Autumn ...	4	1½	
Winter		9	
	9	0	feet.

It may be greater; but is not likely to be much less than is here estimated; and it may be a question whether this present season has or has not been below the average in point of dryness.

The evaporation on the eighteenth of February was more than one inch; the dew point at noon being 37° the mean temperature being 78°, the range 42°, and the highest 99°.

I may here state the formula which is given in scientific works for calculating the rate of evaporation from the temperature of the air and its dryness. Water at 212° is ascertained by careful experiments to evaporate at the rate of 0·725 grain per square foot per minute. By referring to Dalton or Ure's tables, the tension of watery vapour at any given temperature can be found. Let T be the tension at the temperature of the air, and T″ the tension at the dew-point, than by a simple rule of three sum,

$$\text{As } 30 : 725 :: T - T'' : x$$

x being the answer in grains per square foot per minute, from which the quantity in inches can readily be calculated.

This rule however affords us no guide for estimating the ratio of increase from the action of wind in proportion to its velocity.

The experiments which I have made on the rate of evaporation can easily be repeated by other persons, and I have no doubt that the correctness of the results, considered as approximative will eventually be fully confirmed. But of course it is not intended to represent that the level of every natural water hole will sink at the rate of half an inch per day in the summer months, because the contrary is well known. The adjacent soil may be porous and become saturated with water which is altogether protected from evaporation. This water would of course return into the pool, and supply the place of that which had been dissipated by evaporation from the exposed surface. It is probably only in cases where the sides and bottom of the pool consists of impervious clay, that the level of the water would sink in anything like the proportion I have mentioned.

I have now to speak of the winds of Melbourne; and it will be seen on reference to the Journal, that the prevalent winds are those from the south, or within a few degrees of south. The next in frequency are those from the north and north-west. Winds from all other points of the compass occasionally blow, but are not of long duration. It will, I think, presently appear that this is just what might have been

expected on theoretical grounds. Before however explaining my particular views on this subject, it will be necessary to introduce a brief reference to the phenomena of winds generally, and their causes as far as they are well understood. Winds arise from the circumstance that different portions of the earth's surface are unequally heated, and that air expands and becomes lighter in proportion as its temperature is increased. The air in contact with the overheated surface has of course a tendency to ascend, and a partial vacuum being thus induced, the air from the cooler regions in the vicinity flows towards that point. In order to destroy the equilibrium, it is manifest that the heated air, after having ascended to a certain height, must flow off again horizontally, in a direction opposite to that in which it moved at the surface.

It is on this principle, that the great comparative heat of those portions of the earth within the tropics causes a constant flow of air from the poles towards the equator at the earth's surface and a current from the equator towards the poles in the upper regions of the atmosphere. But in consequence of the motion of the earth in its rotation on its axis being greater in proportion as we approach the equator, the north and south currents of air at the earth's surface become converted into north-easterly and south-easterly, and, from the converse operation of the same cause, the upper currents returning from the tropics become north and south-westerly. All up to this point is so well understood and appears to be so simple that it almost needs an apology for its introduction into a paper of this description; but, as we further pursue the study of the winds, we shall find that they become modified by the utmost complexity of causes. We shall have to deal with some facts difficult to explain, and with others which defy all our powers of calculation; so that the scriptural saying in reference to the wind, "Thou canst not tell whence it cometh or whither it goeth," is still true in the present state of our scientific and geographical knowledge.

From what has been above stated, it might be supposed that, irrespectively of local influences, the general tendency of the winds at the earth's surface in all latitudes should be north and south-easterly. The fact however is, that beyond a certain limit outside the tropics, the prevailing winds are more or less westerly. Explanations of this fact are to be found in different treatises upon the subject; but I have not seen any that entirely meets the case. It appears to me that the fact may be accounted for by the greater amount of friction

and resistance to the wind which occurs at the earth's surface than in the upper and free regions of the atmosphere. From the influence of this cause it is easy to understand that the upper current of air would retain its velocity or momentum in its progress to the poles, so as to be enabled at a certain distance from the tropics to overcome the more sluggish lower current, and force it into its own direction. It is evident that the current of air towards the poles can only be equal to that which is flowing towards the equator; I suppose, therefore, that in the belt in which the westerly winds prevail, the upper current has overcome the lower, only by communicating its own westerly and not its southerly direction.

With respect to the winds of Australia it is to be observed that we have a very large island or continent, of a compact form, not deviating greatly from that of a circle, and for the most part remote from any other large tract of land. Of this immense region a part is situated within the tropics, and the remainder very close outside the tropics, so that, having much higher temperature than that of the surrounding ocean, the land may be considered as a vast heating surface, which, on the principles already explained, will have a tendency to draw currents of air in all directions towards its centre of heat. There can be no doubt that the hottest part of the island exists to the northward, and probably also to the westward of the geographical centre. The influence of the trade winds within the tropics would probably throw this point towards the west; and, in confirmation of this view, I would observe that the hottest part of the ocean in the vicinity is south of the line, and to the N. W. of Australia, according to Black's map of Physical Geography:—viz. Java and Timor. For the sake of illustration, we will suppose the hottest point to be in long. 130° and lat. 22° or a little to the N. W. of Sturt's Desert. Confining our investigations to the southern portions of the continent, we have next to consider that the wind, blowing outside the coast, has a prevailing direction from west to east, and therefore on approaching the coast it would not at once assume a direction towards the centre of heat, but rather a direction intermediate between that and its original eastward motion.

On proceeding along the line of coast from west to east, we shall expect, on this principle, to find the westerly character of the wind gradually diminished, and that it will at a certain point become southerly, and beyond that again more or less easterly. Thus in South Australia the prevailing winds ought to be

S. W., and in the vicinity of Melbourne almost due east, and still further on south-easterly, and this we find in point of fact to be the case.

It is to be presumed that in the upper regions of the atmosphere, far above the level of the clouds, the returning current of air is almost constantly flowing in the opposite direction to that of the wind which prevails at the surface; that, in fact, the north wind is always blowing over our heads. So long as the pressure of wind from the south is sufficient, as indicated by the barometer standing high, a hot wind, according to my observation, does not generally occur. But let the barometer sink one or two tenths below its previous elevation, and the partial vacuum, of which this is the symptom, is liable to be immediately filled by the air nearest at hand, which is that overhead; and it continues to blow until the barometer either again rises, or else sinks still lower. In the former case, there will be first a lull and then a rapid return of the southerly wind; in the latter case, which, as I suppose, indicates that the hot wind has blown to a certain distance out to sea before it is met by the southerly wind, there will be rain, and the north having counterbalanced the south direction, the wind will be rather westerly. If the barometer be high, it indicates a tendency to efflux of air in all directions, and no immediate recoil, producing storms or rain, is to be expected.

It is a very common thing to speak of the hot winds as though they had blown to us direct from the interior desert, horizontally over the surface of the land. I have even read of a proposition to dam up rivers, so as to form artificial lakes towards the north, in order to mollify them. Such a view of the case is, however, totally irreconcilable with observed facts.

In the first place, a remarkable feature in these hot winds is their extreme dryness. The meteorological journal will show that the dew-point of a north wind, when blowing strongly, is always very low, sometimes as low as 35°. This wind is drier than that which would blow from the sea in any direction, and especially from the north at the corresponding season of the year. Air may be heated, but cannot be rendered drier, it cannot be deprived of its moisture by contact with hot sand, however dry. Seeing, therefore, that there are no elevated mountains toward the north, we are led to conclude that this air has been dried simply by having risen into the higher and colder regions of the atmosphere, where its moisture has separated in the form of

clouds. This character of dryness is not peculiar to the hot winds of Australia. In the Deccan the wind has been seen at 90°, while the dew-point has been as low as 29°, or 3° below the freezing point, making the degree of dryness 61°

To some persons the doctrine that a hot wind should come from a cold quarter may appear paradoxical. This is not the occasion on which it is necessary or proper to discuss the elementary principles of chemistry or natural philosophy. I may, however, state that air when expanding in consequence of mere diminution of pressure, becomes cold independently of any heat being absolutely abstracted from it: its heat merely becoming latent; and it acquires its original temperature by simply restoring the pressure which previously existed. The experiment of igniting tinder by pressing cold air in a syringe is sufficiently familiar to every one; and the freezing temperature produced by the sudden expansion of air let out of a vessel in which it has been condensed is equally well known. In fact, the cold which exists on the tops of high mountains is attributable solely to the rarefaction of the air in those situations.

If the rationale of the hot winds, as above recited, be the true one, it becomes easy to understand why it is that hot winds occasionally occur in Van Diemen's Land and in the Island of Sicily, raising the thermometer above 100°, notwithstanding the great width of the intervening sea, which might be supposed to have exerted such a cooling influence as to have rendered such a temperature impossible.

Barometric observation appears to show that hot winds originate, not so much from an increase above the average in the pressure of the currents from the north, as from the diminution of pressure from the south and west. To account for this, I must refer to a previous remark as to the comparative friction and resistance in varied directions which exists at the earth's surface. From the absence of this influence in the upper currents of air, and for other reasons, it is legitimate to infer that they should be of a much more uniform character, and preserve more nearly a mean pressure; and hence we find that they do not occur when the barometer is either at its maximum or its minimum.

A northerly wind is frequently, and except during the middle of summer, almost invariably followed by rain. This circumstance at one time appeared to countenance the idea of an inland sea. It admits however of a very different explanation; bearing in mind, that from a variety of causes, the irregularity of the earth's surface, and the meeting and cross-

ing of independent currents of air, the winds have a tendency to blow in curves, both horizontal and vertical, rather than in straight lines.

When a hot wind blows out to sea, it is cooled by contact with the water; but, at the same time, in consequence of its elevated temperature, it induces rapid evaporation, and becomes loaded with moisture. In proportion to the fall of the barometer, indicating the greatness of the vacuum which originally caused the descent of the hot wind, and the deposition of moisture occurring at the line of its meeting with the southerly wind, will be the tendency of the southerly and westerly winds eventually to become set in motion, in order to restore the equilibrium. The meeting of the cold with the hot wind, both comparatively loaded with moisture, will cause an immediate deposit in the form of clouds and rain. We have in fact the hot wind blown back upon us, after having been to sea, as it were, to bring back water.

We are apt to complain of these hot winds as one of the principal inconveniences of the climate. Had we however no hot winds, we should probably have little or no rain. The southerly winds would not bring it, because as they proceed northward they become warmer and drier, and have less and less tendency to deposit their moisture. Even the winter rains are usually the consequence of a northerly, although we do not at that season call it a hot wind.

The great redeeming feature of the Australian hot wind, is its low dew-point, or in other words, its dryness; but for this it would be intolerable. It is easy to conceive that with the thermometer at 112° and the air nearly saturated with moisture, profuse perspiration would be caused, but it would not be removed from the surface of the body, and the effect on the system would be nearly the same as if it were immersed in a scalding hot bath. It were vain to hope, and wrong to wish, that the hot winds of Australia should ever be abolished. But much may be done in the next generation to mitigate their inconvenience. The cultivation of the land, and especially the extensive planting of trees, will have some influence. The leaves of trees and shrubs act almost as wet cloths suspended in the air, and the cooling effect of evaporation from their surface is very considerable; added to which, is the probable cold produced by the absorption of carbon, by which an effect, the reverse of that produced by its oxidation or combustion, may be produced. The coolness of ripening fruits may perhaps be accounted for on this principle. The construction of houses, whether in adaptation to the exigencies

of the climate or otherwise, of course depends on the will of private proprietors, and all that can be done in this particular, appears to consist in the erection of model dwellings, to show in what manner increased comfort may be obtained, without great increase of cost. But in the laying out of townships, and the planning of streets, it appears to me that the aspect, with reference to prevailing winds, ought to be taken into consideration, and that if this were duly regarded, the nuisance of dust might in a great measure be avoided. The streets and apppoaches might, to a certain extent, be so laid out as to direct the dust, by the shortest channels, off the town altogether. And this, in a district where the prevailing strong winds have so constant a character, would not, as I conceive, be attended with any particular difficulty.

Before bringing this paper to a close, I must briefly advert to the continued droughts to which some, at least, of the extra-tropical portions, of the continent of Australia are occasionally liable. In the Sydney district a drought has been known to continue for eighteen months together. The partial failure of the crops of last season in South Australia, appears to be attributable principally to the unusual deficiency of rain during the winter months of May, June, and July. Van Diemen's Land, notwithstanding its insular position, is not exempt from droughts. I am aware that I am now approaching the mysteries of meteorology: and it is not my intention to offer any bold hypothesis upon a subject which, in the present state of our knowledge, is undoubtedly inexplicable. It has by some writers been suggested, that these droughts are periodical, by which I understand that they should be liable to recur at stated intervals. I am not aware of any sufficient foundation either in theory, or in fact and observation, for such an opinion. There is no particular conjunction of the sun, moon, or planets, which could, upon any known principle, give rise to a drought. I know of no reason why we may not have a drought next year or the year after, without reference to the date of the last occurrence of such a calamity.

The droughts of Australia appear to be no more periodical than the tempests which, from time to time, and, fortunately at distant intervals, sweep the English and other coasts; and we ought at once to disabuse ourselves of this impression.

According to the principles proposed in a former part of this paper, the fall of rain will mainly depend upon the frequency and the extent of the alternations of the hot

winds from the interior and the winds from the ocean. Supposing the wind to blow continuously in either one of these directions we should certainly have no rain. The dry north wind cannot deposit the wet which it does not contain. The sea breeze, coming from the south, has its tendency to absorb moisture increased as it proceeds northward, and will consequently give no rain.

If, therefore, we suppose that from whatever cause, at any time, there may be a more than usually steady current and uniform pressure in the ocean winds, off the Australian coast, we find at once, an adequate proximate cause for a drought on the land. As to the ultimate or remote cause, we have at present no data even for probable surmise, unless indeed we ascend another link in the chain of causes, and attribute the circumstance to the accidental absence of storms in the adjacent regions. On this subject at least a point is gained when a fallacy is cleared away. It is to be hoped that the result of simultaneous observations, which, under the patronage of the Board of Trade, are now about to be made at sea, in all parts of the world, will in due time throw a light upon this subject: I now conclude by recommending a co-operation in this important investigation, as one of the most legitimate objects to which the attention of the Philosophical Society could be directed.

Art. XIV.—*On the Probable Influence of Evaporation on the Quantity of Water to be supplied by the Reservoir at Yan Yean. By* Clement Hodgkinson, C. E., *Survey Department.*

At the last Meeting of the Philosophical Society, after Dr. Wilkie's Paper on the anticipated failure of the Plenty Scheme of Water Supply had been read, and your Committee's Report received, the President, in the course of a few terse and apposite observations, directed the attention of the members of the Society to the necessity of further elucidation of the phenomena connected with evaporation.

I quite concur in the President's opinion that the excessive difference in the estimated effects of evaporation on the surface of the Upper Plenty District by Dr. Wilkie and your Committee, calls for further investigation.

For Dr. Wilkie, on the authority of Thompson's computa-

tions for the basin of the Clyde, assumed that in the Upper Plenty District the evaporation would leave only one-ninth of the total rainfall available for the Yan Yean reservoir; whilst your Committee, Messrs. Acheson and Christie, adopted, on the authority of Tables VI., in Dempsey's treatise on Drainage (which Tables they considered corroborated by their own observations), 0·42 as the amount of the total rainfall available,—a quantity nearly four times greater than that assumed by Dr. Wilkie.

Before discussing the very numerous measurements and experiments made in various localities and climates, and which, in the existing want of a regular and connected series of guagings of the Plenty, afford data for arriving analogically at an approximate determination of the proportionate amount of rainfall in the Upper Plenty District, I wish first to remark that in a tract of country of specified area comprised by a watershed, the proportion between the total amount of the annual rain falling thereon, and that portion of the rainfall that is carried away from it by the main channel of drainage, depends not only upon the climate, geological structure, and vegetation of such a tract, but also (although in a much less degree of course) upon the greater or less extent of the area; as, *cæteris paribus*, the greater the area the longer would be the aggregate distance that the rain water would have to traverse in order to reach the point of outfall of the tract, and consequently the longer time would such rain water be liable to evaporation before final departure from the tract in question at the lowest level. Hence, if a large tract and a small tract present the same physical configuration as regards surface, with the same climate and rainfall, the rate of evaporation for the large tract would be slightly in excess of that for the small tract.

The most extensive and minutely accurate observations ever made in Great Britain for the determination of the evaporation from surfaces of land and water under various conditions, were those taken at Ferrybridge, in Yorkshire, by Mr. Charnock, Vice President of the Meteorological Society of London. These observations were extended over the five years terminating 1846; and tended to corroborate the general accuracy of Dalton's observations at Manchester for the years 1795, 96, 97. Howard's Table, referred to in recent computations by Mr. Ranger, the well known Engineering Inspector under the Board of Health, gave for England generally a rate of evaporation rather greater than that observed locally by Dalton and Charnock. In Scotland

where the rainfall is much greater than in the south of England, and the general temperature and atmospheric influences less favourable for the promotion of evaporation, the latter has been found by the Engineer of the Paisley Waterworks and others to be less than in the southern counties of Great Britain.

In the following table I have placed in juxta position the results arrived at by different observers.

Authority.	Locality.	Mean annual rainfall.	Evaporation from surface or difference between rainfall and available supply.	Remarks on nature of surface to which the observations refer.
Charnock	Ferrybridge	24·6	19·72	Porous well drained soil
Dalton	Manchester	33·56	25·15	Ordinary mould with vegetation on surface.
Howard	...	36·	30·47	General surface of Gt. Britain.
Thom	Paisley	54·	18·	Small gathering grnd possessing well drained surface, watered by numerous catch-water drains.
Beardmore	Bute	45·4	22·5	Low country.
Ditto	Rivington Pike	55·5	31·3	Elevated district, 1545 ft. above sea.
Dickenson		26·6	15·64	Ordinary porous soil.
Charnock	Ferrybridge	...	32·60	Moist undrained soil.
Ditto	Ditto	...	35·03	Water surface.
Dalton	Manchester	...	44·43	Water surface.

The inferences to be derived from an inspection of this table are,—first, that the values assigned to evaporation from land surfaces by these different authorities are, (with the exception of that given by Dickenson), quite compatible with each other if due allowance be made for the variations of the temperature, geological configuration, soil, and rainfall of the places of observation: and, secondly,—that when the annual rainfall exceeds the annual average quantity, *the annual proportionate amount thereof evaporated does not also increase as a necessary consequence of such augmented rainfall.* I may here remark that Charnock's observations indicated at the least annual evaporation during the five years over which his observations extended, had occurred during a year when the annual rainfall had been about the average of the five years. This shows the futility of assuming (as too frequently has

been done), *a certain proportion to exist between the rainfall and the available supply.*

Mr. Dickenson's Tabulated Quantities, which indicated an annual amount of evaporation so greatly differing from the results of all other authorities, were, I believe, made for Mr. Parkes, the well known agricultural surveyor, and were inserted without acknowledgement of their author's name, in Dempsey's Treatise on Drainage. But in Table VI. the very great error was committed of obtaining the *mean-annual evaporation* for the total rainfall of the year by adding up the mean monthly evaporations and dividing the sum by twelve; which result would only be correct if the rainfalls for each month were precisely equal.* Hence the annual evaporation adopted, on Dempsey's authority, by your Committee, was not only based on observations of an exceptionable nature, as just shown, but was also greatly vitiated by a gross mathematical absurdity, which, whether due to Dickenson or Dempsey, was very inexcusable in a professedly scientific series of Tables.

The inadequate rate of evaporation from the ground, as thus assumed by your Committee, is still further shown by its actual application.

Thus, if thirty-six inches represent the rainfall at the Upper Plenty, the evaporation, according to the Committees assumed rate, 0.58, would be only 20.88 inches;—that is, a quantity *less* than has been observed on the average of gathering grounds, whose discharges have been guaged in Scotland, and *very much less* than has been found to prevail in the South of England. Yet how obviously must the evaporation from the surface of the ground be greater here, even on the most favorable surfaces for lessening evaporation, when the high temperature, hot winds, and clear dry atmosphere of this colony are considered!

Although I cannot admit that the configuration of the surfaces of the Upper Plenty District is so unusually peculiar as to warrant the excessively low rate of evaporation assumed by your Committee, yet a portion of these surfaces

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* Let R_1, R_2, R_3, R_4, &c., denote the respective amounts of rainfall in inches for each successive month; E_1, E_2, E_3, E_4, &c., the rates of evaporation corresponding to each successive month; then true mean annual rate of evaporation $= \frac{E_1R_1 + E_2R_2 + E_3R_3 + E_4R_4 + \&c.;}{R_1 + R_2 + R_3 + R_4 + \&c.;}$ but according to Dempsey it would be most erroneously represented by the expression $\frac{E_1 + E_2 + E_3 + E_4 + \&c.}{12}$

is so far favorable for lessening evaporation, as to render, in my humble opinion, Dr. Wilkie's estimated rate of evaporation too great.

For the steep slopes of the ordinary forest ranges comprised within the watershed of the Plenty above Yan Yean, promote the rapid conduction of rain-water to the channels of drainage, and therefore tend to diminish evaporation; this obvious diminution is, however, to a considerable extent, counterbalanced by the increased evaporation that occurs on some extensive tracts of wet undrained land, from whose surface the evaporation is, according to Charnock, nearly as great as from a sheet of water. In this condition are the swamps that extend from the base of Mount Disappointment to the village of Whittlesea,—a swampy tract north of Sherwin's range, the sides of several of the mountain ravines, and even part of the table land on the main range.

From the want of extended meteorological observations taken in connexion with the Upper Plenty districts, or what would have been much more satisfactory, a complete series of stream-guagings to determine the annual discharge, the available rainfall of the district can be only analogically eliminated from the general data afforded by the most trustworthy English observations on evaporation, corrected for the average differences of temperature for the various months of the year, in London and Melbourne, as given in the *Statistical Register* for Victoria. Moreover, as wind, and the hygrometrical state of the atmosphere exercise a marked influence on evaporation, independently of temperature; and as their action is more intense here than in England, some additional corrections should be applied to the English data for this increased action. Due consideration must also be given to the favourable nature of part of the surface of the Upper Plenty district, especially that portion draining direct into the reservoir. Having made allowance for all these contingencies I have arrived at the conclusion that the total annual rainfall at the Upper Plenty may be taken as equivalent to thirty-six inches, and that the amount thereof evaporated may be assumed to be 30·8 inches, leaving the amount available for supply 5·2 inches, over 44,000 acres. But if cuts were made on the catch water principle the amount available might be greatly augmented.

The annual evaporation from the surface of water in England amounts to from thirty-four to forty-four inches. Both Dr. Wilkie and Messrs. Acheson and Christie, have assumed nine feet as the annual loss from evaporation on the

surface of the reservoir at Yan Yean; whilst Mr. Blackburn considered three feet would be the maximum loss, and others have coincided with his opinion, citing instances of the small decrease in depth observable in certain ponds.

Reference to the observed decrease in depth during a specified period in a pond, is of no use in facilitating the inquiry into the amount of evaporation from the surface of the reservoir, unless the rainfall during that period, the area of the pond, and the area of the ground draining into the pond, be given.

In the following case these were attainable:—In the vicinity of my residence near the Yarra is a pond, to whose surface I occasionally have recourse for testing the adjustment of my spirit levels. The area of this pond is about one and a-half acres, its greatest depth ten feet, and the area of the ground draining into it about nine acres.

The surface of the area of drainage is either trap rock, or a thin coat of soil derived from its disintegration, and resting on a substratum of very stiff impervious clay. The height of the surface of the pond above the nearest point of the Yarra was ascertained by me to be, on March 1st, 1855, fifty-one inches. On December 1st, 1854, one of my men defined, by a peg driven down flush with the surface of the pond, its level on that day, and on March 1st I found the water had sunk 16·2 inches. The proportion of the rainfall draining into the pond, from the small area comprised by its watershed, was assumed to be, for the three months of December, January, and February, 0·15 of the small amount of rain that fell on that area during that period. The rainfall during the three months was known by reference to the rain guage kept in Melbourne. From these data I computed the evaporation for those three months to be 24·6 inches.

Having been aware that evaporation from water in small vessels, constructed of materials that are good conductors of heat, proceeds with very much greater rapidity than in large vessels or ponds, I should not feel safe in placing any reliance on the results afforded by the small copper vessels employed by Dr. Davey, and which have led Dr. Wilkie and your Committee to assume nine feet as the annual amount of evaporation from the surface of the Yan Yean reservoir.

During the month of February I placed in an exposed site in my garden a large butt, which I filled nearly to the brim with water, and protected the external wood-work of the butt from the influence of the sun and hot winds by woollen rugs. Having unfortunately lost the record of my observa-

tions on the water in this butt, I can only state generally that the decrease in depth in consequence of evaporation was remarkably less than according to Dr. Davey's observations; and that during the prevalence of one hot wind the observed decrease in twenty-four hours was only half an inch.

I must, however, protest against the greatly exaggerated notions relative to the diminished rate of evaporation in large reservoirs entertained by some practical men. For instance, Mr. Stirrat, the promoter of the gravitation schemes of water supply in Scotland, actually stated in evidence, that in large reservoirs the evaporation was counterbalanced by dew condensed on the surface of the water—a remark, which, if true, would have entirely precluded the possibility of carrying on the well-known process of obtaining salt by evaporation of sea water in large tanks formed near the sea coasts.

If, in the absence of a complete and satisfactory series of observations on the evaporation during the summer months here, from water contained in a vessel of adequate depth and capacity, well protected from the influences of external temperature, my experiment, made during December, January, and February, on the pond, be considered to afford some criterion of the probable influence of hot winds upon the Yan Yean reservoir, then the approximate deterioration of the evaporation of the other months of the year can be arrived at with tolerable precision. For if we omit December, January, and February, the mean temperature of all the other months in the year in this colony agree very nearly with the mean temperature of some of the months in England, for which the rates of evaporation from water surfaces have been registered. By basing a calculation on this principle, and applying some additional correction for the frequent occurrence of dry winds here, &c., I have computed the probable evaporation from the surface of the reservoir to be as follows:*—

	INCHES.
Evaporation for December, January and February, as determined from my experiments on the pond.	24·6
Evaporation for March, April, and November, (determined by analogical deduction, from a comparison of English and Australian Meteorological observations, &c.	19·
Evaporation for March, September, and May. ...	14·2
Evaporation for June, July, and August. ...	8·8
	66·6

* During the period that has elapsed since the lecture of this paper and my inspection of the proof sheets, the President of the Commission of Sewerage

In investigating the probable supply of water derivable from the mountains, the possibility of any of the copious streams in the ravines of Mount Disappointment being derived from sources beyond the apparent limits of the watershed of the Plenty must next be considered.

When I guaged these streams and examined their sources in 1852, the fine body of water that I saw gushing out with great velocity from a fissure in the granite, and forming the source of the Saw Pit Creek, on the western branch of the Plenty, led me to investigate this point; as I was aware, that in the island of Hong Kong, copious streams gush out of similar fissures in the granite formation there, and discharge a much greater quantity of water than the total rainfall of the island.

But on examining the sources of the eastern branch of the Plenty, I saw that the high table land forming the dividing range between the Plenty and the tributaries of the Goul-

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and Water Supply has published a vindication of the Yan Yean Scheme of Water Supply. In the course of his observations, he states that I have committed a palpable error, in ignoring, in the above analogical deduction, the difference in the length of days here and in England, for the months of corresponding mean temperature; as he is of opinion that the evaporation, on account of longer duration of daylight, is greater in England, during a month of a certain mean temperature, than would be found to occur here, during a month possessing the same mean temperature. But Mr. Griffiths, in the calculation by which he illustrates his views on this subject, unfortunately falls into the error of supposing that *evaporation invariably ceases at nightfall.* I, therefore, beg to remark, that in this Colony, where dry windy nights are of such frequent occurrence, the nocturnal evaporation is often very great; so much so, in fact, as to render the correction, to which Mr. Griffiths attaches so much importance, of a very trivial and indefinite nature; not, however, ignored by me, as he supposes, but found to be more than counterbalanced by the greater dryness of the atmosphere in this Colony. Mr. Griffiths further states, that I am one who would prefer the Yarra, with "its tanneries, fellmongeries, and the thousand other daily increasing sources of pollution," to the Plenty. The *nearest point* to Melbourne, at which I ever proposed to derive any supply, was two miles higher up the river than the point where the analytical chemist of the Commission found the Yarra water to be *purer* than the Plenty water; and as regards the nuisances on the banks of the Lower Yarra, below Dight's Mills, I recollect having once stated the necessity, in my humble opinion, (in a casual conversation with Mr. Griffiths, two years ago,) of some legislative enactment to check the contamination of the water.

I have also lately received from T. E. Rawlinson, Esq., Engineer to the Fitzroy Ward Improvements, a letter kindly conveying to me the result of his observations on the Plenty. Mr. Rawlinson's high professional standing and long connexion with Yan Yean impart great weight to his opinions on the Water Supply. He considers that the minimum flow of the eastern arm of the Plenty is 4000 gallons per minute, and is convinced, from long personal observation of the Yan Yean Swamp, that the evaporation from the surface of the reservoir will be very much less than has been estimated by some of the members of this Society.

burn, was sufficiently extensive to maintain the permanent discharge of the streams in question in the following manner: the rain percolates through the very permeable soil on the top of the range, and lodges in extensive interior cavities and fissures in the granite; and from these subterranean reservoirs the water is gradually exuded at lower levels, through the spongy masses of decomposed vegetation which fill up the external interstices of the granite, and constitute the soil from which spring up, in such rank luxuriance, the gigantic mountain Eucalyptus, and dense undergrowth of tree-ferns and creepers that choke up the ravines of Mount Disappointment.

This opinion of the probable cause of the very permanent and regular flow during the summer months of the mountain streams, was briefly enunciated in one of my reports in 1852, and has been since corroborated by Messrs. Acheson and Christie.

During the four hottest months of the year, the enormous quantity of water lost from the effects of evaporation and absorption in the river swamps between Mount Disappointment and Whittlesea (equivalent to a discharge per minute of about 2500 gallons) would render it necessary that, for these months, a quantity of water, equivalent to a discharge of at least 3000 gallons per minute, should be deducted from the total yield of the mountain streams, in order to maintain a sufficiency of water in the Lower Plenty for the adequate supply of the setttlers and stock thereon. During the other eight months of the year, a quantity equivalent to a discharge of 2000 gallons per minute would suffice to effect this.

The guagings of the Plenty made from time to time by Mr. Blackburn, Mr. Jackson, your Committee, and myself, are from their want of connexion in a regular series, of little value in affording data for determining the total annual discharge of the Plenty. The information afforded by the settlers on that river relative to its winter discharge, floods, &c., is also exceedingly contradictory, I therefore considered it safer, as explained in some of my foregoing remarks, to endeavour to arrive at some estimate of the supply on general principles.

I submit with much diffidence the following very rough approximation to the probable amount of population that the Yan Yean scheme would prove adequate to furnish with a sufficient supply of water. Since my lecture of this paper I have however arrived at the conclusion, that sufficient experiments on dew have not been made in this colony to

enable its influence on the augmentation of the water supply to be definitively determined; and as I would wish to give a *safe estimate*, at any rate, (or less rather than more, than the probable supply), I have now excluded any separate allowance for dew from the calculation.*

Supply.

	GALLONS.
Available rainfall, assumed to be equivalent, as already explained, to 5·2 inches, over total surface 44,000 acres, whose drainage either flows into the Plenty above the cut, or else flows direct into the reservoir. ...	5,175,950,208
Rainfall on surface of reservoir,—36 inches on 1,300 acres	1,058,377,320
	6,234,327,528

Demand.

Quantity required to maintain an adequate flow in the Lower Plenty	1,227,240,000
Evaporation,—66·6 inches from 1,300 acres of water surface	1,958,626,613
Contingent allowance for loss of flood-water, during excessive rains, absorption, &c., 6 inches over 1,300 acres	176,452,848
Balance, equivalent to the supply, at the rate of twenty-five gallons per head, per day, of a population 313,880 persons, or a population of about 196,000 if the larger rate of forty gallons per head, per day, be assumed ...	2,872,008,067
	6,234,327,528

* Dr. Hales, in his Vegetable Statistics, states, from experiment, that "the moister the earth is the more dew falls upon it in the night; and more than double the quantity of dew falls upon a surface of water than there does on an equal surface of moist earth." The author of the recent Report to the Board of Health, on the supply of water derivable from the Farnham Tertiary formation, holds the same opinion. Professor Young, in article Dew, in Rural Encyclopædia, states that a water surface condenses more dew than any other surface. White considered that the permanent character of the ponds occasionally met with on the crest of the South Downs was to be attributed to the large amount of dew condensed on the surface of such ponds. The assertion of Mr. Stirrat, in reference to the influence of dew on the large reservoirs on his bleaching grounds, has already been alluded to. It has been supposed by some writers, that water has a capacity to assimilate to itself the vapour in the atmosphere, under certain conditions, even though the temperature of the surface of the water should exceed that of the air above it. Unless this capacity existed, the surface of water (if its relative temperature to that of the air be only considered) could seldom effect the condensation of dew. In Great Britain every one must have noticed, on nights otherwise clear and serene, long serpen-

I have arrived, therefore, at the conclusion, that in ordinary years no fear need be entertained, but that a very abundant supply of water will be derivable from Yan Yean, for a population three times greater than the present population of Melbourne. But that, whenever this colony is again afflicted with such another drought as that of 1838 and 1839, a failure in the supply would occur.

The great area of the reservoir will cause the water to be occasionally so violently agitated by wind as to obviate some of the evils that arise from the storage of water. I do not, therefore, anticipate that the Plenty water will undergo much deterioration in the reservoir, unless during the prevalence of an extraordinary drought.

It has been suggested, that if an additional supply of water be required, it could be conveyed into the reservoir either from the King Parrot Creek, on the other side of the main dividing range, or from the Diamond Creek.

I believe the able engineer of the Water Commission could not have examined these streams closely. For I have inspected the source of the King Parrot Creek, and being also acquainted with the country within the watershed of the Diamond Creek, I am induced, from my local knowledge, to form a very unfavourable opinion of this mode of increasing the supply.

In the case of the King Parrot Creek, a drift-way of considerable length would have to be made, at a great depth below the surface, through hard, igneous or plutonic rock, and the difficulties attending the execution of such an excessively costly work, would probably be augmented by the influx of water during its progress. With regard to the Diamond Creek, several of its tributaries, and steep intervening schistoze ranges, would have to be crossed, before the waters of the main creek could be conveyed to the Yan Yean Reservoir. In point of fact, the western tributary of the

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tine bands of mist defining the courses of rivers or large sheets of water; and in Australia I have occasionally, on clear nights, seen similar mists suspended over lagoons, and which mists saturated my hair with moisture on traversing them. Mists of this very circumscribed nature are much less frequent in Australia than in Europe; yet, if they resulted, as some have supposed, from the temperature of the air being below that of the surface of the water, such mists ought to be of more frequent occurrence here, where the temperature of the atmosphere during night is so remarkably less than during day, and consequently the temperature of water surfaces during night generally greater than that of the air. I venture to hope that the phenomena connected with vapour in the atmosphere here will be elucidated by Mr. R. Brough Smyth, whose accurate and judiciously conducted observations will ultimately render his name our chief authority on the Meteorology of this Colony.

Diamond Creek, called the Sugar Loaf Creek, would be the only stream that would be practically available as a feeder for the reservoir; and although the watershed area of the Sugar Loaf Creek is very limited, and its discharge in summer very insignificant, much tunnelling through hard schists would be requisite, in order to convey any portion of its water to Yan Yean.

The contamination of river water caused by a dense population on its banks, has been very frequently assigned as a very cogent reason for preferring the Plenty water to the Yarra water.

Yet, for that very reason, a decided preference should have been given to the Yarra. For the banks of the Upper Yarra consist, with few exceptions, of steep, rocky, stringy-bark ranges, frequently precluding all access to the water, and totally unsuited for the location of a dense population. But the Upper Plenty District, around the Yan Yean reservoir, is a fine, rich, well-watered, and well timbered tract of country, already possessing within its limits, a numerous agricultural population, and the rising village of Whittlesea.

Now, supposing that one of the owners of land abutting on the Yan Yean reservoir, or draining into it, were to convert such land into a township, and by puffing it into notoriety on account of its proximity to a magnificent fresh-water lake, lovely scenery, rich land, and so forth, were to cause the township on paper to become a township in reality, a population of only two thousand persons thus located, would cause a greater amount of deterioration in the water of the reservoir, than would be inflicted on the Yarra by a densely-peopled town of fifty thousand inhabitants formed on the banks of that river at Heidelberg. Although the Plenty affords an unusually soft and excellent water, that of the Yarra, taken from any point above Dight's Mills, has been proved by a quantitative and qualitative analysis to be yet more excellent; and I see no reason for departing from the opinion I formerly expressed, relative to the superior purity of a supply derivable from the Yarra, above the Yarra Bend Asylum. Those persons whose impressions of the Yarra have been influenced by its sluggish aspect near Melbourne, would have formed a more favourable opinion of this beautiful stream had they seen it in the upper portions of its course, where it rapidly rushes down its stony bed with sparkling brilliancy, or else forms foaming cataracts over ledges of rock.

In concluding my remarks, I have avoided all allusions to

Redrawing Wl. Ors Melbourne.

the engineering plans and operations adopted for the storage and conduction of the Plenty water, as the high professional standing of the engineer to the commission, and the administrative ability of the president, should be a sufficient guarantee that the details of the scheme will be efficiently carried out. I cannot but regret that I have been compelled to express my dissent from the views entertained by several gentlemen whose judgment and ability I deeply respect, and to whom I beg to apologise for the introduction of their names into this paper.

ART. XV.—*Report of the Commissioners appointed by the Philosophical Society of Victoria, to investigate the alleged insufficiency of supply for the Yan Yean Water Works by Dr. Wilkie.*

TO THE PRESIDENT AND MEMBERS OF THE PHILOSOPHICAL SOCIETY OF VICTORIA.

MR. PRESIDENT AND GENTLEMEN,—In compliance with your resolution of the 9th on January last, requesting us to report on the alleged insufficiency of supply available for the Yan Yean Water Works, as conveyed in a paper read before your Society by Dr. Wilkie on the same day, we have the honour of laying before you the following report.

Our first step in the prosecution of this inquiry, was, to proceed to the Yan Yean reservoir, and to examine its modes of supply, as also the drainage-basin of that part of the River Plenty that is intended to feed it, where we made measurements of discharge, in order to guide our conclusions.

Our subsequent investigations were directed to ascertaining the different sources of supply and loss, and therefrom obtaining the available amount.

Foremost among the causes of loss stand evaporation, in soils and still water, the former of which, from the various conflicting conditions under which it occurs in this instance, cannot be easily ascertained from scientific deductions, but is rather a practical question, to be dealt with by the results it exhibits; the latter we obtained from the careful experiments and deductions of Dr. Davy, to whom we are much indebted for communicating the results of his valuable experiments.

Our aim in arriving at and adopting our conclusions, have been rather to exaggerate our amounts of loss, while we have

only accepted so much of our supply as was warranted by data, although apparently larger, so that our results might represent the minimum, if not the actual amount.

Impressed as we are with the difficulty and intricacy of this question, in a locality where so many conditions come into play, and, consequently not subject to deductions from known data, we approach this subject with great diffidence, and hope that the mode in which we treat it, to the best of our humble abilities, shall receive from your society a candid and considerate judgment.

We commenced our investigations on the 24th of January, by measuring the discharge of the River Plenty, one mile below the reservoir, at the bridge, being the same place alluded to in Dr. Wilkie's paper, as measured by him, and giving 153·8 cubic feet per minute, and on which he based the supply by the Plenty, at 3,000,000 cubic yards per annum; our measurement of discharge at this place was only 75·9 cubic feet per minute, deduced from a sectional area of thirty-eight square feet, and surface velocity of ·05 feet per second, or only half that of Dr. Wilkie's discharge. We then followed up the river to the reservoir, at which point we found it diverted into the puddle trench of the new embankment, and dammed up for the use of a water-wheel, which at once accounted for the smallness of discharge at the bridge, as also Dr. Wilkie's previous discharge. Proceeding further up, we came to that point of the river where it joins with the aqueduct, or inlet, for supplying the reservoir, here, finding a clear and uniform flow, we took two accurate sections, the mean of which, or, 13·2 square feet we adopted, also the surface velocity, from a number of experiments equal to 8·568 inches per second, the mean velocity being obtained by the following formula, double the square root of surface velocity, in inches, deducted from surface velocity, and one added, gives the velocity at bottom, the mean velocity is half the sum of top and bottom velocities, was found to be 6·15 inches per second, hence the discharge was 406 cubic feet per minute, or more than two and half times that of Dr. Wilkie's discharge at the bridge.

Further up we crossed the river at Mr. Sherwin's Bridge, at which point it flows out of the swamps, and a little above which it divides into two arms, one from the westward, the other from the eastward. We followed up the western arm two miles, the whole of which distance it was nothing more than a swamp, about 100 yards wide, having no defined channel, and over the surface of which, the whole flow of the water is diffused, and exposed to evaporation nearly equal to

still water, This swamp was composed of vegetable matter to an unknown depth, and so boggy, that a fencing rail was forced into it by one man to a depth of five feet; the flow of water at this point was so trifling that it could not be measured, and was probably all evaporated before reaching the junction with the eastern arm. From minute inquiries we learnt that this swamp extended two and half miles further up, making in all four and half miles of swamp, averaging 100 yards wide, thus exposing 787,000 square yards to surface evaporation. We did not follow this arm up to its source, but we feel satisfied that it affords little, if any, supply to the Plenty during the summer months, and on this occasion none.

We then proceeded to examine the eastern arm, which also flows, with the exception of a slight divergence, through a swamp, for two and a half miles above its junction with the western arm. This swamp is two and a half miles long, and averages 700 yards wide, having, therefore, a superficial extent of 3,000,000 square yards; it is charged with water from the eastern arm, and is in some places less boggy than the western arm, and the flow of water through it has a more defined channel and consequently has a less proportionate evaporation. We measured this discharge about two miles up, and found it to be 712 cubic feet per minute, the surface velocity being 10·18 inches per second, and sectional area 14 square feet, the mean velocity being obtained, same as in former case; it is thus $1\frac{3}{4}$ times the discharge of the Plenty, where previously measured at aqueduct below the swamp; thus showing, that at that time 43 per cent of the discharge was lost by evaporation in the swamp.

Our next subject of inquiry was relative to the source from which the River Plenty derived its supply in the summer months, as it was perfectly evident that there was no surface drainage into it from its basin, excepting after heavy rains, the surface of the ground being quite dry, and the eastern arm the while discharging a strong current of water; to this end we determined to follow up the eastern arm to its source. Proceeding accordingly, we crossed Jack's Creek, which is a fine tributary to the eastern arm, and through which a considerable volume of pure water was flowing; and pursuing the eastern or main arm, we crossed the Sugar Loaf Creek, which is another small tributary of good water being now at the foot of the Ranges, we again crossed the eastern arm at the Ford, and commenced ascending up a deep gully or gorge down which it flows. This gully is clothed with verdant and dense vegetation, consisting of tree-ferns, &c., increasing in

luxuriance and beauty according as we ascended, having climbed for two miles over dislocated granite rocks and fallen trees, and through dense scrub, we came in upon the river, where it formed a magnificent cascade, the water falling over immense granite rocks for a height of fifty feet, the sides of the stream being formed of granite blocks, in the interstices of which the tree-ferns grew in the greatest luxuriance, forming a scene of great beauty. In this lovely spot we rested under the shade of the tree-ferns, and having tasted the water were surprised at its extreme coldness. We continued our ascent up the stream, sometimes forcing our way through dense scrub and climbing from rock to rock; the stream gradually decreasing in volume, being fed from its sides by small supplies of water, which we observed frequently ousing out from a dense spongy mass composed of tree-fern roots and other vegetable matter, on the surface and in the interstices of the granite. We at length arrived at the summit, which is near that of Mount Disappointment, where there was still a very slight stream flowing in a small gully, on apparently table land, where it turned to the left.

Having thus traced up the eastern arm of the River Plenty to its principal source, we beg to offer the following opinion as to the mode by which that source is fed:—

The eastern arm of the River Plenty, taking its rise near the summit of Mount Disappointment, flows over a granite bed down a deep gully, the sides of which are composed of immense granite blocks, the surfaces of which are covered and the interstices filled with a mass of spongy vegetable matter, capable of retaining a large quantity of water, and giving it out slowly. The natural fissures of the granite serve the same purpose of storing the water, which was proved by its intense coldness on a very hot day.

This description appears to be the general character of the Ranges, and coincides with Mr. Hodgkinson's report on the source of the western arm.

We therefore, conclude, that as these interstices and fissures store an immense body of water obtained from rainfalls, and a moisture from clouds that are attracted over, and lie upon Mount Disappointment, they hence constitute the original and only constant source of supply to the River Plenty.

The summer supply of the Plenty is derived wholly from these sources, excepting after heavy rains, as it was evident that it received no surface drainage whatever, when we measured its discharge, but was solely supplied by its eastern arm which led from one of the sources. The discharge of

the River Plenty, therefore, as measured by us, is only an index of the supply derivable from one of the sources, which has but a limited drainage area, and does not represent the quantity due from the surface drainage of its basin. Hence any calculations founded on this discharge as the only available amount passing through the Plenty, and for supplying the reservoir, must be erroneous, inasmuch as it is only storage water from the ranges, and not due to recent rainfalls. We are further of opinion, that in consequence of the steep character of the basin in question, facilitating a rapid delivery of its rainfalls into the Plenty, and the Plenty discharge being always dependent upon the amount and duration of the rainfalls, and hence constantly varying, that no single measurement of discharge, at any given time, can be depended upon for a useful result.

Impressed with these views, we consider our actual measurement of discharge taken above and below the swamps, as only valuable in furnishing us by their difference, with the amount of loss from absorption and evaporation in the swamps.

With a view therefore to estimate the total amount available from the River Plenty, for the supply of the reservoir, we propose to take the rainfall on the basin supplying that part of the Plenty, as a basis, and from it make deduction for surface absorption, and evaporation loss, by swamps, &c.

The River Plenty, above the reservoir, drains a basin comprising at least sixty square miles of superficial extent, including the southern half of Mount Disappointment and contiguous ranges, it rests, with the exception of the ranges, on the slate formation, and has a close impervious surface, incapable of more than surface absorption, and the whole presents, with the exception of a few square miles, a steep basin-like form, favorable to a rapid delivery of its rainfalls into the Plenty, which is materially assisted by the non-absorbent character of the surface.

The mean rainfall upon this basin will therefore represent the total supply of water thereto, the mean annual rainfall for Melbourne, according to Archer's Statistical Table, is 30·85 inches, or thirty-one inches nearly; in the absence of experiments on the rainfall in this locality, we are compelled to accept this amount as the general rainfall, but it was perfectly evident, that over Mount Disappointment, and the surrounding ranges, there was a much greater amount of moisture derived, either from rainfall or atmospheric humidity, or both, due to its superior elevation; this was abundantly proved by the altered

character of the vegetation in the ranges, consisting of immense gum trees, 250 feet high, tree-ferns, thick scrub, and other plants, whose growth and luxuriance indicated a great amount of moisture, as also a thick vegetable soil, capable of holding a large quantity of water; but, as this increased vegetation appears to be the effect of the increased moisture, and hence, consumes as nutriment a large proportion of it, if not all, we are hence not prepared to assert that any portion of this additional moisture over Mount Disappointment swells the supply already estimated at thirty-one inches over the whole basin, which depth of rainfall we therefore adopt.

Having, therefore, taken the rainfall, we have next to estimate what proportion of it will be delivered into the Plenty, or that amount which is left and flows over, after surface absorption and evaporation.

This amount will materially depend upon the declivity of the surface, combined with the imperviousness of the soil, and the number and duration of the rainfalls. In the absence of data on this subject, in this country, we are obliged to fall back upon English data, although obtained under different conditions. In England, according to G. D. Dempsey's work on *Drainage of Districts and Lands*, in Wheale's Series, the mean annual amount evaporated from the surface of the ground, is 57·6 per cent. of the rainfall, leaving 42·4 per cent. as available for collection; assuming therefore that 58·6 is the correct per centage of evaporation for England, we propose to take such a comparative view of its conditions in England, relatively with those in the Plenty basin, as shall enable us to form a practical judgment as to the applicability of this per centage of evaporation to the Plenty basin.

This English per centage of loss of 57·6, is in a country highly favorable to evaporation, owing to its cultivated surface exposing a loose spongy soil, capable of holding a large amount of rainwater while being evaporated by the sun, also to the slightly undulating character of the country, not involving so rapid delivery of its rainfalls into the rivers, and finally from the differences of the rainfalls producing milder showers, a a greater proportion of which must necessarily be evaporated from longer exposure.

On the other hand, the basin in question is composed mostly of steep ranges and hills, presenting only a few square miles of flat land, and hence capable of delivering its surplus waters with rapidity into the Plenty; it also has, for the most part, a close impervious surface, undisturbed by agriculture, and only capable of surface absorption, which character of

soil, combined with slope, is unfavourable to loss from evaporation on its surface. The rainfalls also being mucn less frequent, and consequently heavier than in England, it is evident that under similar circumstances there would be less loss from evaporation, than if more diffused, as in England.

It is reasonable therefore to conclude, that if 57·6 per cent. of rainfall is lost by surface evaporation in England, under circumstances highly favorable to evaporation, a much smaller per centage of the rainfall will be lost when the same circumstances are very unfavorable, as in the basin in question. We should hence be justified in estimating a much less per centage of loss from evaporation in the basin of the Plenty, were it not that another important question must enter into the calculation, namely the difference of temperature, equal to ten degrees in favour of evaporation in the Plenty basin, which must act to some extent as a counterpoise against its unfavourable character, for same in other respects notwithstanding that the action on evaporation does not last nearly as long as the English temperature.

Viewing therefore the conditions of the surface drainage of England relatively with those of the basin of the Plenty, we are of opinion that the English per centage of evaporation of 57·6, if correct, embraces that of the Plenty basin, if it does not exceed it. We hence proceed in our calculations on this assumption, leaving it further on to be shown how it is borne out by the facts.

This per centage of 57·6 will therefore give 17·856 inches on 31 inches rainfall, the supply from rainfall of 31 inches and loss on same by evaporation will therefore stand thus,

Rainfall of 31 inches on basin of 60 square miles, superficial extent, or 185,856,000 square yards	160,042,666 cub. yards.
Loss due to surface absorption and evaporation over same extent, to depth of 17·856 inches	92,184,564 cub. yards.
Balance delivered into the Plenty ...	67,858,102 cub. yards.

Having thus ascertained the amount discharged into the Plenty, on this assumption, it is next necessary to determine the amount of loss entailed, by the passage of its western and eastern arms through the swamps.

The swamp on the western arm as before stated, has a superficial extent of 787·000 square yards, over which its waters are spread, thus exposing them to evaporation almost

as in still water, to obtain the loss from which, the annual depth evaporated should be multiplied into the superficial extent. We have been kindly favoured by Dr. Davey with the results of his experiments on evaporation in still water, for the three summer months, which give ·55 inch per day, equal to 42·5 inches for the three months. He has further furnished us with a proportionate evaporation for the rest of the year, as follows:—

Evaporation for the six autumnal months, equal to four-thirds of the three summer months	66·0 inches
Evaporation for the three winter months, equal to one-sixth of the three summer months, equal	8·2 inches
And adding evaporation for the three summer months	49·5 inches
We have	123·7 inches

or 10·3 feet equal depth of water evaporated annually.

As this amount was partly derived from inference and therefore not absolutely proved, however certain; we requested Dr. Davey to furnish us with such an amount as in his opinion did not admit of a doubt, and were accordingly informed that we might safely adopt nine feet.

Hence the amount evaporated in the western swamp can be obtained by multiplying the superficial extent, equal to 787,000 square yards by the depth of evaporation, or nine feet, but as 17·856 inches has already been allowed for surface evaporation over the whole basin, this amount must be deducted from the nine feet, thus leaving 7·512 to be multiplied into the area of the swamp, thus giving 1,970,648 cubic yards evaporated per annum on the western swamp.

The loss by evaporation in the swamp on the eastern arm, must be determined in a different manner, inasmuch as the water is not spread over its surface, but rather absorbed by it. This loss is accurately represented by the difference between the measured discharge above and below the swamp on the same day; the discharge of the eastern arm, near the head of the swamp, was on January 24th, 37,990 cubic yards per day, the sectional area being fourteen square feet, and mean velocity 10.18 inches per second; the discharge below the swamp, at junction of the Plenty with aqueduct, was 21,653 cubic yards per day, the sectional area being 13·2 square feet, and mean velocity 6·15 inches per second; the discharge

above the swamp therefore exceeds that below the same, by 16,337 cubic yards per day, this amount therefore fairly represents the rate of loss from evaporation for the three summer months; this spread over the area of the swamp, or 3,000,000 square yards, gives a depth of evaporation of ·1958 inches per day, or 17·82 inches for three summer months. Then by Dr. Davey's rule four-thirds of this, or 23·76 inches, will equal evaporation for six autumnal months, and one-sixth, or 2·97 inches will be evaporation for three winter months, the sum of all these give 44·55 inches for the year, but we have already allowed 17·856 inches for surface evaporation all over the basin, which must therefore be deducted, leaving 26·69 inches depth of evaporation for the year in the eastern swamp equal to 2,224,157 cubic yards.

The total amount of loss by evaporation due to the western and eastern swamps is therefore 4,194,805 cubic yards, and this deducted from the amount received into the Plenty already ascertained, or 67,858,102 cubic yards, leaves 63,663,297 cubic yards, equal to the whole amount available for collection from the River Plenty.

Having now arrived at the total effective discharge of the Plenty, above the reservoir, and as this result has been obtained on the assumption that 57·6 per cent of the rainfall, or 17·854 inches truly represents the amount of loss from surface evaporation, we now propose to test the correctness of that assumption through the medium of the results obtained therefrom. If therefore the effective discharge of the Plenty per annum, or 63,663,297 cubic yards, obtained on this assumption of the correctness of 57·6 as the per centage of evaporation, be confirmed by legitimate calculations and deductions, it may hence be inferred that the assumption of evaporation itself, or 57·6 is correct.

The eastern arm of the Plenty discharges in summer, as before stated, 11·87 cubic feet per second, which we were informed was its ordinary least discharge; the sectional area of this discharge is fourteen square feet, and mean velocity 10·18 inches per second as before obtained; having both which, we obtain the fall in two miles by Eytewein's formula, as follows:—The velocity in a second is ten-elevenths of a mean proportional between the hydraulic mean depth and the fall in two miles, hence the fall in two miles will be 8·1 inches; now the section of the eastern area at this point is rectangular, and the ordinary winter level, irrespective of floods, as pointed out by a resident on the spot, on particular inquiry, is exactly three feet above the summer level at this point, hence we

obtain the sectional area of the winter discharge, equal to forty-one square feet, and having already the fall in two miles equal to 8·1 inches, we can obtain by Eytewein's formula as above quoted, the velocity equal to 1·15 feet per second, which multiplied by the sectional area, forty-one square feet, gives 47·15 cubic feet per second as the winter discharge.

Hence having the summer and winter discharges per second, we obtain the mean discharge by taking the half of their sum, which is 29·51 cubic feet per second, or 34,467,680 cubic yards per annum, and then deducting the loss from the eastern swamp already obtained, equal to 2,224,157 cubic yards, we have 32,243,523 cubic yards as the effective mean discharge of the eastern arm per annum.

As the western arm has a larger drainage area than the eastern arm, and the loss in its swamp not so much, and as all its conditions relative to imperviousness, slope, rainfall, &c., are precisely similar, it is evident that it must have at least as great a mean discharge, if not greater; hence the combined mean discharge of both arms will be at least double that of the eastern, or 64,487,046 cubic yards, equal to the effective mean discharge of the Plenty above the reservoir, according to this calculation.

But the result previously arrived at by the application of the English per centage of evaporation of 57·6 of the rainfall, was 63,663,297 cubic yards, thus leaving only 823,749 cubic yards difference between the two calculations.

As the calculation of effective discharge for the Plenty, previously made upon the assumed correctness of 57·6 per centage of loss from evaporation is so amply confirmed by this last calculation, we adopt it as correct.

The whole effective discharge of the Plenty above reservoir, or 63,663,297 cubic yards, is therefore the amount available for collection.

But as it cannot be supposed that the whole waters of the Plenty can be diverted into the reservoir, and thus be abstracted from the settlers along its banks, we assume that at least half of its whole amount will be retained for their use, leaving the other half, or 31,831,648 cubic yards, for the supply of the reservoir.

As therefore this amount has to be conveyed by the aqueduct before mentioned, leading from the Plenty to the reservoir, it is necessary to ascertain the aqueduct's capacity of discharge, especially as some of this supply will come in the form of floods, and also the amount likely to be carried down by the Plenty during the greatest ordinary floods.

One inch rainfall in twenty-four hours is seldom exceeded, and may therefore represent the greatest ordinary flood that may be expected, and as such a rainfall may fall within twenty-four hours, or in half that period, it may be delivered into the Plenty within twenty-four hours from its commencement, owing to the steep character of its basin, the loss it is liable to sustain in its passage over the ground into the Plenty will be considerably diminished if the ground was previously saturated, as may be the case, while the loss in the swamp will be increased owing to the spreading out of the water.

Taking these circumstances into consideration, we conclude that three-fourths of the inch of rainfall may possibly reach the Plenty and be delivered in twenty-four hours at its junction with the aqueduct.

This amount is equal to 3,871,999 cubic yards in twenty-four hours, but as half of this amount must remain in the Plenty, the aqueduct will only be required to convey the other half, or 1,935,999 cubic yards in twenty-four houss.

We have measured the sectional area of the aqueduct which runs along sideling ground, so that for the most part it only requires a bank on its lower side, that on the upper side being formed by the natural slope of the hill along which it runs.

It contained 127 square feet of sectional area, and assuming it had a fall of twelve inches per mile, the mean velocity per second will be, by Eytewein's formula, ten-elevenths of a mean proportional, between the hydraulic mean depth and the fall in two miles, the hydraulic mean depth being found by dividing the sectional area, 127 square feet, by the wet contour thirty-four feet, equal to 3·73 feet or 44·76 inches, hence the square root of the product of the hydraulic mean depth 44·76 with the fall in two miles, 24 inches, will be the mean proportional, or 32·8 inches, ten-elevenths of which will be the mean velocity, or 29·8 inches per second, this velocity multiplied with the sectional area, 127 square feet, will give the discharge per second equal to 315 cubic feet, or 1,008,000 cubic yards in twenty-four hours. The aqueduct therefore with this sectional area of 127 square feet and assumed fall of 12 inches, (more than which it cannot judiciously have) is insufficient to convey its half of the amount of flood-water by 927,999 cubic yards, but as the banks of the aqueduct were not quite completed when measured, we cannot say what sectional area they will contain when finished, but of this we feel certain, that by raising the lower bank a few feet, the discharge may be doubled so as to include the required amount.

But it may be objected that the great body of the flood-water will so spread over the land and flow past that the aqueduct cannot catch its proportion of it, this may be prevented by the construction of a low dam of an inexpensive character.

We hence affirm that the aqueduct, with slight additions to its lower bank, will be capable of conveying 31,831,648 cubic yards per annum into the reservoir, with a maximum delivery in time of floods, of 1,935,999 cubic yards in twenty-four hours, being half the assumed amount discharged by the Plenty after a rainfall of one inch within twenty-four hours.

Having thus determined the total amount that can be delivered into the reservoir from the River Plenty, our next subject of inquiry is relative to that derivable from the drainage basin of the reservoir, and also from the rainfall upon its surface, both of which can be arrived at from the data already determined on.

The area of the drainage basin of reservoir is 3,000 acres, or 14,520,000 square yards, obtained from Government surveys, a rainfall of 31 inches on which will equal 12,503,333 cubic yards; then the amount due to 17·856 inches loss from surface evaporation, as before determined, must be deducted, equal to 7,201,324 cubic yards, leaving 5,302,009 cubic yards derived from surface drainage into reservoir.

The area of the reservoir itself is 1,460 acres, equal to 7,066,400 square yards; hence 31 inches rainfall on the area would equal 6,084,955 cubic yards.

Hence the different amounts of supply to the reservoir will stand thus:—

Supply derivable from the River Plenty ...	31,831,648	cubic yards.
Supply derivable from drainage area of basin of reservoir	5,302,009	do.
Supply derivable from rainfall of 31 inches on surface of reservoir	6,084,955	do.
Total in reservoir	43,218,612	cubic yards.

This amount, as delivered into the reservoir, is subject to the further loss of evaporation from its surface, already determined at 9 feet of depth for still water, which, over a surface of 7,066,400 square yards, will give 21,199,200 cube yards to be deducted from the last amount, leaving 22,019,412 cube yards in reservoir.

This supply is equal to 101½ gallons per head per day, for a population of 100,000 persons.

In thus laying before you, Mr. President and gentlemen, the results of our investigations, as also the several modes by which we have arrived at those results, we do so with much diffidence, being fully impressed with the difficulty in obtaining accurate results, under constantly varying conditions, resulting from meteorological changes, configuration and character of surface, &c. We believe that refined scientific deductions, relative to surface absorption and evaporation, however true under certain circumstances, are liable to many sources of error, where so many conflicting conditions have to be meted out, adjusted, and balanced with each other, so that each shall have a consideration consistent with scientific facts. We have not, therefore, attempted to solve this, the most important part of the problem, by such means, but viewing it more as a practical question due to this particular locality, we have, in the absence of local evidence, applied the data for surface evaporation of another country to this particular case; in the hope that its falsity or truth would be shown in the results it gave, when checked by legitimate deductions, we have shown how those results have been confirmed by the mean discharge on the eastern arm, and the other deduced therefrom. This result of mean discharge on the eastern arm was founded on accurate measurements, and most minute information as to summer and winter levels, furnished by a most intelligent farmer, in the immediate neighbourhood, who told us that the summer level was not lower than what we then saw it, and that the ordinary winter level was at the place of measurement up to the top of the banks, which exactly measured three feet above the summer level, and that the floods were over this again.

In calculating the mean discharge, we have made no allowance for increase of fall with the increase of volume, but, in ignorance of its amount, have taken it upon the known summer fall of 8 inches in two miles. We have also taken the discharge at such a point, near the head of the swamp, as to exclude at least six square miles of the drainage basin from the calculation. Taking all these circumstances into consideration, we believe our result of mean discharge is under the actual amount.

Our deduction of the mean discharge of the western arm from that of the eastern must appear obviously sound, when we consider that their conditions are precisely similar, their basins being both in the same formation, having the same soil and character, and therefore having the same per

centage of loss from evaporation; their relative discharges must hence be as their superficial extent, diminished further by their ascertained loss in the swamps.

Our measurements of discharge have been obtained by finding the mean velocities, by the following formula, "double the square root of surface velocity in inches, deducted from surface velocity, and one added, gives the velocity at bottom, the mean velocity is half the sum of top and bottom velocities."

The calculations of loss from the swamps have been taken with such minuteness as circumstances would permit, that for the western swamp has been taken as if for still water, as the water spreads over the surface. The loss on the eastern swamps was truly represented by the excess of the discharge of the eastern arm above the swamps, over that of the Plenty below the swamps on the day of measurement, as at this time the Plenty was only fed by the eastern arm, the western being wholly lost in its swamps.

We have not attempted to disprove Dr. Wilkie's calculations, by carrying investigations in the same track, as we believe by doing so we could not arrive at a truthful result, inasmuch as he bases his calculations on the summer discharge, which is only derived from storage water in the ranges, which hold the water back and prevent it being delivered more suddenly, hence if there were no ranges there would be no summer discharge, although as much water would pass down. This is the case with the Merri Creek which has 122 square miles of basin, but as it does not rise in ranges, its waters near the source are not stored, but are delivered with rapidity according as they are received, there is therefore no summer discharge, hence measurements of summer flow, unless after rainfall, only indicate the least discharge.

It only remains therefore for us to state, it was impossible to follow up Dr. Wilkie's paper through the several allegations and deductions contained therein, inasmuch as his calculations are almost wholly based on the fallacy of summer discharge, which we have shown is only due to storage in the ranges, and which therefore only forms the dregs of the actual discharge.

The amount allowed by him for floods is assumed, and therefore cannot be depended upon, more especially as there is no defined line between least flow and highest floods, the discharges coming down in variable volumes between these points, hence the inaccuracy of computing ordinary discharges and floods separately, to obtain the total discharge.

We have therefore adopted a different mode of investigation

to obtain those required results which we have now the honour of presenting to you, as representing such amounts of discharge and supply as are safely warranted by our calculations and deductions, while we are not prepared to state that they embrace the actual or total amount of same.

The following is a summary of the results of our calculations:—

Supply from Basin of River Plenty.

		Cube Yards.
Original supply by rainfall of 31 inches, on basin of 60 square miles		160,042,666
Loss from same—		
By absorption and evaporation over surface of basin, at the rate of 57·6 per cent. of rainfall ...	Cube Yards. 92,184,564	
By evaporation in swamps	4,194,804	
Making the total loss		96,379,369
Which loss deducted from the original supply by rainfall, gives the total discharge of the Plenty, per annum, above the reservoir, equal to		63,663,297
The half of this last amount being assumed as the greatest quantity that can be judiciously abstracted from the Plenty, will represent the total supply to the reservoir from the Plenty basin, equal to ...		31,831,648

Supply from Basin of Reservoir.

	Cube Yards.
Supply by rainfall of 31 inches, on basin of 3,000 acres, draining into reservoir	12,503,333
Loss on same—from absorption and evaporation over surface of basin, at the rate of 57·6 per cent. of rainfall	7,201,324
Which amount of loss, deducted from rainfall, represents the amount of drainage into reservoir from its basin, equal to	5,302,009

Supply from Rainfall on Reservoir.

	Cube Yards.
Rainfall of 31 inches, on 1,460 acres, superficial extent of reservoir, equal to	6,084,955

Total of various Supplies into Reservoir.

	Cube Yards.
Supply from basin of River Plenty	31,831,648
Do. do. reservoir	5,302,009
Do. rainfall on reservoir	6,084,955
Total of supplies in reservoir	43,218,612

Loss from evaporation over surface of water in reservoir, at the rate of nine feet deep, on asuperficial extent of 1,460 acres, equal to 21,199,200 cube yards.

Which amount of evaporation, deducted from the total of supplies in reservoir, will give the amount of water available for consumption, equal to 22,019,412 cube yards.

This total result is equivalent to 101½ gallons per head per day, for a population of 100,000 persons.

Before concluding this report, we feel it our duty to represent the deterioration of the Plenty water, owing to the passage of its western and eastern arms through the swamps, we tasted the water above and below the swamps, in the former case it was perfectly clear and refreshing, and free from impurities, as coming from the rock, while below the swamps it had a flat unpleasent taste, and was not nearly so pure as that above the swamps; this deterioration of the water might have been avoided if the site of the reservoir had been chosen above the swamps, on the eastern arm, while the western arm might have been left to supply the settlers, the reservoir could be formed by the construction of a short dam, at the junction of Jack's Creek with the eastern arm, which would store nearly all the catch of the eastern arm above the swamps, equal to fifteen square miles, thus giving nearly 17,000,000 cubic yards, with a loss from evaporation on about half a square mile of reservoir surface, equal to 4,600,000 cubic yards, leaving 12,400,000 cubic yards, equal to fifty-seven gallons per head of pure delicious water, fresh from the rock, available for the supply of Melbourne, instead of 22,000,000 cubic yards of indifferent water, as in the present reservoir.

As it is now too late to adopt this scheme (and thereby avoid the loss by the evaporation of 21,000,000 cubic yards in the present reservoir), we are of opinion that the eastern and western arms of the Plenty should be diverted from the swamps through which they pass, by means of open cuts, carried round same, the water would thereby be conveyed into the reservoir as pure as from the ranges, and the loss from the swamps, or 4,194,805 cubic yards being hence avoided, would be added to the reservoir supply, making in all 26,214,217 cubic yards, equal to 121 gallons per head per day.

We have now had the honour of submitting our views on this important inquiry, and in conclusion beg to express a hope that the limited materials, in the form of data, local

evidence, &c., from which we had to draw our conclusions and results, will be borne in mind, in forming an estimate of the mode in which we have treated this important subject.

We have the honor to be, Mr. President and Gentlemen, your very obedient humble servants,

F. C. Christy, C.E.
F. Acheson, C.E.

Art. XVI.—*On the Influence of the Physical Character of a Country on the Climate; being a Letter to the President, by* R. Brough Smyth, Esq., *Mining Engineer.*

Museum of Natural History, Melbourne.
March 8, 1855.

Sir,

Considerable attention being directed, at this time, to the capabilities of the rivers in the colony of Victoria, in respect of water supply, I have the honour to submit, for your perusal, the following observations:—

I am aware that attempts have been made, very recently, to calculate the probable annual discharge of water from a river by computing the drainage area, the rainfall, the evaporation, &c., but as there are other counteragents, equally worthy of attention, and bearing directly upon the results of such calculations, I propose to offer some remarks, that may, perhaps, arrest the attention of those immediately interested.

My present object is more particularly to inquire how far the physical character, and the geological structure of a country, extend their influence over peculiarities of climate and in what manner they serve to determine the hydrographical features. This connexion, Sir, which I shall seek to establish and enlarge, is, as you are aware, not new to those who have made the science of Geology their study. As I design to apply it, in a practical sense, to the solution of some questions which have been lately brought before the Philosophical Society, I feel that I shall best accomplish this purpose, by divesting it entirely of purely local interest. This increases the difficulties of the subject, which I approach with some reluctance, aware of the many and great sources of error to which all such inquiries are liable; and

yet, if conducted with ordinary care, and with impartiality, it cannot fail to place in a new and important point of view, many questions of great public interest; of greater interest here, than in other climates where the hydrographical features are of a different character; and whatever errors may occur, they will be out of all proportion to the useful results of such an inquiry.

Geological Formations of Victoria.—This country may be described as consisting of vast beds of sandstones, shale, and clay slate, members of the Primary Fossiliferous series. These beds are variously contorted, and dipping at angles of 30°, 40°, 60°, and 70°, and they are sometimes vertical. Mr. Selwyn,* the Government Geologist, estimates the thickness of these deposits at 30,000 feet or more, and this is probably very near the truth. These sandstones and clay slates have been upheaved by Plutonic rocks, which are found to occupy comparatively large areas. The hills in the Ovens district, Mount Alexander, Mount William, and the hills in the north-eastern parts of the province, are granitic, and excellently illustrate the character of such rocks. Then, there are plains of basalt, sometimes of great extent, where the subordinate rocks are entirely hidden, or only appear in isolated hills of some height, or where denuding causes have removed the upper basaltic formation.

Basalt is also found filling the valleys, near the rivers, and in such cases the streams have cut a passage between the former rock and the clay slate; as may be seen in some parts of the river Yarra, in the rivers Coliban and Campaspie, at the Deep Creek near Mount Greenock, and in many of the streams in the western part of the Province.

A considerable part of the Great Dividing Range is composed of igneous rocks, and they in like manner form isolated hills in many localities, which sometimes attain a considerable altitude—as Larnè Baramul, Mount Boninyong, Mount

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* "The great longitudinal extent of the auriferous deposits is a fact, not difficult of explanation, when we regard what appears to be the general geological structure of the country, which, in making a section from east to west, or from the Australian Alps to the Pyrenees and Grampians, is found to consist of a succession of steep hills, ranges, and gulleys, composed of an enormous thickness (30,000 feet, or more) of upheaved and contorted palæozoic and older strata, intercepted by great masses of granitic and other apparently non-auriferous plutonic rocks, with extensive intervening tracts of recent igneous or volcanic rocks, forming plains and table lands, also non-auriferous, but, in all probability, often resting on and concealing auriferous deposits."—*See page* 10, *Geological Surveyor's Report*, 1854.

Warreneep, Mount Greenock, Mount Macedon, &c. Of other formations—the Carboniferous and the Tertiary, it may be proper to mention that the former is found to extend over very limited areas, while the latter is constantly met with, but rarely of considerable thickness.

The secondary series is supposed to be wholly wanting, but our knowledge of the geology of the province is insufficient to determine this with accuracy. I beg to ask inspection of section No. 1, which is intended to show the structure of the country, and the general arrangement of the strata. How far it tends to explain the phenomenon of river beds without rivers, and the absence of the numerous springs which are found in countries of a different character, I shall presently proceed to explain.

General Configuration.—The physical character of the country is low and level.

The Great Dividing Range which separates the tributaries of the river Murray from the waters flowing southward, is elevated about two thousand feet above the level of the sea. There are hills much higher than the general elevation of the chain—as Mount William, 5,300 feet or more, in the western district, and in the north-eastern part of the country the Australian Alps reach a height of 7,000 feet above the sea, according to the observations of Mr. Tyers and others who have surveyed the district.

There are a number of spurs at right angles to the Great Range, the culminating points of which are from 2,000 to 3,000 feet in height. These minor spurs are flanked by steep narrow ranges, often densely timbered with stringy bark (*Eucalyptus Fabrorum*), or covered with dense scrub.

When we examine the vast extent of country lying between the Dividing Range and the river Murray, we notice, as a remarkable feature, the inconsiderable height of the ranges, and the continual recurrence of intervening plains, many of which are twenty and thirty miles in extent. The Wimmera district, towards the west, is very low and flat. From the Glenelg northwards there is a succession of sandy plains, covered with Mallee scrub (*Eucalyptus dumosa*), which alone must exercise a powerful influence on our climate.

The country south of the Dividing Range is broken into hills, ranging from 500 to 1,500 feet in height. And, again, there are plains of large areas, differing but slightly from those to the northward. This is the proper place to remark that the country south and east of the Great Range

contains a greater number of streams than that to the north, and, probably the waters flowing southward have an aggregate volume equal to many times that of the southern tributaries of the Murray.

From this rapid glance at the main features of the country, we are led to infer that very little practical importance can attach to meteorological observations limited to one locality. For example, the fall of rain in Melbourne will be greater than that in the northern part of the Wimmera district. Again, that of the Ovens district must be different to either of these—judging alone from the local peculiarities of configuration. Indeed it would be difficult to calculate the rainfall in any given district, even to a remote approximation, by data resting on observations in a place situated as Melbourne is.

As the above may seem to be arbitrary opinions, I will at once advert to the more obvious causes which influence the climate of a country.

It is impossible, under existing circumstances, to confine my observations to Victoria, since we are possessed of only a small amount of information respecting climatic variations in inland districts. Authenticated cases of variation in other countries, however, can teach us important lessons.

*Causes of Differences in Climate.** — The climate of a country, its coldness or warmth, the degree of moisture or dryness in the atmosphere, is not dependent altogether upon its distance from the equator, but is modified, nay, indeed, sometimes entirely altered, by other lands in its neighbourhood, by its insular position, or by its proximity to seas of great depth. Again, its general configuration—its systems of hills and valleys, produce local effects not less appreciable than the former.

There are lands in the southern latitudes, in the same parallel as the north of Scotland, where the line of perpetual snow descends to the level of the sea; and, as an illustration of the changes produced by local causes, I may mention the great difference between the climate of Victoria and that of the northern part of New Zealand.†

The peculiarities in the climate of Australia are owing

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* Those who may be desirous to obtain the best information on this subject would do well to consult Lyell's "Principles of Geology," chap. vii. p. 92, also Humboldt on Isothermal Lines, there quoted.

† During the summer months, in New Zealand, the temperature is generally about 70°, and I am not aware that it is ever above 80°. In winter it varies from 42° to 52°.

rather to distinct characters of geological structure and configuration than to unmodified solar influence. First, with regard to configuration: let us suppose a complete change in the whole of the features of the country. If, instead of the Great Dividing Range, there were a chain of mountains extending from Cape Otway northwards for 500 or 700 miles, with an altitude of 14,000 or 16,000 feet, which is far above the line of perpetual snow in these latitudes, as they are circumstanced, we should have corresponding alterations in the course and extent of the rivers, some of which might, in the discharge of their waters, rival the lesser streams of Russia or America. The lower currents of air, flowing from the south, highly charged with moisture, would be condensed as they approached the snow-clad heights, and copious showers of rain would fall at all seasons of the year. Hot winds would be unknown. In winter we should have ice on the rivers very near the level of the sea. The results of such a change in the features of the country would extend to the neighbouring islands, and the snowy height of Mount Erebus, with the vast extent of land lying around the Antarctic circle might not be unaffected.*

But let us suppose another change, equally great, of a different character. I have previously described this country as being low and level, with extensive plains and chains of hills of inconsiderable height. By a modification of the formative causes producing such results, the whole extent of Victoria might have been raised gradually and evenly to the present elevation of its plains. Instead of the contorted shales and sandstones, and the protruding Plutonic rocks, we we might have had a series of perfectly horizontal strata.† Instead of the gulleys and ranges, the diversity of hill and plain, the result of this would be a level tract of sandy waste, without one hill to break the dreary monotony of the outline. The present rivers and creeks would be replaced by swamps and lakes of fresh and brackish, and salt water, fully exposed to the intense solar heat of these latitudes. Vegetation not

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* It is, perhaps, necessary to state, that the effect here spoken of would tend to moderate the intense cold of the Antartic regions. Very high lands, in Australia, would radiate solar heat over an immense space, while high lands much farther south would lower the temperature very sensibly.

† This is not a violent supposition. The Silurian strata in Russia are invariably horizontal. Sir R. I. Murchison has ably explained the geological structure of that vast country, and he particularly mentions the recurrence of *plains of palæozoic formations*—the strata being horizontal.—See Murchison's Siluria, pp. 16, 19, 322, 323.

very dissimilar to that which marks the era of the later Coal formation would flourish luxuriantly, affording sustenance to tribes of animals suited to such conditions of life.

It is far from my present purpose to enter largely into this branch of the subject; it is only necessary to show how materially configuration regulates the intensity of heat and cold; how a chain of lofty hills may serve as reservoirs of congealed waters, whence rivers are supplied unceasingly; how low level plains, by favouring evaporation, and yet preventing the formation of rainclouds over their surface, either become arid and desolate wastes, or swampy jungles. This is not only true of continents and large islands, but in lesser proportion is known to influence districts of small area. A lofty hill sometimes makes a perceptible difference in the rainfall in its neighbourhood; a plain of a few miles in extent is sufficient to give a distinctive character to the climate within its limits. A difference in the superficial features of a country will not, however, always explain vicissitudes of climate over limited areas. The rainfall, more especially, is largely affected by the direction of the winds. I am anxious to show the superiority of not one particular cause, but rather to recognise them all. Perhaps the best argument I can use is to refer briefly to the almost inexplicable variations of the rainfall in places very near to each other.

Instances of Variations in the Rainfall.—The mean fall of rain for the whole of England is stated to be thirty-six inches, but near London there is a fall of twenty-three inches, and in Cumberland sixty.* The unequal fall of rain in Scotland is also remarkable; the average in Glasgow is rather more than twenty-nine inches, in Edinburgh it is twenty-three; and this within a distance of forty miles! In the south-west of Ireland the rainfall is forty-two inches, in Armagh it is about twenty-two.

The inequalities of climate being so palpably influenced by such a variety of causes, we ought to reject every calculation that is not based on actual observations within the locality, to which such observations have reference.

The Mean Annual Temperature also presents great differences in different localities, and in countries within the same parallels of latitude. As an instance of this I may mention the mean temperature of Switzerland, viz., 47°, which

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* Sir Charles Lyell mentions the following variations:—"At Whitehaven, in Cumberland, there fell, in 1849, 32 inches; while the quantity of rain in Borrowdale, near Keswick, (only 15 miles to the westward,) was no less than 142

singularly contrasts with its geographical position, and is undoubtedly very much owing to the superficial features of the country.

Evaporation.—The amount of evaporation from lakes and running streams has not received that attention from men of science to which it is justly entitled, and the consequence is an exaggerated estimate of the amount of evaporation in warm climates, amongst those whose attention has not been specially directed to its consideration. It may not be out of place here to mention briefly the conditions which are favourable to evaporation, and to show how clearly dependent is this force upon all other atmospheric phenomena, being in itself merely the result of secondary causes, governed by the geographical position of the country, and its configuration.

In the first place, it must be remembered that evaporation is dependent on three very uncertain conditions of the atmosphere—namely, the degree of saturation, the temperature, and the force of the winds. The climate of Victoria, during the summer months, is very warm—the thermometer not unfrequently indicating 100° in the shade—and if the wind is from the north, the dew point oftentimes falls below 35°.* Such a condition of the atmosphere is most favourable to

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inches![a] In like manner, in India, Colonel Sykes found, by observations made in 1847 and 1848, that in places situated between 17° and 18° N. lat., on a line drawn across the western Ghauts, in the Deccan, the fall of rain varied from 21 to 219 inches.[b] The average in Bengal is probably below 80 inches, yet Dr. G. Hooker witnessed at Churraponjee, in 1850, a fall of 30 inches in 24 hours; and in the same place, during a residence of six months (from June to November), a fall of 530 inches!"—*Principles of Geology*, p. 200. Sir R. I. Murchison, in his address at the anniversary meeting of the Royal Geographical Society, 24th May, 1852, also gives some curious information on this point. He says, "My friend, Professor Oldham, in writing to me from Churra Poonjee, in the Khassya Hills, north of Calcutta, states that the rainfall is there about 600 inches, or 8½ fathoms per annum; 550 inches of which descend in the six rainy months, commencing in May; and that in one day he measured a fall of 25·5 inches." . . . . "The annual amount of rain at Alexandria stands in contrast to that which I have just mentioned as occurring in places in India, the quantity at the former being only 7½ inches. This quantity, indeed, might be expected to be small, from our knowledge of the fact that, three or four degrees to the south, the country is nearly rainless."

* These figures, however startling, are not overstated. On Sunday, December 11th, 1854, at 11½ A.M., the thermometer indicated a temperature of 99°, and the dew-point fell to 35°; the wind, during that state of the atmosphere, blowing in strong gusts from the north. On December 13th, at 4 P.M., the

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[a] Miller, Phil. Trans. 1851, p. 155. [b] Phil. Trans. 1850, p. 354.

evaporation; but it happens that north winds are the exceptional and not the prevailing winds. When we have south winds, or winds west or east of south, the dew point is commonly much higher; and though the daily mean temperature may yet be very high, the conditions for rapid evaporation do not exist. Unquestionably, as compared with many other climates, evaporation is very rapid in this country; but I am justified in stating, that the amount of evaporation during the seven months commencing in April bears no proportion to the rapid evaporation during the other five months; and this is owing to the low prevailing temperature, and the moist condition of the atmosphere. During the rainy season the daily mean temperature is very low, the air is laden with moisture, and, excepting a few chance days, when a dry north wind prevails, evaporation progresses very slowly. With a temperature of 57° the dew-point is not unfrequently 48° or 49°, and even higher; and should the wind come from the west or south-west it sometimes happens that we have an atmosphere almost completely saturated. With the temperature and dew point as above stated, the daily evaporation is seldom more than 8-100 of an inch per diem, under a stiff breeze. In the absence of figures, derived from daily observations, extending over a period of twelve months, I cannot even venture to hint at the amount of evaporation in Melbourne; and how much more should we hesitate to express any opinion as to the amount of evaporation in far distant places, under often changing conditions? It is impossible, I repeat, to calculate the amount of evaporation from tables of temperatures during the several months of the year, unless we are also informed as to the daily hygrometric condition of the atmosphere, and the force of the wind; and even with that information, the result would be the mere expression of an opinion, valueless as a matter of fact. I am the more anxious to enforce these facts, as, unless they are borne in mind, much valuable time may be mispent in calculations and discussions, not merely useless but dangerous to the true interests of science.

Effects of Different Geological Formations.—I will now

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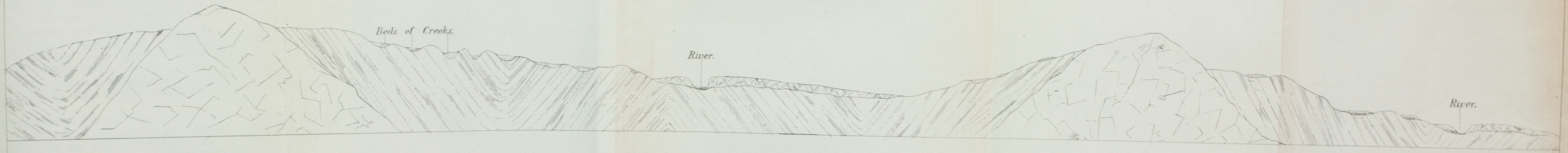
wind had changed to south, and the thermometer fell to 65°, while the dew-point was 46°. On January 29th of this year, at 11½ A.M. the thermometer stood at 109°, and the dew-point at 41°, the wind being from the north; and in the afternoon of that day, at 4 o'clock, the thermometer indicated a temperature of 78°, the dew-point being 58°; the wind, meanwhile, having changed to south. I have drawn these facts from the Meteorological Journal of Dr. Davey, the Assay Master.

No. 1.

SKETCH OF A SECTION, SHEWING THE GENERAL CHARACTER OF THE GEOLOGICAL FORMATIONS AND THEIR USUAL RELATIVE POSITIONS.

Victoria, ——— Australia.



Granite.

Sandstone & Clay slate. *(Paleozoic)*

Basalt.

Tertiary & Alluvium.

Surveyor Generals Office, Melbourne, June. 1855.

Drawn by R. Brough Smyth Mining Engineer.

J Jones Lith.

proceed to consider in what manner geological formations may take the place of other physical characters in modifying a climate. These act, either by storing water in subterranean lakes, and in loose sandy strata, or by permitting the storm waters to flow rapidly and at once to the river basins, and thence to the sea. Under the former of these conditions we have permanent and abundant springs and well filled river basins; under the latter, feeble springs, generally arid summers, and a deficiency of river currents.

In this case I shall confine my illustrations as much as possible to Victoria; but, in attributing all due importance to geological structure, we must not forget that it is only one of the causes formerly adverted to—not the most important in the extent of its results—and chiefly worthy of especial notice, because it immediately concerns man in his daily wants and pursuits.

It is necessary for me to refer you again to section No. 1, which very fairly exhibits the geology of the greater part of Victoria. It will be seen on reference thereto how the rivers of this country are supplied with water.

The paleozoic rocks upheaved by the granite are highly inclined or vertical. The newer tertiary formations. and alluvium constantly occur. These are shown in the section, reposing in the valleys, forming the beds of numerous creeks, and separated by steep narrow ranges of clay slate and sandstone.

It is manifest that the storm waters, received on a surface of this kind, must be quickly conveyed to the river beds, since the higher lands are almost destitute of soil. I have seen miles of schistose rocks and granite, where the tops and sides of the ridges presented at every turn the outcrop of the rocks.

The numerous gulleys are, however, almost invariably covered with a thin stratum of porous sandy clay and gravel, with a pretty strong clay substratum.

Even if the ridges of paleozoic rocks were less steep, and better clad with soil, it is evident if they absorbed much of the rainfall, that it would be conveyed to great depths beneath the surface, and could not again appear as springs except under very peculiar circumstances.

The granite rocks may retain small supplies of water, which slowly percolating through the close seams of such a rock, will reappear in small patches of swamp or in springs, but these latter are seldom found of large volume.

Streams of water which are seen to issue from granite rocks, are usually traceable to some swamp or morass in the

neighbourhood, and on the surface, as caves or great hollows are rare in the crystalline rocks, and when they do occur, are of small dimensions.

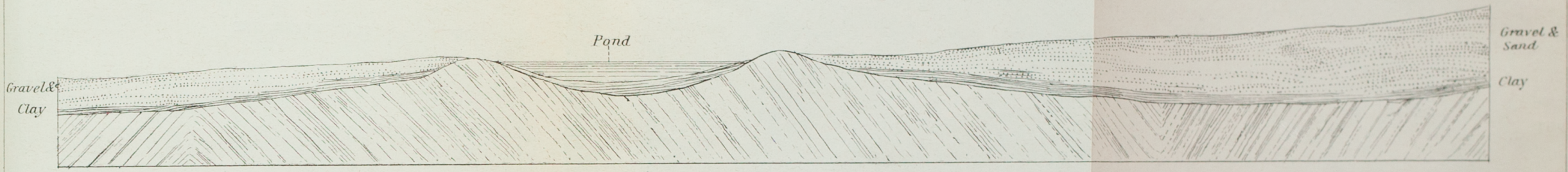
The strata which absorb the largest per centage of storm waters, in proportion to their extent, are clearly those beds of sand and quartz gravel which form the beds of the creeks. Perhaps the most satisfactory evidence of this is to be found in the gold fields, where there are comparatively extensive valleys of quartz gravel, sand, and clay. In winter these form the beds of deep and rapid streams, and it is not unusual at that season to walk across a deep dry gulley one day, and the next to find a current of water some yards in width. The water ceases to flow however very soon after the rain has passed, and in some places, the labors of the gold miner, even in winter, are occasionally obstructed by the absence of a sufficient current. In summer the course of these streams is marked by a succession of small ponds and sedgy swamps; and it is worthy of remark that the ponds are not strictly in the alluvium, but appear where the tilted edges of the slate form a barrier, transverse to the valley, as shown in section No. 2. A question arises here of some importance to the present inquiry,—what can be offered in explanation of the seeming anomoly, the impermeability of the titled clay-slate rocks? All our experience in this colony shows that there are natural basins in these rocks, where very little of the contained water is absorbed. I think the lithological character of these strata is sufficient to explain the fact. These ponds are found where the beds are composed of fine clay and mud, and are so little altered, that they weather into a plastic mass; and when this fills the interstices and joints of the rocks, or covers the extent of the basin to the depth of three or four, or several feet, it will effectually prevent the percolation of water. This of course can only take place where the clay and mud is deposited slowly, and cannot be held to render these rocks impermeable where they rise in steep ridges.

In sinking a shaft through the tertiary beds shown in section No. 2, water is invariably found within a few feet of the subordinate rock. We have abundant proof, however, that the supply is limited, and that strictly according to the extent of the basin, which is sufficient to show that very little water is derived from the neighbouring ridges. If we examine a number of shafts in one of these valleys, commencing at the top of a gulley and going gradually downwards, we observe that the "wet sinking" is always towards the outlet of the basin; and though the surface, even there, may be dry, and

N° 2

Longitudinal Section of a Valley shewing the position of the

ALLUVIUM IN RELATION TO THE SANDSTONE & CLAYSLATE ROCKS.



Inclined Sandstone & Clay slate
(Paleozoic)

Alluvium

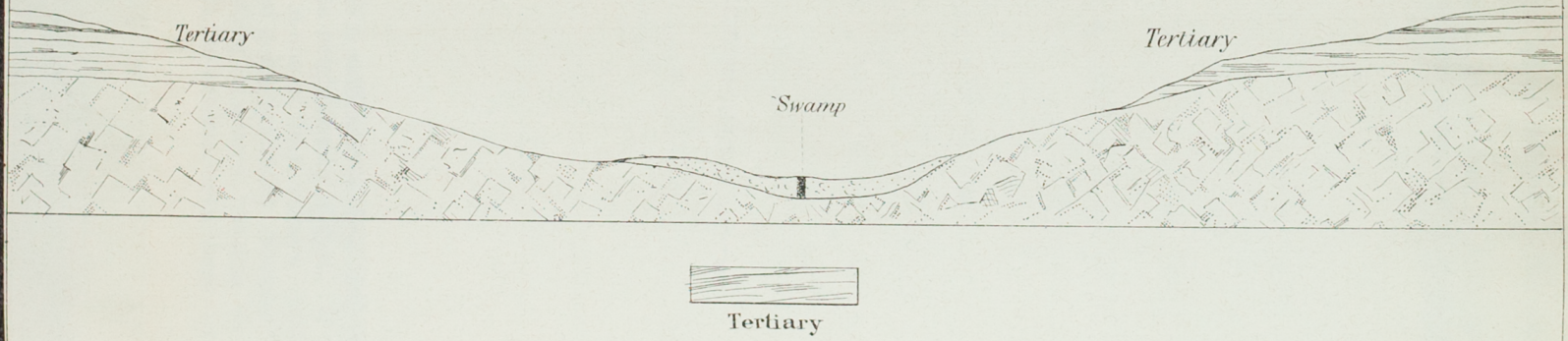
Lithographed at the Surveyor Generals Office by J. Jones.

Melbourne, June, 1855.

Drawn by R. Brough Smyth Mining Engineer.

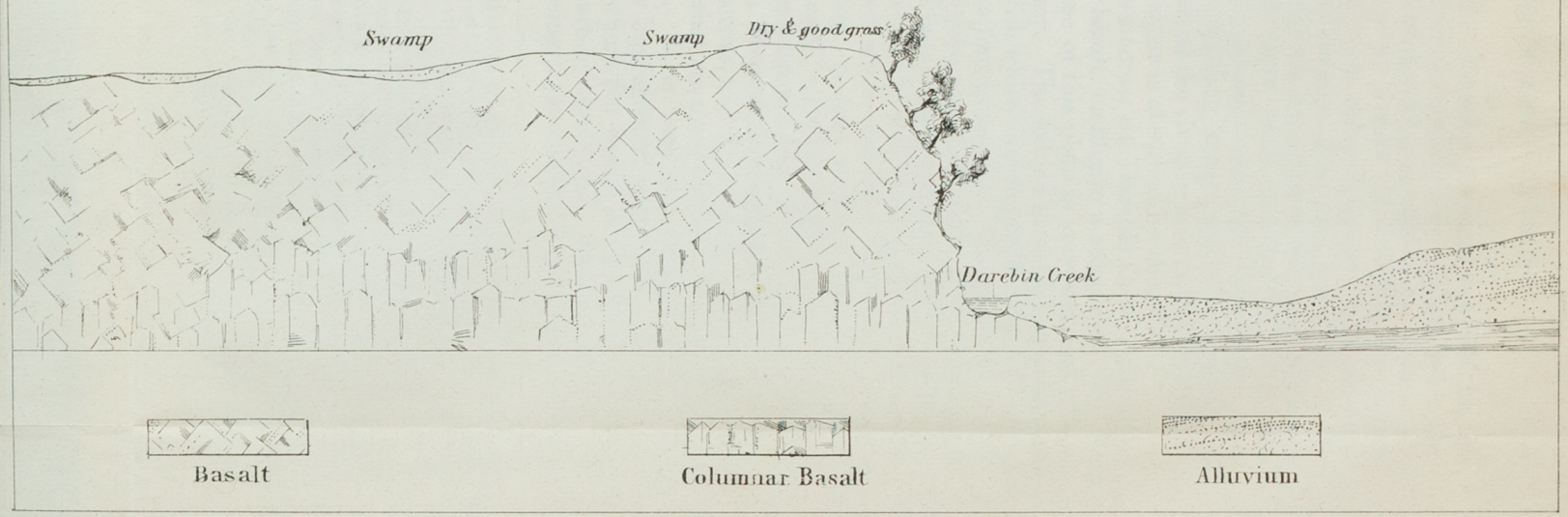
Nº 4

SECTION ACROSS THE BASALTIC HILLS NEAR MELBOURNE



Nº 3

SECTION ACROSS THE DAREBIN CREEK



Lithographed at the Surveyor Generals Office Melbourne June 1855
BY J. JONES.

Surveyed & Drawn by R Brough Smyth . Mining Engineer

the grass withered, the quantity of water retained in the gravel and sand is frequently considerable. This water undoubtedly flows very slowly and gradually to the rivers.

With regard to the storm waters which fall on the plains, it is necessary to mention, in the first instance, that the rainfall will be less, on the average, than that received on the higher lands, even under the most favourable circumstances, unless the plain be of very small area indeed. Notwithstanding, a considerable quantity must fall during the year, on plains south of the Dividing Range, and it is necessary to inquire whether it reaches the river beds in the usual manner, or is wholly evaporated, or is absorbed by the soil.

Section No. 3, drawn across the Darebin Creek, represents the edge of a plain of basalt, ending in a steep cliff. In the rainy season the surface of this plain is very wet, and indeed might be called a swamp. The soil is a loose black mould, with a substratum of yellowish white clay; the depth of which varies, being usually from one foot to ten feet. On examining one of the quarries in that neighbourhood, I observed that the spaces between the blocks of basalt were completely filled with this clay, which in short, is due to the decomposition of the rock, and is exactly what we might expect. Taking this circumstance into consideration, we may conclude that a very small per centage of the rainfall will permeate such a stratum, and that its loss may be accounted for by evaporation, and by decomposition.* When we consider the character of the rock, its close compact structure, and the absence of large hollows, we perceive at once, that we must not look there for strong or permanent springs. It is true that feeble springs issue from this rock, highly impregnated with iron, but they are usually in situations where the basalt is decayed, or where the shrinkage cracks are numerous and close together.† In addition to this rock being unfavourable to absorption, it has the

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* A relatively small proportion of the rainfall is always decomposed, and the elements form plants—and, of course, that cannot again appear as water. It would be curious to estimate the probable quantity thus lost, in the borders of a reedy swamp, for instance, for comparison; but in an inquiry of this kind it is only necessary to consider what is lost by absorption, evaporation, &c.

† This may seem at variance with the experience of many:—for instance, the high ranges whence the Yarra River takes its rise, are composed of basaltic and other igneous rocks; and many small streams descend from these heights, which are permanent, so far as they flow over impervious strata. This may be due to the dense vegetation covering these hills, which, in a state of semi-decomposition, will retain moisture. I have had some conversations with Mr. Hodgkinson, the District Surveyor, and with Mr. Daintree, the associate of Mr. Selwyn in the geological survey, and the information which those gentlemen have so generously afforded, has led me to take this view of the question.

property of carrying what water it does absorb directly downwards; when it reaches the next formation, which, in this country, is most often inclined clay slate, it will penetrate to great depths, and ultimately reach the sea, at much lower levels than the river basins, because, when the clay-slate rocks are secured from the action of the weather, they are decidedly permeable.

To show how water is retained on the surface of basaltic rocks, permit me to direct your attention to section No. 4, which is drawn across the basaltic hills near Melbourne. The hollow shown in the section is a swamp in winter, receiving the drainage water of the adjacent hills, where there are thin tertiary beds. The trend of the land is toward the Saltwater River, but there is no true water course. The owner of the land has sunk a pit about four feet in depth, and he has obtained a small supply of water during this summer. It is by no means of good quality. This section shows the usual manner in which swamps occur on basaltic flats.

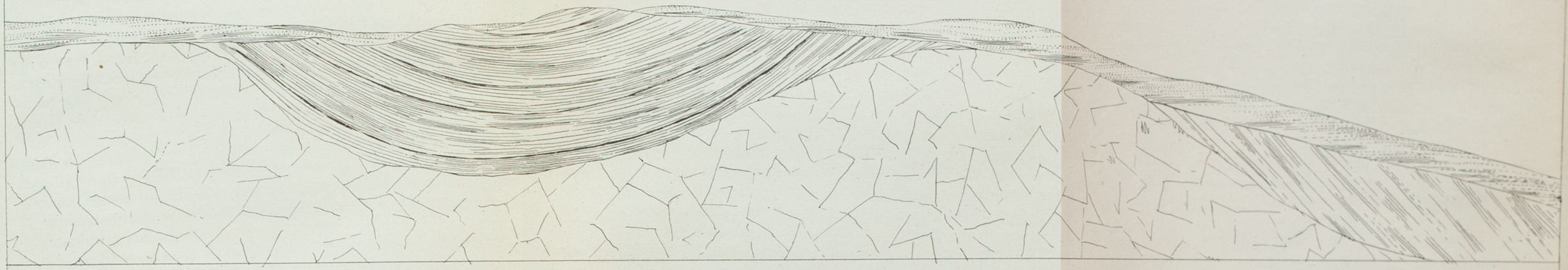
In thus treating generally of the geological formations of this country I have omitted a description of merely exceptional cases, such as crateriform hills, &c., &c. My object has been to shew that the thin tertiary beds are the principal reservoirs in this country. And according to the elevation of the land, and the prevalence of schistose rocks, so are these numerous and more extensive.

Now instead of thirty feet of tertiary gravel and sand resting on paleozoic rocks, let us suppose a basin to exist in the district of Mount Alexander, somewhat similar to that shown in section No. 5. The granite in this instance is covered with a vast thickness of sandstones, shales, and beds of coal. The dip and arrangement of the strata are favourable to the absorption and retention of water. The beds are disturbed by faults, which permit the water to descend with rapidity, as the fissures thus created are filled with sand or sandy clay. The rain, instead of falling on steep and naked ranges, whence it rapidly flows to the river basins, is received on well bosomed hills, and in gently sloping valleys. The alluvium of these valleys, like that resting on the clay slate rocks, becomes saturated, and the water, percolating through to the sandstone beds, is thence conveyed through innumerable fissures and faults till it meets with an impermeable bed of clay.

In strata, such as is shown in the section, it is not unusual to meet with two or more distinct sheets of water. At the edge of the granite, it will be seen several beds are basseting

No. 5.

SECTION ILLUSTRATIVE OF CARBONIFEROUS STRATA



Granite

Schist

Coal Measures

Tertiary & Alluvium

Lithographed at the Surveyor General's Office by J. Jones

Drawn by R. Brough Smyth, Mining Engineer

Melbourne June 1855

out, each of them being an inlet for the waters falling on the surface. A retentive bed of clay may stop the descent of the water, at a depth of ten feet, as, for example, beneath the alluvium. When this basin is full, and overflows, it is received in a lower basin, the retentive stratum of which may be at a depth of 100 feet, and thus downwards. This is not an ideal section, at variance with truth, but illustrates what is met with in practice.* Let us not, however, view this as an isolated case. Let us assume that the older stratified rocks and granite of this country were covered with paleozoic Coal and Secondary strata throughout large areas; can we estimate too extravagantly the changes of climate, of soil, of river currents, which would be the result? Instead of the rains being collected in shallow basins, exposed to the rays of a subtropical sun, or absorbed by thin beds of gravel, which can retain only small quantities of water, we should have vast reservoirs at various depths, the waters of which, continually reappearing as springs, would render the climate moist and cool; and the rivers, fed from inexhaustible sources, would suffer little change, even during the heats of summer. The evaporation from the streams would be scarcely more than at present; for though the volume of water might be largely increased, it is an ascertained fact, that the depth of a river increases in far greater proportion than the width, thus presenting a proportionably smaller area exposed to atmospheric influences.

I may here cite a few instances, proving in some degree the extent of subterranean lakes. Mr. Mulot was engaged ten years in conducting the boring through the beds of the Paris basin, and he penetrated to a depth of 1,800 feet. This magnificent enterprise was most successful. The water rises to a height of ninety-eight feet above the surface, and discharges at the rate of 600 gallons per minute.

At Southampton, at Chiswick, in various parts of England and France, the chalk has been reached by boring or sinking, and the supply of water thus obtained, though enormous, must bear no proportion to that flowing from such reservoirs to the sea. In Africa, the natives are said to find water at great depths in the deserts. In nearly all other countries

* At the Monkwearmouth Colliery, in the County of Durham, a spring was struck at a depth of 300 feet, after passing through the magnesian limestone, and the lower new red sandstone. It poured in water at the rate of 3,000 gallons per minute. At a depth of 1,000 feet a fresh spring was found, also very considerable, which obliged the proprietors to erect additional machinery, to clear the workings of water. Instances of this kind might be multiplied.

instances are recorded of such reservoirs having been reached. I may also mention the numerous springs in the coal districts in England, which pour their waters from every hill side, and are seldom affected by the seasons.

River Currents.—On comparing the rivers of this country, one with another, the vast superiority of the Gipps Land District, in this respect, cannot fail to be noticed. A recent report* by Mr. Surveyor Dawson, a keen and intelligent observer, has particular reference to this. He justly attributes the superiority, in a great measure, to the very high hills which form the northern part of the great Dividing Range. Amongst them may be mentioned the Munyang Mountains, the Coborras, Mount Kosciusko, and other higher hills to the westward, as the Boyong Ranges. These exercise a powerful influence on the climate of Gipps Land, many of them being covered with snow during a great part of the year. The hills near the sources of the Wonnangatta, Wonnangaratta, and the Moroka, tributaries of the River Mitchell, are very high, and are sometimes covered with snow in November. Near the head of the Moroka, Mount Valentia rises to a height of 4,000 feet, Mount Wellington 5,000 feet, and Mount Castle 5,000 feet.

The Snowy River, which has its embouchure within the boundaries of this province, is said to be a splendid stream. It drains an enormous extent of country—probably nearly 5,000 square miles.

The McAlister, and the Latrobe, which unite and flow into Lake Wellington,—the Nicholson, the Mitchell, and the Tambo, flowing into Lake King,—are also very large streams, navigable for a considerable distance inland.

Dr. Ferdinand Mueller,† who has recently visited the north-eastern mountains, describes them very much in accordance with the officers who have been employed in surveying that part of the country. Their geological character is not dissimilar to other parts of the colony. Granite and auriferous schistose rocks abound, and there-

* Mr. Dawson's Report to the Surveyor-General, on the Gipps Land Country, was published in the daily newspapers, and, I believe, may be found in the printed papers of the Legislative Council. It well repays a perusal.

† Dr. Mueller, whose high scientific attainments, and intense application to his arduous labours, have gained him the esteem and admiration of all who can appreciate learning, has evinced his enterprise by climbing these rugged heights; but I think he is under some misapprehension when he asserts that he is the first explorer. The whole district, I am informed, has been traversed, and the greater portion surveyed, except that bordering on the Snowy River to the eastward. Dr. Mueller's enterprise, and noble exertions, are not, however, at all the less praiseworthy.

fore the almost constant supply of water is due to the height alone, and not to the contour, nor to the prevalence of porous strata.

A somewhat remarkable feature of the river currents of this country is their very tortuous course. The rivers Loddon and Campaspie, flowing northwards to the Murray, are striking illustrations of this. The Yarra, the Saltwater River, the Barwon, and the Moorabool, are scarcely less capricious in their windings. This applies also to the creeks, except those flowing from considerable elevations, such as some of the tributaries of the Saltwater River, near Mount Macedon, the creeks near Mount Alexander, &c.

This peculiarity is explained by the configuration of the country. When a current traverses low plains, with a very slight fall, the force of the water is necessarily reduced, and is insufficient to remove the rocks that occur in its course. When sand or mud accumulates, or any slight obstruction occurs, the stream is diverted, and it gradually wears away the opposite bank. The larger rivers, in this way, not unfrequently cut through the narrow peninsulas, and leave small islands, which mark the boundaries of ancient channels. These can be seen on the Saltwater River, the Loddon, the Coliban, and various others.

The natural course of running water is proved to be not straight, but in lines of curves of great radius. My observations have led me to the conclusion that the radii of these curves is in a ratio with the volume and velocity of the stream. The calculations and experiments on which this belief are founded are not sufficiently advanced to permit me to enter into details.*

The most considerable of the rivers of Victoria, flowing northward is the Goulbourn. It drains very high lands, and its extreme length is also very great. It is said to be navigable for flat bottomed boats, nearly as far as the town of Seymour.

The rivers on the north-western parts of the province, which flow to the Murray, traverse a great extent of sandy waste, and present remarkable features. The river Avon, after receiving the waters of the Richardson, flows nearly due north to Lake Buloke, which is said to have no outlet. The Avoca enters Lake Bael Bael. The Wimmera is lost

* In England I have seen hundreds of pounds wasted from inattention to this. The fact that water does not flow in straight lines is well known to every engineer, but I think the method of determining the radii of curves for artificial channels has never been sufficiently investigated.

in the wild sandy country, between 35° and 36° south latitude, very much of which, for some miles east and west, is covered with scrub. It first enters Lake Hindmarsh, the waters of which flow northward, by an outlet creek, sixteen miles in length, to Lake Albacuyta, and there are a number of swamps north of the latter, which appear to derive their waters from the same source. The Yarrambiack Creek, after draining a considerable extent of country, flows into Lake Corong. Of course it is impossible to explain these facts, unless we have more accurate information than is at present available; judging from analagous effects, however, it is improbable that the evaporation from Lakes Hindmarsh and Albacuyta is sufficient to dissipate the waters of such a river as the Wimmera, or that the Avoca has its only outlet in Lake Bael Bael. South of the Murray the country is covered with a great of thickness of sand and pervious strata, and it is therefore highly probable that these rivers have subterranean channels: as to whether they are received into the Murray, or penetrate to depths greatly beyond its level, I am not prepared to offer an opinion. It is not, however, a problem very difficult to solve; observations in the locality would soon settle the point. I believe the absence of summer streams is not always to be explained, by quoting the rapid evaporation of storm waters. Subterranean drainage carries off no inconsiderable portion of the waters of such rivers as the Yarra, the Mackenzie, &c., and it may sometimes happen that a stream is dry in summer from this cause alone. The rocks in this country vary in their lithological character, and though we are justified in assuming, that, under ordinary circumstances they will not absorb much of the rainfall, they may become recipients of millions of cubic feet of water, where a river happens to flow over coarse sandstones, rent and fissured, and cut through by dykes. In creeks, or in gently flowing streams, the bed is usually a stratum of clay, whereas the winter flood of a river may have a velocity sufficient to strip the bed completely of mud and clay, and expose the pervious stratum beneath.

I might adduce many instances of extreme variations in the summer currents of rivers, where the drainage areas are nearly equal, but where the geological formations are different; but as it is not possible, in that manner, to educe general laws useful in practice, these instances need not be recorded. It is only by careful observations and inquiry that we can meet the difficulties of each case; each, invariably, presenting local peculiarities that must be studied on the spot, and not referred to distant places for comparison.

Practical Applications: Reservoirs.—In surveying the drainage area of a river, with a view to ascertain the actual available supply, it is absolutely necessary to have the most accurate information respecting the geological formations; not only to determine the amount of surface-water which may reach the river basin, but to learn what portion of the rainfall is retained in the strata, which can also ultimately flow thither. In this country, if the hills are very high, they will retain a certain proportion of water, which may either flow to the river basin, or descend to great depths.

We have immense floods in winter, and almost dry beds in summer; and hence it is exceedingly difficult to compute the mean annual discharge of any river. It would, manifestly, be wrong to compute the mean annual discharge, by taking the lowest summer level and the highest winter level: the latter might represent the condition of the river for one day only, and the former for 200 days out of the 365.

The only discharge on which a calculation can be founded for practical purposes, is the lowest, or rather the average summer level. It is upon this supply that we must depend, most certainly, if the requirement is for sanitary purposes; for it would be manifestly highly injurious to the health of a town to store surface-water, in a climate such as this, in an open reservoir. Let me express myself more clearly on a point which is all-important in Australia. The summer current of the river must be carefully measured, and it ought to bear a certain proportion to the consumption. For example, if the consumption is 100,000 gallons per diem, it would be well to have a *permanent* stream, equal at least to 25,000 gallons; but in this proportion I would rather indicate a principle than assert a fact. If the surface-water is collected where basaltic rocks abound, the supply of running water should be proportionably greater, because the soil, in such localities, is charged with decomposing vegetable matter. If, on the contrary, sandstone rocks abound, a smaller supply of pure water might suffice to render the drainage water innoxious.

When I attach so much importance to the summer stream, I do not mean to assert that it is impossible to collect the winter rains, or that such a method is always objectionable. It is only objectionable when it is largely in excess of the permanent current. Setting aside all difficulties attending the formation of an impervious reservoir, it is exceedingly hazardous to rely upon winter rains. The climate of Victoria is very peculiar. For many months in the year we have

rainy days when very little rain falls. For one, two, or three days, we have heavy showers, when all the water-courses are flooded. In connexion with the afore-mentioned geological formations this is an important fact. If we have 20 or 30 showery days, and only ·100 of an inch of rain falls in each day, we may rest assured that a meagre portion of this will ever reach the rivers. The soil absorbs it rapidly, and it is as rapidly evaporated, though not appreciable to the eye. Then, if we have four or five days of heavy rain, with an average of three inches per diem, this will quickly flow to the river basins, and produce floods. We are led into error and confusion if we estimate the fall of rain, in a district, at so many feet per annum, without any reference to geology, or to peculiarities of climate. We ought rather to estimate the fall of rain on those days when it is sufficient to flood the creeks. If the annual fall of rain in Victoria were concentrated in five or six days, I can easily believe that it would nearly all reach the rivers; but, fortunately, our climate is differently arranged.

In a country like this it is not unprofitable to consider every fact, which bears even remotely on the permanence of the supply, or the purity of the water.

In constructing reservoirs in the inland districts, for supplying a town where the population is not considerable, in situations where no permanent stream is sufficiently near, it will be necessary to resort to filtration on a large scale. This will remove the grosser impurities, but it cannot be denied that this fails to remove animalculæ and chemical impurities. When supplied to persons who are able to resort to those appliances for purification, taught by the chemist, it becomes comparatively pure, but to the mass of the population it is positively injurious. Whatever can be done to remedy such an evil ought to be done, at any pecuniary sacrifice, for the results consequent on its removal cannot be overstated in their importance. It would be quite possible to extend these remarks, to apply them in detail to the rivers in our immediate neighbourhood, but this, I fear, would be merely useless. I have endeavoured, with how many short-comings I am only too conscious, to indicate to what extent we are indebted to scientific observations, and to principles founded on the unerring precepts of sciences in all inquiries of this kind, and to show how utterly indefensible it would be to rely upon either what is commonly called "experience," or "practical knowledge."

Science, our helper in the humblest as in the greatest

things, cannot be despised with impunity; and, whether we consider the effects of its teachings in the abstract, or as applied to practical labours, we are equally persuaded of its high importance.

It will soon be necessary to supply the towns near the gold-fields with water sufficient for machinery and sanitary purposes, and therefore minute observations in meteorology in all these localities, have become of greater importance than ever.* If commenced at once they may be the means of preventing endless disputes, and possibly saving a large expenditure of public money.

I have the honour to be, Sir,

Your most obedient, humble servant,

R. Brough Smyth.

Capt. Clarke, R.E., M.L.C.,
President of the Philosophical Society of Victoria,
&c. &c. &c.

Art. XVII.—*A Description of Fossil Animalculæ in Primitive Rocks from the Upper Yarra District. By* William Blandowski, Esq.

I have the honour to lay before the members of the Philosophical Society, a few specimens of rocks, containing minute fossil remains, forwarded to the Society through me, by Fred. Acheson, Esq.; having been discovered by that gentleman, on the left bank of Anderson's Creek, about a mile from the junction of that stream with the Yarra Yarra.

These specimens were procured from a vein about fifteen inches in thickness, inclosed between layers of hard blue slate, inclined at an angle of 75 degrees southward. They are chiefly composed of coarse porous quartz, but those specimens procured from larger blocks, or at a greater depth, are dense and of a blue colour. In this state the rock assumes a crystalline appearance, much resembling marble, and is dotted with numerous specks of iron pyrites, which, becoming decomposed by the action of the atmosphere, result in the

* Since writing the above, I learn that Captain Clarke is about to establish a system of Meteorological Observations, at the various Survey Offices throughout the Colony, in connexion with the Observatory already established in Melbourne. This is a step in the right direction; such observations can be conducted inexpensively, and with much accuracy, without any large sacrifice of time on the part of the observers.

formation of iron oxyde. The sulphite, too, decomposing the lime of the encrinites and corals, destroys the colour and crystalline appearance of the rock. Thus rendered porous, it obtains a rough surface, and a brownish colour (imparted to it by the oxide of iron). The multitudes of very minute fossil remains which this rock contains, and which have been alluded to above, with a few exceptions, can be detected only by the aid of a powerful glass. Those which are of sufficient magnitude to be perceived by the naked eye are inhabitants of the deeper parts of the ocean; and, judging from their diminutive proportions, I should suppose them to belong to the most primary era of organic life—the harbingers of those higher orders of existences which, after the lapse of countless millions of ages, now people the altered surface of our planet.

The forms which I have been able to recognise in these remains are:—

1. *Cyatocrinites* (probably) *pinnatus*, (*vide* diagram.) This species, whose habitat is the tropical seas, belongs to the family *Trochyten (Echinodermata)*. The animal manifestly attached itself to rocks and other solid bodies at a vast depth, beyond the influence of the turbulent waves which agitate the surface of the ocean. Not possessing the full power of locomotion, but capable only of swaying to and fro, lashed, as it were, to the rock, they depended on procuring prey by the motion of their long fringed arms, which also served as an additional means of security in retaining their immutable position. None of the remains under consideration are so perfectly distinct as to enable me to discover any signs of the caput, or of the roots of these remarkable animals. The trunk consists of a long jointed column, only small portions of which, about a quarter of an inch in length, are at all distinguishable. A hollow channel or central orifice passes longitudinally through this column; both the upper and lower surfaces of the joints around it are replete with dichotomous ribs.

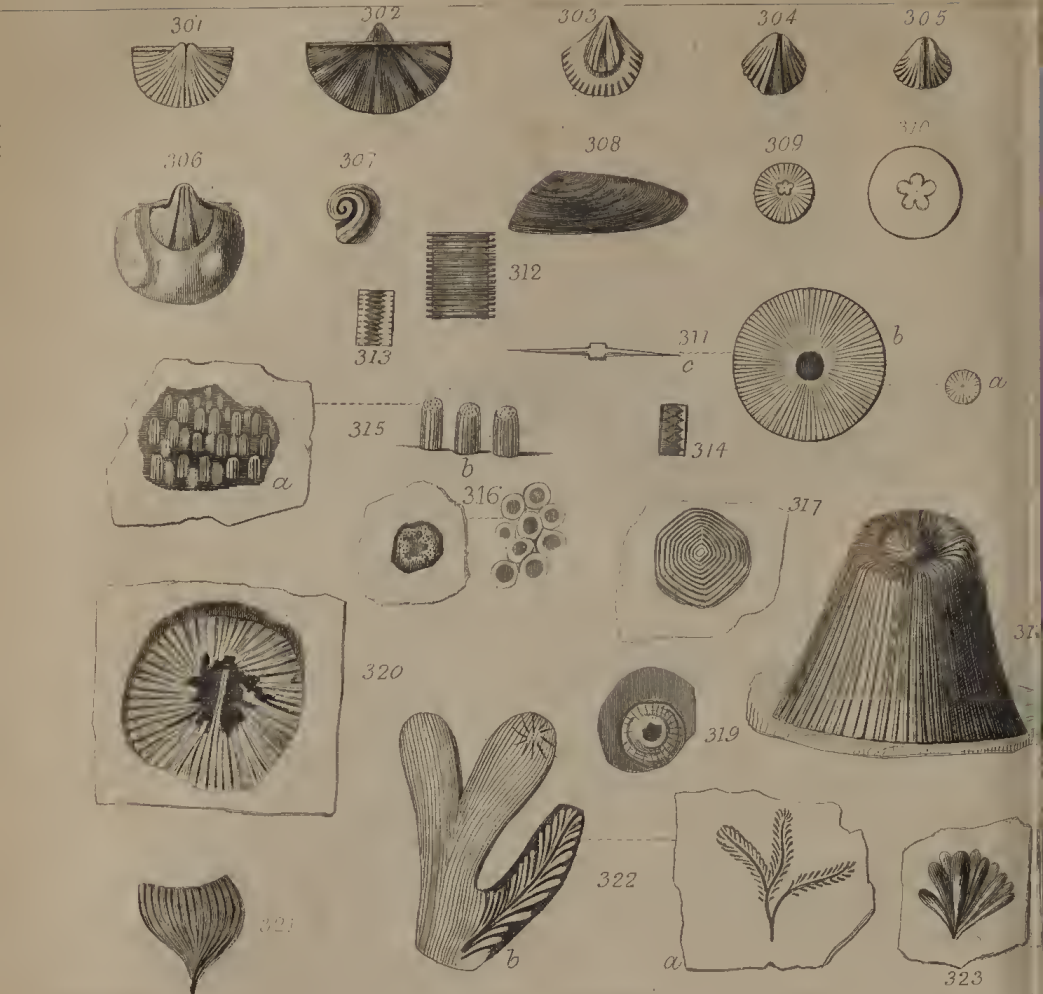
The rarity of the encrinite in the modern seas is a circumstance of a very remarkable nature; when we consider the immense number of fossil species already discovered, and find whole masses of rock consisting of their relignia. At an earlier period of the existence of our planet, when a high degree of temperature favoured the propagation of beings, of which only rare analogies now obtain in the tropics, encrinites swarmed the ocean, and were the original cause of the deposition of the calcareous rocks.

FOSSILS OF VICTORIA

SILURIAN FORMATION

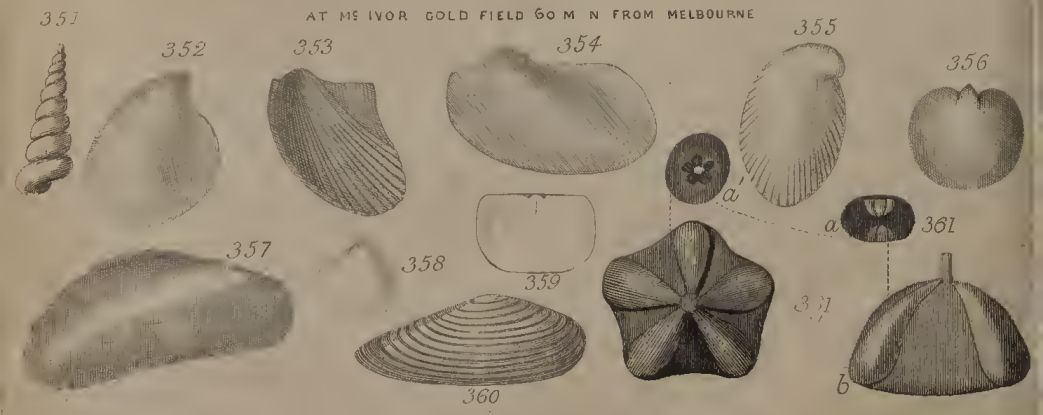
VI. CALCIFEROUS SANDSTONE ROCK

AT ANDERSONS CREEK GOLD FIELD 20 MILES E FROM MELBOURNE



VI. QUARTZOSE SANDSTONE

AT MC IVOR GOLD FIELD 60 M N FROM MELBOURNE



W. B. Landsborough Australian.

Engraved by Rodaway & Son.

Bryozoa or Moss Corals.—These creatures occupy a higher position in the organic scale than the simpler-formed polypes with which they were formerly associated. Many hundreds of microscopic fossil species have been discovered within the last few years. The shells, or outer tunics, enter into the composition of chalk beds, compact limestone, and sea sand, as well as the sands of the deserts. These fossil forms, many species of which are still living, are mostly microscopic; those which are visible resemble minute grains. Those which at present engage our attention belong to the *genus Celaria*, and, I am of opinion, are closely allied to *C. Loricata.*

A second species of *Bryozoa*, which, however, I am unable to distinguish, also occurs in company with those mentioned. This variety forms rounded columns, about an eighth of an inch in length, with fine ribs or threads passing longitudinally downwards.

The few forms which I have been able to detect in the specimens forwarded to me lead me to the conclusion, that the strata in which they occur belong either to the uppermost cambrian or to the lowest silurian formation. It is highly remarkable that these rocks are found in an auriferous locality, and in the immediate vicinity of our earliest gold-field.

In conclusion, I may beg to observe, that fossil remains of the oldest Neptunic era may be obtained in abundance at certain spots in an extensive line of district eastward of Melbourne, and which would well repay the trouble of the enterprising man who would institute a search for them.

Subsequently to writing the above, I have discovered by a minute examination, in the rocks referred to, the forms exhibited in the plate. The palæontological description of these will form the subject of another paper.

Art. XVIII.—*Practical Remarks on Hydrometry. By* Clement Hodgkinson, Esq. C. E.

The contradictory results of the hydrometrical observations made by different persons in this colony, had induced me, some weeks ago, to give notice of my intention to submit to this society a paper embodying my objections to the mode of guaging streams often adopted by the engineering profession, and the result of my own experience in these operations.

Recent domestic afflictions had, however, caused me totally

to forget my previously expressed intention of contributing such a paper; so that, having ascertained, at the last moment, that the paper was announced for this meeting, I must crave the indulgence of the members now present for submitting to them the following cursory and hastily written remarks.

As questions of moment, in reference to water-power or supply, are often dependent upon the accuracy with which steam gaugings are conducted, I have been surprised at the unsatisfactory manner in which experienced engineers have frequently, in Great Britain, performed the simple operation of measuring the discharge of a stream or river.

Little discrimination, for instance, has been displayed in the selection of the site for determining the sectional area of a stream, notwithstanding that the surface velocity was derived from observations on a float; yet, when a float was employed, no near approach to accuracy could be attained, unless not only the sectional areas but also the cross profiles, differed so little within the longitudinal limits assigned to the observations on the float as to have caused the stream to approximate closely thereabouts to that condition aptly termed by French writers "*Regime uniforme.*" The size, and sometimes even the specific gravity of the float have also been considered of immaterial importance, and the mean velocity has been almost universally deduced from Dubuat's Formula, which makes, when expressed in inches, the bottom velocity equal to the square of the difference between the square root of the surface velocity and unity, and the mean velocity equal to half the sum of this bottom velocity and the surface velocity.

I protest against the employment of this formula, which, when applied to very small or very great surface velocities, is productive of grave errors.

I am, however, aware, that this formula of Dubuat's (originally promulgated near the close of the last century), has been adopted without question as to its accuracy in various standard English publications; for instance, the hydrometrical table contained in the last edition of the *Encyclopædia Britannica* is based thereupon, also, the table in Stevenson's *Hydrometry*, as well as those given in several engineering manuals. But on the continent of Europe, where the hydraulic investigations since the publication of Dubuat's "*Principes d' Hydrauliques*" have been most extensively and accurately conducted, on profound scientific principles, Dubuat's formula has been superseded by more accurate although less simple rules.

There is little doubt but that Dubuat, with that yearning for mathematical generalisations so characteristic of the French philosophers, must, to a certain extent, have ignored the results of experiment, in order to obtain the neat expression in the formula in question.

De Prony's Rule, as expressed in metres, is

$$x = \left(\frac{2{\cdot}372 + v}{3{\cdot}153 + v}\right);$$

or,

$$\left(\frac{7{\cdot}71 + v}{10{\cdot}25 + v}\right) v, \text{ when expressed in English feet.}$$

It is far more accurate that Dubuat's, having been tested by an immense number of observations, made not only in small artificial channels, but also on the largest and deepest European rivers, with the aid of tachometers adapted for the correct registration of velocities, at any depths below the surface.

For a surface velocity of fifteen English inches per second, De Prony's rule gives the same *mean* velocity as Dubuat's formula; but for surface velocities much less or much greater than fifteen inches per second, the diversity between the results is very great.

For example, I will suppose that the observed surface velocity of a stream is one inch per second. Then we should have,

Corresponding mean velocity		According to Dubuat's formula, applied to English inches,	0·50 inches.
Ditto	ditto	According to De Prony,	0·75 inches.

If, therefore, the sectional area of the imaginary stream be such, that when multiplied by the mean velocity, as determined from Dubuat's formula, it would represent a water supply for 100,000 persons, the more correct mean velocity, according to De Prony, would represent a water supply for 150,000 persons! Whilst De Prony's formula thus gives greater comparative mean velocities than Dubuat's, for surface velocities less than fifteen inches per second, it gives less mean velocities than Dubuat's for surface velocities exceeding fifteen inches per second.

The ratio of the mean velocity to the surface velocity being mainly influenced by the rate of such velocity, and being altogether independent of the depth or sectional area, I cannot but think that tabulated quantities, for practical

use, might have originally been more readily derived from the actual experiments than from empirical formulæ.

Some years ago I computed for English inches, for my own use, the following short table of ratios between surface and mean velocities, and which ratios give results conformable to De Prony's Rule.

Surface Velocities in Inches.		Multipliers for Mean Velocities.
1 to 3	... ...	0·75
3 to 8	... ...	0·76
8 to 13	... ...	0·77
13 to 18	... ...	0·78
18 to 25	... ...	0·79
25 to 35	... ...	0·80
35 to 45	... ...	0·81
45 to 55	... ...	0·82
55 to 65	... ...	0·83
65 to 76	... ...	0·84
76 to 87	... ...	0·85
87 to 100	... ...	0·86

When I have employed a float for determining surface velocities, I have taken the following precautions to ensure due accuracy. Having chosen for the measurement of the discharge, a site where the apparent regularity of the width of the stream, and general aspect of its banks, led me to suppose that no very material variation of the cross profiles of the bed of the stream would occur for a distance of fifty feet, I then departed from the usual mode of procedure inasmuch as I took *eight* or *ten* cross sections within the longitudinal extent of fifty feet.

If these cross sections and corresponding sectional areas did not differ to any great extent, they afforded a proof that the site was favourable for the correct determination of the discharge of the stream. The mean of the sectional areas was then taken as the mean transverse sectional area, corresponding to the assumed longitudinal distance of fifty feet, which distance was defined by parallel transverse lines perpendicular to the axis of stream, and indicated on the banks of the stream by ranging rods.

Bearing in mind the fact that a large floating body, through not participating in the irregular intimate motion of the particles of water of a running stream, would move with somewhat greater velocity than a minute fragment of the same body, I employed a very small float, consisting of a very diminutive vial, so weighted with sand as to cause it to float along when corked, with the top of the cork flush with the surface of the water.

The float was then thrown into the main thread of the stream, a few yards above the upper line, and the number of seconds observed to elapse in its passage from the upper to the lower line. The number of seconds consumed in this passage was observed about a dozen times, and that observation which gave the least number of seconds was obviously adopted as the most correct. With this number of seconds, the distance of fifty feet, and the table, the mean velocity corresponding to the portion of stream under examination was computed.

Then this mean velocity, multiplied by the *mean sectional area of the stream within the specified limits*, gave the discharge of the stream much more accurately than if one cross section only had been measured.

If the observer be provided with Brunning's, Woltman's, or any other accurate tachometer, then Mr. Stevenson's mode of determining the discharge of a river, by subdividing the cross section into a number of trapezoids, and determining the mean velocities for each of them as multipliers for the corresponding areas thereof, is a very correct one. I have followed this method when I formerly had occasion to determine the quantities of water that passed to, and through, opposite a town on a tidal estuary, during the flow and ebb of a tide that rose and fell a certain number of feet and inches at a tide-guage. I tried Pitot's tube during the operation, but found it unsatisfactory for great velocities; also the hydrometrical pendulum, which was not adapted for determining the great variations that occurred in the surface velocity; for when the ball of the latter instrument worked well for moderate velocities, it proved quite unmanageable for high velocities, whilst for low velocities it showed no appreciable deflexion from the vertical. I subsequently constructed a hydrometrical pendulum, furnished with four balls of gradually increasing specific gravity, so that whilst the lightest ball was very sensible to the influence of very small surface velocities, the heaviest was not too violently acted upon by the highest velocities that occurred in ordinary rivers.

The co-efficients for each ball were respectively determined by direct experiment; and the numbers affixed to the balls and corresponding coefficients were registered on the instrument.

Then, in the measurement of the surface velocity of a stream, that ball was employed which proved on trial to be the best adapted for the measurement of such velocity, by

causing the thread attached to the ball to form with the vertical an angle of from twenty to thirty degrees.

Denoting by θ the coefficient corresponding to that ball, and by δ the observed angle, the surface velocity was found by the ordinary formula $X = \theta \sqrt{\delta}$.

I have known cases where engineers, with a mere knowledge of the fall per mile in a river, and the sectional area, taken at one point only, have, from such very insufficient data, endeavoured to compute the discharge. For the usual formula, by Eytelwein, from which have been derived the tabulated quantities in Beardmore's Hydraulic Tables, and other works, is only applicable under the following conditions, which never occur unless in carefully constructed artificial channels: viz.

Unchanging sectional area.

Unchanging wetted perimeter.

If on the length corresponding to the fall, a great number of cross sections had been taken, so as to admit of a *mean sectional area*, and *mean perimeter of the water contour* being deduced therefrom, then of course a rough approximation to the discharge could have been computed.

Many instances might be cited of disappointment attendant on the completion of hydraulic works, owing to the preliminary calculations having been made on erroneous principles. For instance, when the works for conducting water into Edinburgh were completed, the quantity of water delivered was only one-sixth of the quantity estimated by the designer of the work, although he himself acknowledged that the work had been executed in strict accordance with his plans.

Art. XIX.—*On the Primary Upheaval of the Land round Melbourne, and the recent Origin of the Gypsum or Sulphate of Lime in the great swamp between Batman's and Emerald Hills, Flemington, Williamstown, and Melbourne, illustrated by a large number of Specimens from that Locality. By* William Blandowski, Esq.

The land which now constitutes the colony of Victoria owes its origin to the same mighty convulsion which upheaved the Australian Alps. Beginning where those mountains cross the latitude of 37°, eruption followed eruption in rapid succession, the plutonic agency constantly advancing westward,

and with but little deviation from that parallel, thus forming the different granite ranges throughout the country. This mighty power, however, ultimately exhausted, a long period of comparative quiesence ensued, and the mud which was hitherto in mechanical combination with the agitated waters, was deposited on the bed of the now placid ocean; thus was formed the clay-slate strata of the present era. By some internal causes submarine volcanoes again broke forth through the crust of the earth; the first eruption of this nature was apparently in about longitude 145°, and after successively extending the sphere of its action over the whole country, finally became extinguished beneath the ocean. The last of these convulsions, there is reason to surmise, occurred near Mount Benson, in South Australia.

The most important result of this volcanie period, is the existence of the basalt, or as some English geologists term it, the trap formation. The rocks of this class are eomposed principally of felspar and hornblende, or augite, and when in a molten state, bear in many respects, a near resemblance to glass: hence the reason of the great frequency of the trap formation on our extensive plains, which were rapidly covered with the overflowing liquid mass. An enormous volume of steam generated in the interior of the globe, together with the constituent gases resulting from the actual decomposition of the sea water, were discharged through the crater, greatly assisting the volcanic power in ejecting the burning matter. Assuming the degree of heat necessary to liquify the basalt, to be identical with that of glass, we might thereby estimate the depth at which the former becomes fluid, in other words, ascertain the thickness of the solid crust of the earth. Now 2650° Fahr. (the temperature at which glass liquifies) would require, (according to the annexed table, exhibiting the increased heat at the several depths named, and which are the more to be depended upon, as they are the results of actual borings taken for the purpose, by the Governments of Prussia and the Canton of Geneva, Switzerland), a depth of 105,000 feet, or twenty miles nearly. This depth, which at first sight appears truly enormous, would scarcely equal the thickness of a coat of varnish on a globe of three feet in diameter.*

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* The Austrian Government caused twenty-seven borings to be made for the same purpose. No practical results could be expected from these deep and expensive sinkings; they were undertaken for the pure love of science, and afford an example which must excite shame in us for refusing to make a few borings in order to discover the real value of our coalfields.

Borings through Limestone strata at Rudersdorf, near Berlin, in Jan., 1833. Surface 180 feet above the sea level.

DEPTH. E. Feet.	TEMP. FAHR. Degrees.
104	27·03
209	27·82
313	34·45
417	36·57
521	37·63
626	39·22
730	42·14
834	45·05
918	48·23

Borings at Geneva. Surface, 299 feet above level of Geneva Lake.

DEPTH. Feet.	TEMP. FAHR. Degrees.
31	22·26
104	23·32
156	24·38
208	25·18
260	26·50
313	27·83
365	28·89
417	30·21
460	31·00
521	32·33
573	33·39
626	34·72
	35·78
709	36·57

Showing a gradual increase of temperature with the depth, being about two and a half degrees every hundred feet.

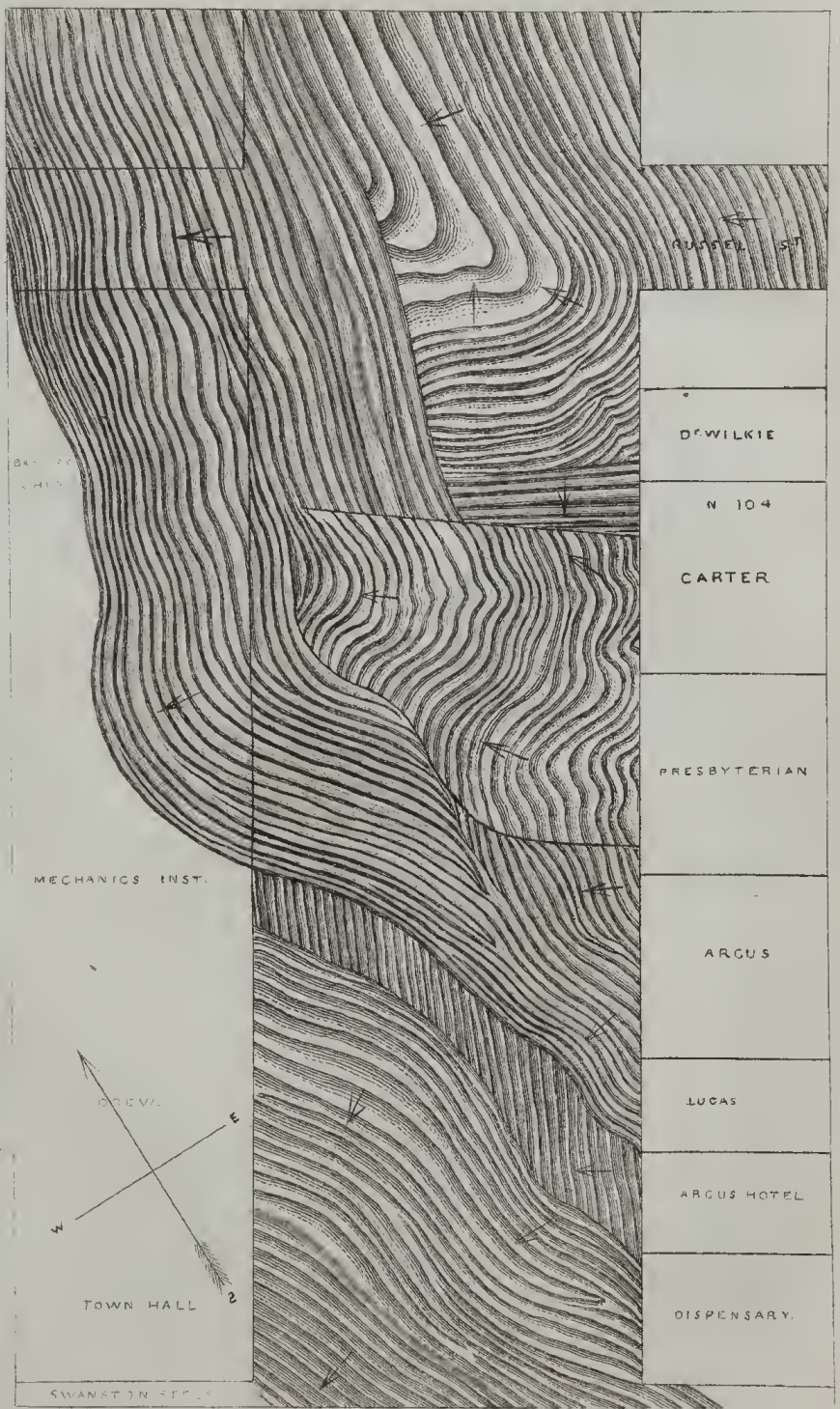
The decomposition of the basaltic rocks produces the rich alluvial soil which covers so large a portion of the country, and renders its agricultural capabilities of so striking a nature. as induced its earliest explorer (Major Mitchell) to bestow upon it the appropriate title of Australia Felix.

The strata eastward round the City of Melbourne consists of micaceous clay slate, frequently of a siliceous or quartzy nature, surrounded and partly overlapped by the trap; they are very strongly compressed, the evidences of which are especially manifest before the Argus Office, in Collins Street, between Swanston and Russell Streets, to the westward, and which seems to be the point at which the great volcanic power, the cause of this compression, was suddenly checked; and in Gisbourne Street, connecting the reservoir with the waterworks, eastwards. (*Vide plate.*) The gases and fluids confined within the earth, forcing their way with irresistable power through the present great swamp included between the localities named in the commencement of this paper, and which then composed the bed of the ocean, moved bodily eastward the whole strata (all more or less in a plastic state), but owing to the tremendous hydraulic pressure exerted by the superincumbent water, the movement received a violent check, resulting in a powerful compression of the strata on the spot where the Rev. A. Morison's and Dr. Wilkie's houses now stand. The

GEOLOGICAL SKETCHES OF VICTORIA

COMPRESSED STRATA IN COLLINS STREET

MELBOURNE.



motion of the strata being thus arrested, the volcanic power expended itself in upheaving them from the bed of the ocean, the higher portions of land eastward of Elizabeth Street, being thus elevated above its surface. The lava however, not yet cooled, and still subjected to a considerable hydraulic pressure (which is manifest from the occurrence of porous discoloured basalt, below the dense black basalt which is found cropping out from the surface in so many localities,) spread itself over the country by means of the numerous gulleys which already existed beneath the waters of the ocean. One of these ancient channels leads from Flemington to Collingwood, between the Botanical Gardens and Government Paddock, thence beneath Prince's Bridge, towards Emerald Hill. The two varieties of basalt just mentioned, owe their specific characters either to hydraulic pressure in the manner described above, or otherwise are derived from the union of silica and calcium in a molten state; when these ingredients are combined in quantities such that the ratio of the oxygen of the calcium, to the silica be as 1·2, or even 1·3, to unity, a crystalline mass is produced, *resembling dense basalt;* but when the proportion is 1·4, a *porous* matter similar to amygdaloidal basalt is obtained.

Such is my explanation of the primary cause of existence of the extensive basalt formation in the country north and west of Melbourne, and between Flemington and Williamstown. The same theory applies to the whole district between Melbourne and Mount Macedon, as also between Mount Alexander and the new Sydney Road; in fact I was led to form this theory while travelling from Mount Gambier on the frontier of South Australia, where the proofs of its correctness are strongest, becoming fainter as the traveller progresses eastward.

The crater, though still buried beneath the ocean, retained its tremendous power for a considerable time, but was finally overpowered and extinguished by the agitated sea, which pouring into the crater, and becoming comparatively calm, deposited in it a vast quantity of mud and sea weed; ultimately a placid lake as it were, rested on the bosom of the extinct volcano, and innumerable multitudes of shell fish found in it a secure harbour in which they could, without molestation, propagate their species. The Yarra and Salt Water Rivers however, again disturb the tranquility of the scene. Each directing its course to the lake, their united current sweeping over it, eventually filled up the crater with alluvial deposit, and entirely buried the marine animals which had found a

quiet retreat in its waters, being cut off from the sea by an effectual barrier, formed on one side by the waste materials carried down by those streams, and on the other by an accumulation of sand caused by the meeting of the marine current with that of the Yarra. The vast bar or bank of sand (now called by us Sandridge) which was thus created, appears to have been formed by separate deposits acting at long intervals, and not as many suppose, by the drift sands of the coast being carried inland, although the rising of the coast must undoubtedly have materially assisted in the formation of this remarkable sand-belt.

The shells and other organic substances in the crater, buried under the clay in the manner above described, by the process of decomposition, evolved nitrogen, hydrogen, oxygen, and sulphur; the accidental combinations of which resulted in the following chemical changes:—

1. The combination of sulphur with hydrogen.
2. The formation of hydro-sulphate of ammonia, by the combination of nitrogen, hydrogen, and sulphur. Some hydrogen being subsequently expelled, sulphate was formed, and at length sulphate of ammonia produced.
3. The formation of water by the combination of oxygen and hydrogen.

My hypothesis assumes the decomposition of sulphate of ammonia to have taken place, owing to a certain elevation of temperature, and the cotemporaneous resolution of the shells (carbonate of lime) into their constituent parts, lime and carbonic acid. The carbonic acid of the shells, combining with the ammonia, was volatilized; and the lime, uniting quickly with the sulphuric acid of the decomposed sulphate, formed *sulphate of lime* or *gypsum* ($\dot{C}a.\dot{S}. + 2\,\dot{H}$,) the crystalising process being effected with a rapidity commensurate with the quantity of crystalising water present. This water results from the decomposition of organic matter, as mentioned above *(vide* 3*)*, and, if present in a less ratio than 20·78 per cent, no crystals are produced.

The specimens accompanying this paper are obtained from Batman's Hill, in the neighbourhood of Melbourne. I am of opinion that gypsum might be subsequently found in considerable quantity in that locality, and if so, will become an article of commercial value, being the substance which, burnt and powdered, forms the well-known material plaster of Paris, extensively used for stuccoing buildings. When

SHELLS CONSIST OF

I ORGANIC SUBSTANCES AND II CARBONATE OF LIME

Organic substances decomposed will evolve severally

NITROGEN HYDROGEN OXYGEN SULPHUR

water

ydro. Sulphate of Ammonia

SULPHURETTED HYDROGEN

EXPELLED

1. Sulphite of Amm.
2. Sulphate of Amm.

Interchange at a certain elevation of temperature

Sulphate of Ammonia

Lime Carbonic Acid

CARBONATE OF AMM.
[volatilized]

SULPHATE OF LIME OR
GYPSUM.

Redaway & Sons Melbourne

simply pulverised it is an excellent manure for the improvement of sour soil, and is much valued as a plastic material for artistic purposes.

Gypsum is soluble in water to a certain extent only; that is, till the water becomes saturated with it, it being found by experiment that 1 of gypsum will be dissolved in 400 of water. When exposed to a heat of 424° Fahr., the water entering into the composition of this remarkable mineral is expelled by evaporation, and the gypsum becomes possessed of a peculiar antipathy to any combination with water. If, however, heated to 318° only, it readily re-unites with water, heat is evolved from it, and a dense crystalline mass appears as the result of this combination. This (the efficient degree of heat) is the secret of producing plaster of Paris from the gypsum in its raw or crystallised state.

In a purely scientific point of view these crystals possess a considerable degree of interest. They occur both in clino-rhombical forms and polygonal columns. Twin or double crystals, of which there are specimens now before the Society, also exist, together with the single ones. These remarkable combinations, presenting a varied field of observation to the ardent admirer of nature, are so perfectly developed that the crystallographer does not readily distinguish or individualise the twin parts of which they are formed.

These specimens are of a dirty greyish or soapy colour: specific gravity equal to 2·40; and their chemical composition, calcium 33, sulphuric acid 46, water 21. That these are still in course of formation in the manner which I have attempted to delineate there can be but little doubt. This supposition applies particularly to those places where fissures and cavities are formed in the parched mud, by the intense heat of the summer sun—the crystalising power having, in such spots, abundant room for operation, besides obtaining large supplies of sulphuretted hydrogen, derived from the decomposition of organic matters on the surface.

In order to exhibit a more succinct view of the process which I have here endeavoured to describe, I have sketched out the opposite classification of details. *(Vide plate.)*

In the same basalt formation in other parts of Victoria I have found magnesite, opal, carbonate of iron, carbonate of lime, carbonate of strontium, mesotype, and steatite (soapstone). The component parts of all these minerals are held in solution in common sea water, whence I am of opinion that they derive their origin from the enormous evaporation

and decomposition previously alluded to, of the sea water in the interior of the crater.

I have received from Dr. Davey, to whom I had previously expressed my opinions on the foregoing subjects, a communication corroborative of the chemical theory which I have advanced in the preceding pages.

Art. XX.—*On What Data does the City of Melbourne depend for an Adequate Supply of Water from the Yan Yean Reservoir. By* David E. Wilkie, Esq., M.D.

Several papers having been recently read before the Society on the subject of the probable supply of water derivable from Yan Yean, I think it of great importance now to inquire upon what data we depend for obtaining this supply.

I entertained the hope that the interesting questions treated of in the papers above referred to would have induced some of our scientific men to devote their attention to their elucidation; and I confess that I am rather surprised that no one seems disposed to investigate those questions further, although on a correct solution of them must depend all our hopes of securing a sufficient supply of pure and wholesome water, which would contribute so largely to our health and comfort, and the failure of which would be so disastrous to the city.

The question of evaporation, from its great importance in relation to the subject of this paper, claims our first consideration.

Our meteorological experience in this colony is very limited, and little is known with respect to the annual rainfall in different localities. Judging from the tables that have been kept in Melbourne for some years, there is reason to believe that there is considerably less rainfall in Victoria than in England. The geological features of the country are unfavourable for the production of rivers, much of the rain water being held on the surface, and lost by evaporation. Our high temperature also conduces greatly to diminish the proportion of the rain that would otherwise reach the rivers.

Thus the physical conditions of the country are very unfavourable for the preservation of water, and a great scarcity prevails in many districts. Hence the importance of arriving at a correct knowledge of the subject of evaporation, in order that, in our endeavours to preserve water in parts of the country that are ill-supplied, and to store it for the supply of

towns, we may adopt such measures as are really calculated to attain these ends.

But the question of evaporation is especially important in relation to the subject of this paper, as upon its decision depends at this moment the very important question, whether the Legislative Council ought to permit the Yan Yean works to be proceeded with, or to abandon them as a hopeless failure.

It is to be regretted, however, that the subject of evaporation is very little understood, and its importance very little appreciated in this colony; and it is not a little singular that Dr. Davey's experiments and observations, which in any other country would be deemed sufficient to determine the rate of evaporation, are here regarded with distrust, and are thought to possess little practical value.

If those, therefore, whose duty it is to proclaim the truths of science, and to vindicate their paramount claim to consideration in the conduct of our great public works, hesitate to do so, can we wonder that the members of the Legislative Council should hesitate to interfere with matters involving scientific questions which they cannot themselves resolve?

But, independently of the great public importance of having this question of evaporation satisfactorily settled, there are other reasons which induce me again to bring this subject before you. The different papers that have been read on this subject contain opinions, observations, and experiments of so opposite and conflicting a nature, that it is altogether hopeless to expect that the public will arrive at correct conclusions, unless the members of the Society can first agree among themselves.

Surely it must be possible for a body of scientific men to determine the rate of evaporation in this country, and this is really all that is wanted, in order to determine the success or failure of our water supply, derivable from Yan Yean.

It is not too much to expect from the Philosophical Society that they should be able to inform the Legislative Council what loss will be sustained from evaporation in the Yan Yean Reservoir, and I should be sorry to think that a problem of so easy solution elsewhere should be deemed either difficult or impossible here. I trust, therefore, that it will not again be said of us that we are unable to decide this question. It surely will not be regarded as very complimentary to this colony, that one of our daily newspapers should have published in its summary for England, that scientific men here were divided on the subject of evaporation, and on the deficiency that might result therefrom in the water supply of the city.

In difficult scientific questions to whom are the public and the Legislature to look, if not to the Philosophical Society? And shall it be said that they have looked to us in vain?

I am also induced on other grounds to bring this subject before you.

It will not be forgotten that Messrs. Acheson and Christy, in their report on the Yan Yean Reservoir scheme, assumed that 10·69 inches of the rainfall of the Plenty basin would be available for the reservoir, while Mr. Hodgkinson clearly showed, by a reference to Mr. Charnock and Mr. Howard, who are the best recent authorities on the subject, that with a rainfall varying from 24 to 36 inches, the available rainfall for the average surface of England varies from 4·88 inches to 5·33 inches, the mean of which is 5·20 inches, with a mean rain of 30·6 inches. Thus these gentlemen have assumed for the Plenty basin an available rainfall more than double that of England.

I had imagined, therefore, that Mr. Hodgkinson had demonstrated the fallacy of "the excessively small rate of evaporation assumed by those gentlemen," and that their enormous estimate of the available rain was "utterly at variance with the recorded observations of all other meteorologists." It appears, however, that they are by no means convinced of their error, and that they congratulate themselves in the belief that they have arrived at the very same result with Mr. Hodgkinson, only by a different method.

When the premises are so very opposite, it would be singular indeed if the conclusions were the same.

I cannot, therefore, understand how they have deceived themselves into the belief that they have arrived at the same results with Mr. Hodgkinson, unless after this singular method.

They assume double the amount of available rainfall that he does, and, at the same time, they rely on Dr. Davey's estimate of the evaporation from the reservoir, which is nine feet, while he rejects Dr. Davey's estimate of the evaporation, and assumes five feet and a half from his own observations on a pond. But they altogether forget that, while they generously leave 9,386 gallons per minute for the use of the district, he only allows 500 gallons per minute, or an equivalent to eight inches in the reservoir, which is less than one-eighteenth part of what they allow; and they also forget that a mere coincidence in their results proves nothing in their favour; on the contrary, when similar results are obtained from data which are altogether dissimilar

and contradictory, it rather proves that both the premises and the conclusions are alike unworthy of confidence.

I could readily understand how Messrs. Acheson and Christy might be right and Mr. Hodgkinson wrong, or *vice versa,* but I cannot imagine how both could be right. If Mr. Hodgkinson is correct in assuming five inches as the highest reliable amount of the available rainfall in the Plenty basin, then most assuredly Messrs. Acheson and Christy are egregiously wrong in assuming 10·69 inches, or more than double that amount; and if they are right in relying on Dr. Davey's experiments and observations on evaporation, then, in like manner, Mr. Hodgkinson is wrong in rejecting Dr. Davey's estimate of nine feet, and prefering his own of five and a half feet.

I have thought it necessary to notice this supposed coincidenee, because it is very probable that many persons may be deceived by it. Most people are satisfied with merely looking to the results in any inquiry, without examining the data or calculations on which they are founded, and, in this instance, being so positively assured of a very abundant supply of water in two different ways, they will regard the supply as all the more certain on that account, and will be contented to have it either way.

It is far more correct, therefore, to infer that both are wrong than that either is right, since each denies and controverts the premises of the other; and it is altogether a fallacy to suppose that the similarity of their results will be of any avail in securing a more certain or abundant supply of water.

And I trust to be able to show in this paper that no confidence whatever is to be placed either in theoretical estimates of the available rainfall of the Plenty basin, or in experiments on evaporation conducted on ponds and waterholes, but that actual measurements of the river, and Dr. Davey's estimate of the evaporation are alone to be depended on in deciding the important question whether the Yan Yean Reservoir scheme ought to be proceeded with, or altogether abandoned.

This leads me to notice the confusion that seems to arise from the use of the term "available rainfall." As applied to the Plenty basin it has no intelligible meaning, because many thousand acres, according to Mr. Hodgkinson, are so swampy that there is not only no available rainfall from them, but they evaporate and absorb a large proportion of the available rainfall of the rest of the basin, which is thus rendered no

longer available, although it forms a portion of the rainwater that is shed from the drainage area. Therefore the expression available rainfall very incorrectly conveys the meaning that is intended, and is of little use in any scientific inquiry.

To obviate this difficulty I have made use of the term "watershed" to signify the proportion of the rain that is shed from any given area or tract of country. This term has been ordinarily applied to the area or tract of country that sheds water, but this is so gross a corruption of the analogies of the English language, that I have avoided using it in this sense.

At the time that my paper on the Failure of the Yan Yean Reservoir was published, I had only heard Mr. Hodgkinson's paper read, and, on its subsequent publication, I was much surprised to find that I had misunderstood him in several important points.

While, therefore, I still regard his paper as a valuable contribution to practical science, I regret extremely to add, that I am compelled to differ from him very materially in some of the scientific data upon which he bases his conclusions.

Mr. Hodgkinson himself admits the necessity of throwing more light on the question of evaporation, "in order that definite conclusions relative to the probable supply of water derivable from Yan Yean might be arrived at;" and the extraordinary discrepancy of opinion that prevails on the subject clearly shows that, until this question is determined by scientific investigation, no definite conclusions can be arrived at.

I proceed now to consider what are the grounds upon which Mr. Hodgkinson bases his confident opinion, that there will be a very abundant supply for a population nearly three times greater than the present population of Melbourne, while I have myself found, by a strict method of investigation, based on actual measurements of the river, that, after deducting the loss that is at present sustained from evaporation in the marshes, and the probable loss from evaporation in the reservoir, according to Dr. Davey's estimate, there will be no water for any population.

Mr. Hodgkinson's theoretical estimate of the watershed of the Plenty basin differs very little from my own. In deducing the watershed from English data, I assumed four-and-a-half inches as the nearest approximation, while he assumes five inches. The difference therefore amounts to half an inch or one-tenth, which is equal to one foot in the reservoir.

How is it then that he is enabled to find a very abundant supply for 191,500?

The following table gives Mr. Hodgkinson's calculations reduced to feet, in the reservoir of 1,450 acres.

Supply.

	Feet.	In.
5 inches available rainfall over 62½ square miles, equal to 40,000 acres	11	6·16
7 inches ditto over drainage area of reservoir, equal to 3,000 acres	1	2·48
Rainfall on reservoir of 1,400 acres 32 inches. Dew 10 inches	3	4·55
Total	16	1·19

Demand.

	Feet.	In.
Amount lost in the swamps	2	5
Left to maintain the flow in the river, 500 gallons per minute		8
Evaporation 66.6 inches over 1,400 acres	5	4·33
Loss of flood water, and loss from absorption, equal to 6 inches over 1,400 acres		5·79
Balance equivalent to supply 191,500, at 40 gallons	7	0·52
Total	15	11·64

1. From the above table it will be observed that Mr. Hodgkinson assumes 5 inches over 62½ square miles, instead of 4½ inches over 60 square miles, and in this way gains 1 foot 7 inches.

2. He only leaves 500 gallons per minute, or 8 inches in the reservoir, for the use of the district, instead of 900 gallons, or 14 inches, and thus gains 6 inches.

3. He assumes that the whole of the available rainfall, less 500 gallons per minute, will be available for the reservoir; whereas, I thought it unsafe to rely on any estimate deduced from English tables, and preferred an estimate based on the measurements, which leaves a balance of 1 foot 5½ inches in his favour, and which I considered unsafe to rely on.

4. He assumes that 10 inches of dew will be condensed on the surface of the reservoir, whereas I only allowed 2 inches, and in this manner he gains 8 inches.

5. He assumes the evaporation in this colony at 5 feet 6·6 inches, rejecting Dr. Davey's estimate of 9 feet, and thus gains 3 feet 4 inches.

These amounts will stand thus:—

		Ft.	In.
1.	Difference between 5 inch of rain over 62½ square miles and 4½ in. over 60 sq. m. ...	1	7
2.	„ between 500 gallons and 900 gallons ...		6
3.	„ between my two estimates and not relied on	1	5½
4.	„ between 2 and 10 inches of dew ...		8
5.	„ between 5 feet 6·6 inches of evaporation and 9 feet	3	4
	Total	7	6½
	Deduct loss of flood water, and loss from absorption		6
	Balance to supply 191,500	7	0½

This table, then, exhibits the data on which depend all our hopes of an adequate supply of water from Yan Yean.

If Mr. Hodgkinson is right in assuming these data, we shall have a very abundant supply, at least for our present wants. If, on the other hand, I shall succeed in showing that he is wrong, then, assuredly, the Yan Yean scheme will prove a failure, and we shall have to look elsewhere for our water supply.

Having been induced, on public grounds, to investigate the points upon which Mr. Hodgkinson differs from myself, I trust that, in freely expressing my opinions on our points of difference, he will give me credit for simply wishing to arrive at the truth, and, as the question at issue is a most momentous one for the public interests, both in a pecuniary and in a sanitary point of view, I trust that he will see no impropriety in my calling in question his opinions on subjects which he himself admits require further elucidation.

1. What reason does Mr. Hodgkinson assign for assuming 5 inches of the rainfall, instead of 4 inches or 6 inches?

This is a very important question, as one inch over 62½ square miles will supply 62,500, at 40 gallons per head, per day.

The evaporation tables of Mr. Charnock, the Vice-President of the Meteorological Society, and Mr. Howard, have, according to Mr. Hodgkinson, been chiefly relied on of late years, in estimating the proportion of the rain that is available for water supply in England.

The available rain, according to Mr. Charnock, is 4·88 inches out of a rainfall of 24·6 inches, and according to Mr. Howard the proportion is 6·53 inches out of 36 inches. Mr. Charnock's observations have reference to a previous

well-drained soil in Yorkshire, Mr. Howard's apply to the average surface of England; and it is interesting to remark that the observations of these gentlemen corroborate the previous observations of the late Dr. Thomson, of Glasgow, who estimated four inches as the watershed of Great Britain, from observations and measurements of the Clyde.

It is to be regretted that Mr. Hodgkinson has not clearly stated on which authority he has based his estimate of five inches, or the precise method by which he has arrived at this very important conclusion.

He describes Mr. Charnock's observations as the most extensive and minutely accurate ever made in Britain, but they apply only to the Eastern Counties of England, where the rainfall averages twenty-four inches. They also apply exclusively pervious well drained soil, and are, therefore, not applicable to impervious undrained lands, which receive and evaporate a large portion of the watershed from lands that are pervious and well drained. Mr. Charnock's estimate is, therefore, too high for the average surface of England, and, with a mean annual rainfall of thirty-six inches, would give seven inches instead of five and a half inches, which is Mr. Howard's estimate.

It would be clearly wrong, therefore, to assume Mr. Charnock's proportion of available rain, for pervious and well-drained land in Yorkshire to determine the watershed of the Upper Plenty, where there are many thousand acres of impervious and undrained lands; and, in computing the proportion of the available rain for the average surface of England, Mr. Howard has no doubt made the necessary deduction from Mr. Charnock's estimate. Hence, while the estimate of the latter is one-fifth of the rain, that of the former is only one-sixth, and Dr. Thomson's estimate for Great Britain, excluding dew, is one-eighth.

The mean rainfall for Melbourne, for a period of six years, has been found to be 30·85 inches, and Mr. Hodgkinson seems to have adopted this proportion of rain for the Upper Plenty, as he regards the rainfall and dew taken together, as equivalent to thirty-six inches.

Without any correction, therefore, for temperature or dryness of the atmosphere, Mr. Charnock's proportion of the available rain would give 6·11 inches for the Upper Plenty, and Mr. Howard's 4·73 inches.

On what principle, then, does Mr. Hodgkinson adopt five inches to represent the watershed of the Plenty basin?

He says, "I believe, therefore, that the proportionate amount of the rainfall available in the Upper Plenty district

is less than the English proportion. From the want of extended meteorological observations taken in connexion with the Upper Plenty districts, or, what would have been much more satisfactory, a complete series of stream guagings to determine the annual discharge, the available rainfall of the district can only be analogically eliminated from the general data afforded by the most trustworthy English observations on evaporation, corrected for the average differences of temperature, for the various months in the year, in London and Melbourne, as given in the *Statistical Register for Victoria.* Moreover, as wind and the hygrometrical state of the atmosphere exercise a marked influence over evaporation, independently of temperature, and as their action is more intense here than in England, some additional corrections must be applied to the English data for this increased action. Having made due allowance for all these contingencies, I have arrived at the conclusion that the total annual rainfall and dew at the Upper Plenty may be taken together as equivalent to thirty-six inches, and that the amount thereof available for the supply of the Plenty, in the present state of the natural surfaces, would be about five inches."

I entirely concur with the opinions expressed in the above paragraph, but, in adopting for the Upper Plenty district a larger proportion of available rainfall than is relied on for the average surface of England, Mr. Hodgkinson has altogether forgotten the principles which he has so ably inculcated.

He admits that the proportion of the rainfall in the Upper Plenty district ought to be less than the English proportion: Why does he not, therefore, adopt less than the English proportion? He admits the want of meteorological observations, and that measurements of the river would have been much more satisfactory: Why does he not base his calculations on the December measurements, making due allowance for the winter rains?

He tells us that his estimate of the available rainfall of the Upper Plenty District is only analogically eliminated from English data, corrected in a very complicated manner for temperature and dry winds. How is it then that he places such implicit confidence in an estimate so singularly enveloped in difficulties and uncertainties, and applied under novel circumstances to a new country, with a totally different climate? And after all he has not made the corrections to which he attaches so much importance. He has adopted a less proportion of available rain than Mr. Howard's, which

is relied on as correct for the average surface of England, and Mr. Charnock's tables, which are alone applicable to previous well-drained lands, give only 6·11 inches as the proportion of available rain for the Upper Plenty District, and 6·11 inches, if duly corrected in the manner described by Mr. Hodgkinson, would give considerably less than four inches. I am at a loss, therefore, to discover by what method he has arrived at his conclusion that five inches of available rain represent the watershed of the Plenty basin. There is nothing in his reasoning to show why he should not rather have adopted four inches, but the reverse.

If he has adopted Mr. Charnock's proportion of 6·11 inches, then he has allowed 1·11 inches for all the contingencies to which he refers, and he has given no reasons why he should not rather have adopted Mr. Howard's proportion, which gives, without any correction for temperature, only 4·73 inches, for the rainfall of the Upper Plenty. And, as it appears to me, Mr. Howard's proportion for England, with adequate correction for difference of climate, is the only safe proportion from which to deduce the watershed of the Plenty basin.

I have not had an opportunity of correcting either Mr. Charnock's or Mr. Howard's tables of evaporation, for difference of temperature, but I have in the following tables corrected Dr. Dalton's precisely in the manner explained by Mr. Hodgkinson, and Dr. Dalton's estimate of available rain for England, which is 8·41 inches, when thus corrected gives exactly 4·54 inches as the proportion of available rain for our climate, without any correction for our very dry atmosphere, for which half an inch in addition may be very safely allowed. Thus the conclusion is inevitable that the tables of Mr. Charnock, and Mr. Howard, if similarly corrected would give a still less result.

Admitting, therefore, that Mr. Hodgkinson is right in assuming Mr. Charnock's proportion of the available rain as applicable to the Upper Plenty district, I do not think that he has advanced any good reasons to show that the difference in the evaporation of the two countries is so small, as to warrant the very small allowance he makes for the differences of climate, in adopting five inches.

In my former paper I expressed a very decided opinion that no confidence could be placed in theoretical estimates of the watershed of the Plenty basin, deduced from English data, at the same time, as a subject of scientific interest, rather than of any practical value, I assumed Dr. Dalton's

estimate of 8·41 inches as the average watershed for England, and by correcting this amount for the difference of temperature, I concluded that four and a half inches would represent an approximation to the watershed of the Plenty basin.

TABLE I.—Showing the Mean Rain, the Mean Temperature, and the Proportion of the Rain evaporated, and the Watershed, and the Evaporation from Water in the different months in England, according to Dr. Dalton's tables.

	Mean Rain. Inches.	Mean Temp. Degrees.	EVAPORATION. From Land. Inches.	From Water. Inches.	Watershed. Inches.
January	2·46	36 09	1·61	1·50	1·45
February	1·80	36·75	0·53	2·90	1·27
March...	0·90	42 65	0·62	3 50	0·28
April	1·72	47·57	1·49	4 50	0·23
May	4·18	55·26	2·69	4·96	1·49
June	2·48	60 68	2·18	6·49	0·30
July	4·15	63 17	4·09	5·63	0·06
August	3·55	62 78	3·38	6·06	0·17
September ...	3·28	57·00	2·95	3·90	0·33
October	2 90	50·37	2·67	2·35	0 23
November... ...	2·93	43 12	2·05	2·04	0 88
December... ...	3·20	40·09	1·48	1·50	1·72
	33 55		25·14	44·43	8·41

TABLE II.—Showing the Mean Rain, the Mean Temperature, and the Proportion of the Rain evaporated, and the Watershed, and the Evaporation from Water in Victoria, deduced from Dr. Dalton's tables, allowing the same evaporation to the same mean temperature in both countries.

	Mean Rain. Inches.	Mean Temp. Degrees.	EVAPORATION. From Land. Inches.	From Water. Inches.	Watershed. Inches.
January	1·36	67·94	1·34	8·00	0·02
February	0 95	67 31	0·93	8·00	0·02
March	1·60	63·92	1.57	6 49	0·03
April	3·13	60·56	2·75	6·49	0·38
May	3 67	54 91	2 36	4·96	1·31
June	2·41	51 00	2·21	4·50	0·20
July	2 18	49 34	1·88	4 50	0·30
August	3·61	50 66	3·32	4·50	0·29
September ...	3·27	55·08	2·10	4·96	1·17
October	2·54	58·97	2·28	4·96	0·26
November... ...	4·27	62·25	3·74	6·49	0·53
December... ...	1·86	66·29	1·83	8·00	0·03
	30 85		26 31	71·85	4·54

The above tables show that my conclusion is arrived at in the manner described by Mr. Hodgkinson, and if a further correction of half an inch be made for our drying winds, four

inches will represent the watershed as accurately as such a method of calculation will permit of.

I think I am warranted, therefore, in concluding, that if we must place confidence in any estimate analogically eliminated from English data, we are not warranted in assuming a larger proportion of available rainfall for the Upper Plenty district that four inches.

From Mr. Hodgkinson's estimate of 11 feet 6·16 inches, we must therefore deduct one-fifth, or 2 feet 3·63 inches, which is equivalent to supply 62,500 at forty gallons per head per day.

I also object to assuming sixty-two and half square miles as the area of the Plenty basin.

Messrs. Acheson and Christy in their report thought it safer to assume sixty square miles, and I followed their example in my estimate.

This area has never been thoroughly surveyed, indeed the greater portion of the boundary line has never been visited by any surveyor, being covered with an impenetrable scrub, and many thousand acres, according to Mr. Hodgkinson, consist of swampy and undrained lands, which are not only useless as affording no watershed, but they evaporate the watershed of many more thousand acres which drain into them. As it was of great importance to arrive at a safe and reliable result in this investigation, I think Mr. Hodgkinson erred in assuming sixty-two and half square miles, and for the reasons which I have assigned, I think it will be readily admitted that it was much more correct to have assumed sixty square miles as the area of the Plenty basin.

On this account, therefore, I have to deduct from Mr. Hodgkinson's estimate 4·60 inches in the reservoir, which is equivalent to supply 10,454.

2. Mr. Hodgkinson only allows 500 gallons per minute for the use of the district, and to maintain the flow in the river, and this is only equal to eight inches in the reservoir. Messrs. Acheson and Christy in their report allow twelve feet four inches for the same purpose; so that they allow eighteen and half times the amount that he allows.

They allowed this amount on the understanding that the Commissioners of Sewerage and Water Supply had entered into an arrangement with the resident population not to abstract more than one-half of the river, which was to be allowed to flow for twelve hours out of twenty-four.

What will they say to the small amount accorded them by Mr. Hodgkinson? If his estimate of the discharge of the

river is correct, he only allows one-seventeenth part to remain, and abstracts all the rest for the reservoir.

In this I feel persuaded that Mr. Hodgkinson has also erred, and there can be no doubt that if the Commissioners should ever attempt to carry out his recommendation they would find themselves overwhelmed with legal actions, and would be compelled to make very heavy compensation to all those whose interests might be affected by the loss of the river.

In my estimate I allowed 900 gallons per minute, or one-third of Mr. Blackburn's December measurement of the river at Yan Yean, and an idea of the smallness of even this amount may be got by reflecting on the circumstance, that, during the drought of 1851, when the Plenty had very nearly ceased to flow, Mr. Blackburn's measurement in February gave 865 gallons per minute.

I think, therefore, that it will be readily admitted that at least six inches must be deducted from Mr. Hodgkinson's estimate on this account, and six inches will supply 13,656.

3. I have stated that I have no confidence in theoretical estimates, and this is the reason that I preferred my estimate, that was based on measurement to that which I computed at four and half inches of the rainfall, merely as an approximation from English data, hence I allowed the difference amounting to one foot five and half a inches in the reservoir, as a margin for casualties.

In my preceding remarks it is, I think, clearly shown that I was wrong in assuming four and a half inches, and that I ought to have assumed four inches of available rain as the best approximation that can be arrived at from the most trustworthy English data. There is thus a difference of only 6·43 inches between the two estimates, and there can be no objection to leave this small amount for casualties, and, therefore, it may be deducted from Mr. Hodgkinson's estimate; but as he has allowed six inches for loss of flood water and from adsorption, I shall regard the 6·43 inches as an equivalent for his six inches.

4. I come now to consider the subject of dew. I explained in my former paper that very little dew could be condensed on the surface of water, and I allowed two inches only because it was my firm conviction that, even without drawing off any water from the reservoir, there would often be very little in it; and when the water is very shallow, a small quantity of dew may possibly be condensed on the surface in very cold

and frosty nights, and I was anxious that the reservoir should get every possible advantage.

I must say, therefore, that I was greatly surprised to find that Mr. Hodgkinson relied on ten inches of dew for the reservoir.

I have looked in vain for any authority to bear out this extraordinary opinion respecting dew, and I feel assured that Mr. Hodgkinson could not have consulted the best authorities on the subject.

In England, from four to five inches of dew are supposed to be condensed on the surface of the ground, and its production is easily explained, and well understood.

But Mr. Hodgkinson obtains ten inches for the reservoir, by assuming that this amount of dew is condensed on the surface of water in this colony.

This is a very important assumption, as ten inches in the reservoir will supply 22,727, at forty gallons, per head, per day, and 100,000 at nine gallons, which some allege is really all that is required for ordinary consumption. At this rate the dew condensed on the surface of the reservoir would suffice to supply Melbourne, with all its suburban towns and villages.

Here, again, it is to be regretted that Mr. Hodgkinson does not say upon whose authority he assumes this enormous amount of dew. He certainly states that Mr. Thom, the eminent practical engineer of the Paisley Water Works, and the energetic promoter of the gravitation schemes of water supply in Scotland, considers that the evaporation in large reservoirs is counterbalanced by the condensation of dew, but this is only to be regarded as his individual opinion, and is certainly not based on accurate observation, or experiment.

It is scarcely possible that Mr. Thom could have directed much attention to the subject of dew at the time that he uttered this opinion, and Mr. Hodgkinson himself shows that Mr. Thom's statement is altogether inconsistant with the production of salt by the evaporation of sea water, which has been carried on for ages.

Mr. Thom's opinions, therefore, on scientific subjects are not very remarkable for their minute accuracy.

Mr. Hodgkinson quotes his estimate of the available rain on which he relies for the Paisley Water Works, which is thirty-nine inches out of an annual rainfall of fifty-four inches. I can readily understand how low swampy ground, that is thoroughly intersected with catch-water drains, should yield a much larger amount of water than the whole rainfall, because

such lands often drain large tracts of country, but I cannot understand how Mr. Thom should imagine that fifty-four inches of rain fall in Paisley. This town is only seven miles distant from Glasgow, and, according to the meteorological tables, the rainfall for this city is twenty-one inches.

Mr. Thom's observations and experiments, therefore, could not have been conducted with much regard to scientific accuracy, when he computes the available rainfall at thirty-nine inches out of an annual rainfall of twenty-one inches, and they contrast rather singularly with Dr. Thomson's observations and experiments, which give four inches of available rain out of twenty-one inches for the Clyde district.

Since Dr. Wells published his well known Essay on Dew, his theory of its formation has been almost universally received as correct.

The production of dew occurs in the following manner. The quantity of aqueous vapour that can exist in the atmosphere depends entirely on temperature.

During a clear calm night, all bodies that are fully exposed in the air become more or less rapidly cooled by radiation of heat from their surface. The air in contact with such bodies suffers a corresponding loss of heat, and, as soon as its temperature reaches the dew point, the moisture, which can no longer retain the form of vapour, is condensed in the form of dew. Thus, those bodies which radiate most heat and conduct least, condense most dew, and it is found that all bodies which are good conductors and good reflectors of heat from their surface, are bad radiators.

The metals, therefore, condense dew very sparingly. Water, though a bad conductor of heat when applied to its surface, is from the extreme mobility of its particles, the most rapid conductor of heat and cold, when these are applied with due regard to its peculiar laws.

Water in this sense may be regarded as strictly analogous to the metals, and, being a good conductor and reflector of heat, it is necessarily a bad radiator, and the dew is not formed on any surface whose temperature is not cooled by radiation below the dew point, which ranges from 5° to 20° below the temperature of the air. Unless, therefore, the surface of water be cooled by radiation below the dew point, it is quite clear that no dew can be condensed but its density, which varies with every change of temperature, and its fluidity operate to prevent any reduction of its temperature until the whole mass is similarly affected.

The temperature of water is thus very slowly reduced by

radiation, because, as soon as the surface particles lose any portion of heat, their density is at the same time increased, and they sink to a lower level, being replaced by warmer particles from underneath.

Thus water differs most materially from grass and other vegetable bodies whose power of radiation is very great, and which therefore cool very rapidly, and being very bad conductors, the heat that is lost by radiation is very slowly restored from the ground. Hence in clear calm nights they condense dew in great abundance.

The greater the depth of water, the more slowly is its temperature diminished, as the surface cannot lose even 1° of heat until the whole depth has been reduced to the same temperature. And in this dry climate the dew point or point of saturation is often many degrees below the temperature of the air. It is thus easy to see that when there is a depth of more than a few inches of water no dew can be condensed on its surface.

But we are not left to determine this point by reasoning on general principles. It is fortunately one that can very readily be determined by experiment.

Dr. Wells found that a thermometer laid on a grass plot in a clear night, and in calm weather, sunk 6°, 8°, 13°, and even 20° lower than a thermometer hung at some height from the ground. This explains the rapid extraction of heat from the atmosphere in contact with the grass plot, and the copious deposition of dew on grass. But no such rapid reduction of temperature has ever been observed in water placed under similar circumstances. The surface of the ocean and inland lakes retains a very uniform temperature, corresponding to the seasons, and suffers little change from the ordinary alternations of heat and cold during day and night; indeed the difference in the temperature of the ocean is scarcely perceptible.

In temperate regions, the difference in the diurnal range of the thermometer in the air over the ocean is very trifling, rarely exceeding from 4° to 6°, while upon the continents the range often amounts to 20° or 30°, and between the latitudes of 25° and 50° the air is rarely warmer than the surface of the sea. And it is found by careful observation that while the temperature of the air over the land is rapidly cooled by the chilling influence of radiation during the night, the air over the ocean is several degrees colder than the surface of the water, and is therefore heated, not chilled, by contact with its warmer surface.

With cold winds the temperature of our inland lakes would be much more quickly cooled than by radiation; but for the formation of dew it is necessary that there should be scarcely any wind. It is also necessary that the water should abstract heat from the air, and not that the air should abstract heat from the water.

Dr. Wells also clearly proved by his experiments that water fully exposed in a calm clear night in shallow vessels lost weight from evaporation, while dew was being largely deposited on the surface of the ground. An increase of weight from condensation of dew was only observed when the cold was so great that ice was formed, and in this case he found a slight increase in weight, but the existence of ice proved that the temperature of the water had been reduced far below the dew point.

I am not aware that any subsequent experiments have shown any inaccuracy in the experiments of Dr. Wells.

It is to this uniformity in the temperature of water during day and night that our land and sea breezes are owing. During the day, the air over the land becomes heated, and a sea breeze is the result; during the night, the land is chilled by radiation, and the air being thus rendered much colder and heavier than that on the surface of the ocean, a land breeze is the result.

In this manner, the extremes of heat and cold are very much moderated along the coast lines, and the climate is rendered much milder and more agreeable.

There can be no doubt that like atmospheric currents will take place at Yan Yean. The heated surface of the surrounding ranges, during the day, will produce currents of cool air from the reservoir. During the night, the warmer air on the surface of the reservoir will give place to currents of cold air which has been deprived of its moisture by the chilling influence of radiation on the summits and slopes of the ranges.

Mr. Hodgkinson's theory, would, however, reverse the whole order of things.

If the surface of the sea and our inland lakes becomes during the night so much colder than the surface of the land as to condense double the amount of dew, we should have land breezes in the day, and sea breezes in the night; and our summer watering places would become inhospitable deserts.

But as it is physically impossible for our inland lakes to lose from 5° to 15° of temperature by radiation during the night, so it is physically impossible for any dew to be condensed on their surface.

And I feel persuaded that Mr. Hodgkinson could not have reflected sufficiently on the general principles which regulate the production of dew, otherwise he would certainly have omitted it altogether from his calculations, and his extreme confidence in a very abundant supply for 191,500, would have been considerably diminished.

And there can be no objection to my deducting ten inches from Mr. Hodgkinson's estimate, or an equivalent to supply 22,727.

But there is another view of the subject equally fatal to the assumption of ten inches of dew. Mr. Hodgkinson has calculated the evaporation from the surface of the reservoir from English data. Now, these data represent the amount of water evaporated, as determined by actual measurement, without any reference to dew, the condensation and evaporation of which on the surface of the evaporating vessels are regarded as balancing each other. Therefore, if ten inches of dew are assumed to be condensed on the surface of the reservoir, this amount must be added to the rate of evaporation deduced from English data. But Mr. Hodgkinson has not done this, he has allowed one inch for the three summer months in estimating the evaporation of the pond, but it does not appear that he has added nine inches for the other nine months.

If he has done this, his estimate of the evaporation, excluding dew, would be four feet 9·6 inches for twelve months, which it will surely be admitted is a very small allowance for this country, when Dr. Dalton's estimate for Manchester is three feet eight inches, and Mr. Glaisher's estimate for Greenwich is four feet two inches.

If Mr. Hodgkinson, therefore, insists on retaining ten inches of dew in his estimate, he cannot object to add nine inches to his evaporation, which will thus amount to six feet 3·6 inches; but in this case the dew goes for nothing.

5. I have thus far endeavoured to show that very large deductions must be made from Mr. Hodgkinson's estimate, ere we arrive at the amount that will be available for the supply of the city; and his estimate for 191,500 has been reduced by an amount that would supply 109,337, leaving still sufficient for 82,163.

I now proceed to consider what dependence is to be placed on the amount gained by Mr. Hodgkinson, from prefering his own estimate of the evaporation from the surface of the reservoir, which is five feet 6·6 inches, to Dr. Davey's

This difference for an area of 1,450 acres is three feet four inches, and will suffice to supply 90,909, at forty gallons per head, per day.

The experiment on which Mr. Hodgkinson relies to prove the evaporation from the surface of water, during three of our summer months, has many singular features.

It was conducted on a pond on the banks of the Yarra, very little above the sea level, and, therefore, in the most favourable position to receive a lateral supply from higher levels. Again, decomposed trap resting on stiff clay is exceedingly favourable to retain the winter rains from higher levels, and to afford a large lateral supply to a pond fifteen feet deep.

It cannot be doubted that a large amount of water may be supplied in this way.

In many parts of Melbourne, and particularly at the lowest levels, it is almost impossible to prevent the cellars being filled with water. And, on the Gold-fields, the difficulties that the diggers have to contend with from influx of water at low levels, and in deep excavations, is well known.

In selecting this pond for an experiment on evaporation, especially when the justification of a vast expenditure of public money depended on the result, it was incumbent on Mr. Hodgkinson to show that it contained no springs, and that there was no other indefinite source of supply that could render the experiment fallacious.

Springs are very often found in the ponds and water-holes that form the beds of many of our creeks. This is a well ascertained fact, and was therefore deserving of careful consideration.

In some instances the springs gush out of the rocks above the water line, but, in general, they are principally distingished by the small apparent loss from evaporation in those ponds in which they exist.

The difference in this respect is very remarkable, where there are chains of ponds all those without springs dry up during the summer months, and I have been assured by old colonists, and residents on the Deep Creek, and other creeks, that many of the ponds have from four to six feet of water in them in November, and that they dry up completely in three or four months.

Nor can this be accounted for by any loss that might be sustained from cattle drinking at them. Where there are continuous chains of ponds it would be difficult to understand how so many should be emptied in the same manner, and,

where all are equally accessible, how some should be emptied by cattle, while others, apparently, lose very little water.

And this objection cannot apply to my observations with reference to the Deep Creek, as the land is enclosed for cultivation.

The water of these ponds is lost, therefore, either by evaporation, or absorption. Either admission would be alike fatal to the prospects of the Yan Yean Reservoir.

If so much water can be absorbed through the slate strata which form the bed of the Deep Creek, what reasonable grounds have we to expect that the same amount of absorption will not take place through the slate strata that form the bed of the reservoir?

It may be noticed that some settlers have great confidence in the Yan Yean scheme from observing that small artificial water-holes are often permanent in the summer months.

If my reasoning is correct with regard to the effects of evaporation in this country, we may assume that the evaporation from the surface of water is nine feet, and that one-ninth of the rain may be relied on as the watershed.

The extent of drainage area necessary to give a permanent supply of water to any pond can, therefore, be easily determined.

With a rainfall of thirty-six inches, the ratio of the drainage area to the surface of the pond must be greater than eighteen to one, in order to secure a permanent supply.

The ratio of the Plenty basin to the surface of the reservoir is about twenty-seven to one, but more than one-third of the watershed is not available for the reservoir, a large amount being lost in the swamps, and it being necessary to leave a certain proportion to maintain the flow in the river.

Thus the ratio is practically reduced to eighteen to one, and there is, therefore, no more than sufficient to cover the evaporation.

Reservoirs in England seldom exceed fifty acres, and they are generally much smaller, hence the loss from evaporation is very trifling, and the area of surface drained very large in proportion.

The reservoir which supplies New York is 400 acres, with a depth of forty feet, and an unlimited command of water, the loss from evaporation is, consequently, not equal to one-third of that which will be sustained at Yan Yean.

Had the Yan Yean Reservoir not exceeded 400 acres there would have been a saving of water equivalent to supply 188,500, at forty gallons per head, per day, with a depth of fifteen feet eight inches, instead of four feet four inches.

With thirty inches of rain the proportion would be twenty-one and half to one, and I have no doubt that, in all those cases in which settlers have obtained a permanent supply from artificial water-holes, the ratio of the surface drained to that of the water-holes would be found to correspond to the proportions indicated above. Nor is it difficult to understand how, with a large area and steep slopes, a small pond might be supplied even from the summer rains.

Thus, according to the evidence of gentlemen perfectly competent to describe what they have frequently observed, the evaporation from the ponds referred to is at least double what Mr. Hodgkinson observed in his pond.

I might multiply instances of a very high rate of evaporation that has been observed both in this country, and elsewhere, by gentlemen whose credibility cannot be doubted, but, at present, I merely allude to the fact forthe purpose of showing that Mr. Hodgkinson is not justified in making so momentous a question as the rate of evaporation at Yan Yean, and the whole water supply of Melbourne, depend on a single experiment on a pond, attended by many circumstances of doubt, and not conducted with that minute accuracy of detail which could alone command the confidence of scientific men, and without the most distant reference to the experiments and observations of others, who have arrived at very different results from his own.

Mr. Hodgkinson estimates the area of his pond at one and a-half acres, and the area of the surface which it drains at nine acres. The ratio is, therefore, only one to six.

And he assumes fifteen per cent. of the rainfall for the watershed, which gives 3·6 inches for the three hottest months, from a rainfall of four inches.

For the Plenty basin he has assumed 13·9 per cent. of the rain as available.

In calculating the evaporation from the pond, the 3·6 inches might have been omitted altogether.

If we refer to Dr. Dalton's table we shall find that, with a rainfall of 4·15 inches in July, 4·09 inches are evaporated, leaving only 0·06, or one sixty-ninth part, to represent the watershed.

Instead of 3·6 inches, therefore, Mr. Hodgkinson ought to have added only 0·34 inches, or one-third of an inch, as the watershed from the nine acres.

Thus 3·26 inches must be deducted from the supply of the pond, and, therefore, from the evaporation, and there only remains 20·74 inches of evaporation for our three hottest months, or 6·91 inches for each month.

This is a very important deduction from Mr. Hodgkinson's premises, as it proves one of two things. If his evaporation is right, then the 3·26 inches must be supplied from a spring, or from some distant and higher level beyond the limits of the nine acres. If, on the other hand, the rainfall of the nine acres is the only source of supply, then the evaporation for our three hottest months cannot exceed 6·91 inches. Either alternative would be sufficiently embarassing.

Dr. Davey has shown that the temperature of our three summer months, during last season, exceeded the temperature of the corresponding months in London, according to the meteorological tables of the Royal Society, by 10° of Fahr., and also that our dryness exceeded that of London by two and one-fourth to one. From these data we are warranted, according to the tables of Dr. Dalton, to compute our evaporation at nearly three times the English evaporation; but, if we are to trust Mr. Hodgkinson's experiments in the pond, our evaporation will only exceed Dr. Dalton's estimate for June by less than half an inch for each of the three months. And, if we further deduct one inch of dew, which Mr Hodgkinson has allowed for the three summer months, his estimate of the evaporation accurately deduced from his own premises, will almost exactly equal the English evaporation.

The watershed of the nine acres for twelve months, calculated at fifteen per cent. of the rainfall, is equal to 27·76 inches, which, added to the rainfall of 30·85 inches, gives four feet 10·61 inches, as the available supply for the pond, but Mr. Hodgkinson's evaporation is five feet 6·6 inches. How is it then that the pond does not dry up? And how shall we account for a depth of ten feet of water in the summer months? It only receives four feet 10·61 inches, and it evaporates five feet 6.6 inches, the difference amounting to 7·99 inches.

The conclusion is inevitable that the balance is made up from a spring, or some other source independent of the rainfall.

And, this being proved, who is to compute the amount of water thus supplied? or what confidence can be placed in an estimate of the evaporation based on such uncertain data? Thus, to determine the amount of this lateral supply is purely an impossibility, and to assume the amount is to beg the whole question.

After the explanation given above respecting dew, it will be of no use to allege that the balance is made up in this way.

If nine inches of dew are assumed to be condensed on the

pond during nine months, the same amount must be added to the evaporation, and, therefore, nothing is gained.

It is a singular fact that all our hopes of deriving an adequate supply of water from Yan Yean, at this moment, depend on Mr. Hodgkinson's estimate of the evaporation derived from the pond, and it must be regarded as still more singular that his own data, on which he relies to prove the correctness of his estimate, have furnished the best proof of its fallacy, by clearly showing that the pond is supplied from springs.

In calculating the evaporation of the other nine months, Mr. Hodgkinson has recourse to English data, and computes the amount by "correcting these for the average differences of temperature for the various months of the year," and by "applying a slight additional correction for the frequent occurrence of dry winds."

He does not say whose tables he has employed for this purpose, but, in order to illustrate the principle upon which he proceeds, I have added to the foregoing tables the evaporation from the surface of water at Manchester, according to Dr. Dalton's experiments, and also the evaporation from the surface of water in this colony, deduced from the English evaporation by allowing the same proportion to the same mean temperature in both countries.

For our three summer months I have adopted Mr. Hodgkinson's estimate of eight inches, and the result, as may be seen by reference to the tables, gives five feet 11·85 inches.

Thus it is seen that the corrections for temperature alone, give 5·25 inches more than Mr. Hodgkinson allows, after having made all the additional corrections that are necessary for our very dry atmosphere, and the more "intense action" of our very dry north winds.

But it is not necessary to adopt Mr. Hodgkinson's estimate in order to get eight inches of evaporation for each of our three summer months.

Dr. Dalton's tables give 6·49 inches as the evaporation for June in Manchester, and they also point out the method for correcting the evaporation for temperature and dryness, by a simple formula.

Now, Dr. Davey has shown that the temperature of our three hottest months is 10° higher than the temperature of the three corresponding months in London, according to the tables of the Royal Society. Thus, our increased temperature alone, without reference to dryness, would give 9·73 inches as the evaporation from the surface of water deduced

from English tables, the rate of evaporation being doubled with every increase of 20° of Fahr.

But Dr. Davey has also shown that the mean dew-point of our hottest months is 50°, thus showing a dryness of 19°, or in the proportion of two and one-fourth to one compared with London.

Now, according to the formulæ of Dr. Dalton, and Dr. Ure, 9·73 inches corrected for our dryness, would give 16·22 inches for each month, or 48·66 for three months.

The above table shows that the English evaporation for the other nine months, corrected for temperature alone, is 47·85 inches.

As there are no correct data to show our relative dryness for these months, this correction must be omitted, but, even without this, the rate of evaporation deduced from English tables, in the manner described by Mr. Hodgkinson, amounts to eight feet 0·51 inches.

Thus, if we make some additional corrections for our greater dryness for the nine months, and for the more "intense action" of our dry winds, I do not see how Mr. Hodgkinson can escape from the conclusion, even according to his own method of calculation, that the evaporation from the surface of water in this colony is little short of nine feet.

In my former paper I stated, on the authority of the *Year Book of Facts for* 1854, that Mr. Glaisher had estimated the evaporation at Greenwich at five feet; I have now ascertained from his Hygrometric Tables, that his estimate is four feet two inches, so that Mr. Hodgkinson's estimate of five feet 6·6 inches for Melbourne, is very little more that Mr. Glaisher's for Greenwich, and the Greenwich evaporation when corrected for our higher temperature, would give six feet three inches without any corrections for dryness and winds.

But why does he resort at all to English data in order to deduce our evaporation in a troublesome and unsatisfactory manner? Had Dr. Dalton any peculiar method of determining the evaporation at Manchester different from that adopted by Dr. Davey in Melbourne? If it is correct to deduce our evaporation from Dr. Dalton's evaporation for the nine months, why is it incorrect to depend on Dr. Davey's evaporation for the three months?

Both these gentlemen have adopted precisely the same method of experimenting in determining their respective rates of evaporation.

Dr. Davey's experiments, which were conducted daily during the period referred to, are in every respect similar to

those which are everywhere else depended on for ascertaining the rate of evaporation, and they were conducted with a degree of care and minute accuracy which it would be difficult to exceed. He carefully measured, in a graduated vessel, each portion of water that was exposed to evaporation, and thus every drop that was evaporated was accurately registered.

Those gentlemen who question the accuracy of his results ought to point out in what manner his experiments differ from Dr. Dalton's or Mr. Charnock's, and how it is that his are fallacious while they place implicit confidence in theirs.

The method commonly adopted for the purpose of throwing doubts on the accuracy of Dr. Davey's results is to compare his scientific experiments with observations on ponds and waterholes. But enough, I trust, has already been said to show that a more fallacious test could not be applied.

But, if this question must be decided by observations on ponds, I have mentioned other observations which give nearly double the amount of Mr. Hodgkinson's estimate, and I do not see in what manner he can dispose of these. And I myself measured, with the greatest care, the evaporation from the surface of a pond in the month of February, and found that there was a loss of exactly eleven inches in twenty-eight days. Now, can Mr. Hodgkinson point out any source of error in this experiment? unless it is that I omitted to add anything for rain, or dew, or lateral supply, for all of which he has made a very liberal allowance in his experiment, but this would have added to, not diminished the rate of evaporation.

The only scientific objection that has been urged against Dr. Davey's estimate being applied to the Yan Yean Reservoir is the great extent of surface. It is thought that the air will become so saturated with vapour that the rate of evaporation will be very much diminished.

There can be no doubt that in the case of the ocean this objection would have considerable weight, though, even there, extended observations show that the air is very rarely near the point of saturation; but with regard to the Yan Yean Reservoir, I feel quite certain that the effect which extent of surface would have in retarding evaporation has been greatly exaggerated,

Being surrounded by an amphitheatre of hills, it may, to a certain extent, be protected from strong winds; but, on the other hand, this physical conformation will render it more liable, in calm weather, to atmospheric currents resulting from the unequal effects of solar heat on the surface soil of the

hills, and on the water of the reservoir. The latter will preserve a very uniform temperature, while the former will be subject to great diurnal alternations of heat and cold.

Thus the vapour that is formed on the surface will at all times be quickly removed, and replaced by currents of drier air. And it is important to notice, that the amount of water evaporated, other things being equal, is exactly in proportion to the surface exposed; and it it is not difficult to see that when the water is agitated with winds and currents, the extent of evaporating surface will at least be doubled.

But, independently of winds and atmospheric currents, it appears to me that those gentlemen who urge this objection have altogether overlooked the law of diffusion, which applies equally to vapour and all other gaseous bodies. In a still atmosphere, it is true that diffusion will operate more slowly than when aided by currents; but as the vapour of water is lighter than air at the same temperature and pressure, in the proportion of 62 to 100, its diffusive power is very great, even in a perfectly still atmosphere; and it may be confidently concluded that the hygrometric condition of the atmosphere and the tension of its vapour will not be materially affected by the evaporation from the reservoir, which, notwithstanding its great extent, is very limited compared with the ocean.

And, with our Australian atmosphere, which is so remarkable for its dryness, and with the rapid diffusion that will result therefrom, it would be very unwise to calculate upon a greatly diminished rate of evaporation in the reservoir.

In his estimate of nine feet of evaporation for the reservoir, Dr. Davey has made ample allowance for the retarding effects of extent of surface. His observations have only extended over four months, and the evaporation for these months is as follows:—

	Inches.
January, by approximate data	21·710
February, by daily observations	23·630
March „ „	15·470
April „ „	10·000

With respect to these amounts, as Dr. Davey is absent from town, and as Mr. Brough Smyth thinks that he intended to make some corrections on account of the evaporating vessel used in January and February, he advises me to assume at present, only eighteen inches for December, January, and February; the amounts for March, and April, he thinks, do not require any corrections.

Now, in computing nine feet as the evaporation from the

reservoir, it is only necessary to assume sixteen inches for each of the three summer months, therefore, Dr. Davey has allowed a large deduction from the true evaporation, to compensate for the extent of the reservoir, or any other accidental cause that might operate to retard the evaporation from the surface.

What possible reason, or excuse, then, can be given for rejecting Dr. Davey's estimate of nine feet? According to my judgment the conclusion is irresistible that his estimate is confidently to be depended on, and I feel warranted in deducting the three feet four inches from Mr. Hodgkinson's estimate, which is equivalent to supply 90,909.

Having thus stated the points of difference between myself and Mr. Hodgkinson, and which constitute the data on which we depend for our water supply, and having shown that they are not based on correct or scientific principles, and are, therefore, unworthy of your confidence, and that, on a thorough investigation of the subject, there are no data to show that there will be any water for the city derivable from Yan Yean, I have little to add.

I shall submit, therefore, that the Philosophical Society has now a very important duty to perform; a duty to themselves, as the interpreters of science in this colony; a duty to the Government and the Legislative Council, who look to them for a scientific opinion to aid them in the decision of the question, if it be proper to allow the Yan Yean works to be proceeded with; and a duty to the public, whose health, and comfort, and pecuniary interests are so seriously involved in the success or failure of the Yan Yean Reservoir scheme: and I trust that the Philosophical Society will no longer hesitate to pronounce an opinion on the subject.

Art. XXI.—*Remarks on the favourable Geological and Chemical Nature of the principal Rocks and Soils of Victoria, in reference to the production of ordinary Cereals and Wine. By* Clement Hodgkinson, Esq., C. E., *Survey Department.*

Having visited the four principal Australian Colonies and been connected with agricultural pursuits in New South Wales, I have long held the opinion that Victoria will eventually produce more wheat and wine than any other Australian Colony; partly, because this territory contains the

largest proportionate extent of land adapted for agriculture, and partly in consequence of the geological and chemical influences that have either tended to render much of the best soil here capable of withstanding, without renovation for a long series of years, the most severe cropping, or else established a condition of soil most favourable for the production of wine of superior quality.

For a considerable period, Victoria, notwithstanding the gold discoveries, has been supposed to offer less inducements for the settlement of *bona fide* working farmers than some of the other colonies, more especially South Australia; and I believe that the great extension of agriculture in that province has resulted less from the fertility of the land, and the facility of its acquirement in small sections, than from the numerous class of agriculturists, with small capital, who have been attracted to South Australia in consequence of the superior advantages it has been supposed to offer to small farmers.

The most remarkable characteristic of the physical configuration of this colony, when compared with that of any other Australian colony, is the great prevalence here of volcanic rocks and clay slates. Sir Charles Lyell has noticed the general fertility of soil produced from the disintegration of volcanic rocks, but in Australia the fertility of soil thus produced has often been found most extraordinary. For instance, in New South Wales at Prospect Hills, where a small dyke of trap traverses the sandstone, some of the soil derived from the trap was brought into cultivation before the close of the last century, and has ever since given good crops without manuring; yet this land does not display any symptoms of exhaustion. On the trap formation at Illawarra, I have heard of sixteen successive crops of wheat, having been taken off the same piece of ground, without the last crops having exhibited any falling off, as regards quantity or quality. Even the natural vegetation on soil derived from volcanic rock in Australia, is, almost constantly, more luxuriant than on other soils. This is especially noticeable in the Blue Mountains, wherever the thick stratum of sandstone is displaced by dykes of trap; thus on the basaltic slopes of Mount Hay are found enormous trees, ferns, and luxuriant creepers, whilst all the surrounding mountain ranges and gullies, are only partially clothed with low scrubs. There is also a sudden and startling change on entering the trap formation at Illawarra, from stunted eucalyptus and low bushes to lofty palm groves and semi-tropical vegetation. In this

colony the natural vegetation attains also its maximum luxuriance on those mountain ranges and gullies displaying the older volcanic rocks; thus on the eastern slopes of the Dandenong Mountains, and on some of the ranges of the Port Otway District, which are thus geologically constituted, the enormous dimensions and altitude of the trees are not surpassed in any part of the globe. On the north-west coast of New Holland, Sir George Grey particularly noticed during his explorations there, the remarkable contrast between the refreshing aspect of the vegetation on the few basaltic hills he encountered, and that of the general surface of the country traversed by him.

It would therefore, seem, from the experience of more than half a century in New South Wales, that some of the soils derived from the disintegration of volcanic rocks in Australia are able to bear, without apparent exhaustion, an amount of cropping that has, in America, been found by experience, sufficient to wear out some of the most fertile soils there. Soils displaying the extraordinary power of maintaining, without artificial renovation, their fertility unimpared by cropping, for a long series of years, are of very rare occurrence in Europe, although a few very remarkable instances are recorded by Sprengel.

Thus he states that a field near the village of Nebstein, in Germany, has been cultivated for the last one hundred and sixty years without manure, and without being allowed to be fallow, and yet has produced good crops.

The analysis of soil formed by the disintegration of volcanic rock analogous to that near Melbourne, has been found to be as follows:—

Silica	83·642
Alumina	3·978
Protoxide and Peroxide of Iron ...	5·312
Peroxide of Manganese	0·960
Lime	1·976
Magnesia	0·650
Potash in combination with Silica ...	0·080
Soda in combination with Silica	0·145
Phosphoric Acid in combinatien with Lime	0·273
Sulphuric ditto ditto ...	a trace
Humus, soluble in Alkaline Carbonates	1·270
Chlorine	a trace
Humus	0·234
Nitrogenous Matter	1·480

The cultivation of wheat abstracts from the soil a larger proportionate quantity of silicate of potash than most agricultural products, and also demands an average quantity of

the phosphates. Now, although volcanic rock, especially if augite predominate in its composition, may occasionally contain a less proportionate quantity of the alkalis, or even of the phosphates than some other rocks, yet, the greater intensity of the disintegrating action generally observable in soil derived from volcanic rock would often furnish so large and continuous a supply of the chief inorganic constituents required by cereal crops, as to render the renovation of the soil, by disintegration still going on therein, quite equivalent to the abstraction of inorganic matter by incessant cereal crops. In this way only can I account for the inexhaustible soils already alluded to, at Prospect and Illawarra.

But in Victoria we possess extensive tracts of land, not yet brought under cultivation, whose soils seem to me to be under precisely the same conditions of derivation and disintegration as the soils of those favoured, but very limited localities in New South Wales; and much of this land in Victoria consists of well-grassed plains, easily brought under cultivation. I admit that the soil in connexion with the recent lava, north of Melbourne, is not always rich, but may yet, on the whole, be pronounced so far good as to justify the opinion I now venture to submit to you, that in Australia, soils derived from the disintegration of volcanic rocks are more generally fertile than those connected with aqueous or plutonic rocks.

As the available surface of Victoria embraces a much greater extent of soil thus derived, than that of any other Australian Colony, I have therefore concluded that the natural advantages of Victoria, in reference to the extensive and successful production of ordinary cereals, greatly preponderates over those of her neighbours.

In South Australia the only volcanic district worth noticing is that around Mount Gambier on the confines of the colony. In Tasmania volcanic rocks are more prevalent, but are very frequently associated with steep densly wooded surfaces. In New South Wales the sandstone of the central counties is, in a few localities, displaced by trap dykes, as already metioned; in the northern part of that territory, the volcanic rocks are mostly confined to densly wooded mountain ranges.

But if the disintegration of volcanic rocks in Victoria has rendered so much surface pre-eminently adapted for corn crops, the disintegration of another class of rock very prevalent near Melbourne,—clay slate,—has tended to produce much soil that would prove, in the very highest degree, favourable not only to the growth of the vine, but also to the production of wines of very superior quality.

The paramount influence of the constituents of the soil of a vineyard on the quality of the wine produced is well known. In some of the best wine districts of France it is no uncommon occurrence to find two adjacent vineyards both planted with the same kinds of vine, similarly cultivated, and where all the operations of the vintage are conducted in precisely the same manner, and yet the wine of one of these vineyards remains totally distinct as regards quality and flavour from the wine of the other; such variations being entirely due to differences in the soils of the respective vineyards. It is also known that the application of certain kinds of manure to vines will cause serious deterioration in the quality and flavour of the wine produced in the following season; and sometimes the pristine quality and flavour cannot be regained for several vintages. The composition therefore of any rock whose disintegration has formed the soil of any vineyard must obviously exercise a most important influence on the quality of the wine derived from the vineyard. Now according to the best authorities I have been able to refer to, the disintegration of clay slate produces a soil of unusual excellence for vineyards. Thus, Dr. Adams in his remarks on the rocks and soils of the celebrated Constantia Vineyard at the Cape of Good Hope, has observed how well the vines thrive in a soil produced by the decomposition of clay slate and mixed with the fragments of it.

Humboldt has stated that the vines of the schistose ranges, in the valley of the Rhine, produce most excellent wine; and I am aware that the best wines of the province of Anjou, in France, are obtained from vines grown on the same formation. Albertus Magnus has also observed that the vine thrives uncommonly well in earth mixed with fragments of slate.

Some of the clay slates and schists near Melbourne are accompanied by a fertile soil adapted for ordinary agriculture or vine culture; but more generally the schistose ranges in the basin of the Yarra, eastward of its tributary the Plenty, are not sufficiently accessible to be available for ordinary crops, and are sometimes very barren. But I have occasionally encountered within twenty-five miles of Melbourne, ranges of dark clay slate that have furnished by disintegration, soil now only supporting a dense stringy-bark forest, yet which seems to me to be of the same nature as the soil of the celebrated vineyards on the dark-coloured schists of the Rhenish Mountains.

Very few of the vineyards of the counties of Cumberland and Camden, in New South Wales, have been established on

such suitable sites for vine culture with the view to the fabrication of wine, as could, in this colony, be selected, within half a day's walk from Melbourne, among the stringy-bark ranges already alluded to, and yet which, if now put up for sale, would be declined at the upset price. It is therefore not impossible but that, before the close of the present century, Melbourne will have in its vicinity flourishing vineyards, some of which might occupy ground now considered, notwithstanding its proximity to Melbourne, valueless even for grazing purposes.

PROCEEDINGS.

PROCEEDINGS,

&c.

August 12*th*, 1854.

AT THE FIRST GENERAL MEETING OF THE SOCIETY,

The President delivered an Inaugural Address.

Dr. Ferd. Mueller read a paper:—"Definitions of rare and hitherto undescribed Australian Plants, chiefly collected within the boundaries of the Colony of Victoria."

Presents acknowledged:—Fossils and Minerals from Geelong, Capt. Clarke, R.E. Fossil Plants from Cape Patterson, R. B. Smyth, Esq. Fossils from Mount Eliza, and adjoining district, A. Selwyn, Esq. Botanical Specimens, Dr. Ferd. Mueller.

September 10*th*, 1854.

MONTHLY MEETING. Dr. Ferd. Mueller in the Chair.

The Minutes of the last Meeting were read and confirmed.

New Members admitted since the last Meeting:—The Rev. Dr. M. Goethe, Dr. A. Davey, John G. Foxton, James Paterson, Balfour Stewart, Esqs., and Dr. J. Black.

S. Wekey, Esq., the Honorary Secretary, reported that he had laid before the last Meeting of the Council, a project for the organisation of exploring expeditions for the purpose of "prospecting" in different parts of the Colony, with a view to the development of its various resources, such as Auriferous Fields, Coal, and Minerals generally, and the Vegetable Productions. Owing to the importance of the subject, he was instructed to lay it before this Meeting.

The project being entertained, it was referred to a Sub-Committee, consisting of Dr. Mueller, Dr. Iffla, R. B. Smyth, Esq., and the Honorary Secretary, for details.

Balfour Stewart, Esq., read a paper on "Certain laws observable in the mutual action of Sulphuric Acid and Water." He remarked that these two liquids combined in any proportion, and seemingly without any reference to chemical equivalents; but he would exhibit a method by which a distinct reference to their equivalents might be discerned. If we calculate the specific gravities of the different strengths in Dr. Ure's table, viewed as composed of strong sulphuric acid of the specific gravity 1·8485 and water, we shall find that these are less than the observed specific gravities given by Dr. Ure. This condensation is due to chemical action, and its proportion is greatest for strength 73, which denotes a chemical compound of 1 equivalent sulphuric acid, and 2 equivalents of water. But we may take any strength of mixture as our standard, and view all other mixtures as composed of this mixture, and sulphuric acid, or the same mixture and water according as they are stronger or weaker. In this way, adopting the specific gravity of the standard given by Dr. Ure, we have a different set of calculated specific gravities for each different standard, and consequently a different proportional condensation. If we take the strength 40, 45, 43 as standard, we are pointed to the maximum of condensation at strength 73 as before, but if we take as standards strengths 50, 55, 53, we are pointed to a maximum of condensation between strength 84 and 85 which denotes one equivalent of sulphuric acid, and one equivalent of water. In like manner if we take as standard strengths 40, 38, 45, we are pointed to a maximum at strength 82, which probably denotes a compound containing 5 equivalents of sulphuric acid, and 6 equivalents of water. Mr. Stewart, in conclusion, observed that he did not so much regard the immediate results of this investigation as the means it afforded us of tracing definite chemical action in cases of solution as well as perhaps in alloys and amalgams.

The Rev. A. Morison observed that the subject had no connexion with the Atomic theory, as Mr. Balfour Stewart seemed to imply, nor is it apparent that any result of importance would be gained by the attempt. It is the production or suggestion rather of a mathematical than a chemical mind. In it, the mathematician subordinates the chemist, whereas the reverse is the order of the practical man.

Mr. Stewart agreed that there was no electric affinity in the combination of sulphuric acid and water. The object of the paper was to show that a change was effected by solution, and that that change was regulated by the principles of the Atomic theory. In chemistry the compounds are very often entirely different from either of their ingredients, often slightly different; but in cases of solution it has been the habit to consider that no chemical action has taken place at all. It is not necessary that the compound should possess different optical properties, or differences which are obviously apparent in order to constitute chemical action. The test of contraction in volume is surely quite legitimate.

R. B. Smyth, Esq., said with regard to the maximi of densities, which it was the object of Mr. Stewart's paper to elucidate, he would beg to refer to the following observations of Dr. Ure, who computed the tables on which that paper was founded.

"Dilute acid having a specific gravity = 1·6321 has suffered the greatest condensation; 100 parts in bulk have become 92·14. If either more or less acid exist in the compound, the volume will be increased. What reason can be assigned for the maximum condensation occurring to this particular term of dilution? The above dilute acid consists of 73 per cent. of oil of vitrol, and 27 of water. But 73 of the former contains by this table 59·52 of dry acid, and 13·48 of water. Hence 100 of the dilute acid consists of 59·52 of dry acid + 13·48 × 3 = 40.44 of water = 99·96; or, it is a compound of one atom of dry acid, with three atoms of water. Dry sulphuric acid consists of three atoms of oxygen united to one of sulphur. Then each atom of oxygen is associated with one of water, forming a symmetrical arrangement. One may therefore infer, that the least deviation from the above definite proportions, must impair the balance of the attractive forces, whence they will act less efficaciously, and therefore produce less condensation.

"The very minute and patient examinations which I was induced to bestow on the tables of specific gravities, disclosed to me the general law pervading the whole, and consequently the means of inferring at once the density from the degree of dilution, as also of solving the inverse proportions."

Subsequently Dr. Ure gives clear directions for ascertaining the dry acid and sulphuric acid in any dilute acid of given specific gravity. As Dr. Ure's tables are dependent upon the nicety of his apparatus, and care in truly estimating the various influences to which experiments with sulphuric acid are liable, we cannot implicitly rely upon their accuracy. As a foundation for calculation, such as Mr. Stewart's, he held them to be objectionable. Sulphuric acid, as Dr. Ure observes, has only a small specific heat, and is affected by changes of temperature, which would scarcely be recognised by the most delicate instruments.

Mr. Smyth considered the subject to be highly useful in a scientific point of view, if tested by actual experiment.

Presents acknowledged:—Fossils and Minerals from Mount Ida, M'Ivor, Capt. Clarke, R.E.

September 18*th*, 1854.

Special General Meeting. The President in the Chair.

The Minutes of the last Meeting were read and confirmed.

The Honorary Secretary read the following Report of the Sub-Committee, appointed at the last meeting, to consider the details of the project for organising exploring expeditions:—

"Your Committee, appointed to consider the organisation of Exploring Expeditions, begs to propose that the following resolutions be adopted to that effect:—

"That the Society shall organise exploring expeditions, which shall be despatched from time to time, for the purpose of discovering new auriferous fields, coal, &c., and to collect additional information respecting the various mineral and vegetable resources of Victoria.

"That each exploring party shall be furnished with special instructions by the Society.

"That the reports of such expeditions shall form part of the Transactions of the Society, and be published for general information.

"That in addition to the individual exertions of the members, the whole proceeds of the first Transactions of the Society shall be appropriated to this purpose, and the half of each subsequent publication.

"That any further funds which may be required to carry out this object shall be raised by public subscription.

"That the President be requested to communicate with His Excellency the Lieutenant-Governor, as patron of the Society, requesting him to give his assent to the enterprise."

The Report of the Sub-Committee was unanimously adopted.

R. Brough Smyth, Esq., read a paper on the "Comparative value and durability of Building Materials used in Melbourne."

S. Wekey, Esq., the Honorary Secretary, said that the accumulating business of the Society rendered it scarcely practicable that one person (having other engagements) should perform the duties of Secretary, and moved accordingly:—

"That R. Brough Smyth, Esq., be elected Honorary Secretary, to act in concert with himself."

The motion was seconded by Dr. S. Iffla, and carried.

Presents acknowledged:—Thomas Adair, Esq., Mineral and Botanical Specimens. Capt. Ross, R. N., Shells from Sealer's Cove, Native Bear. R. B. Smyth, Esq., Shells from the Barbadoes, &c.

October, 21*st*, 1854.

MONTHLY MEETING. The Rev. A. Morison in the Chair.

The Minutes of the last Meeting were confirmed.

New Members admitted since last Meeting:—His Honor the Acting Chief Justice, Redmond Barry, Esq., the very Rev. Dr. Geoghegan, the Rev. James Clow, Edward Wilson, J. H. Brooke, Fred. Acheson, Clement Hodgkinson, and L. Becker, Esqs.

Wm. Blandowski, Esq., read a paper,—"Personal Observations during an Excursion through the Central Parts of Victoria."

November 14*th*, 1854.

Monthly Meeting.

In the absence of the President, R. Eades, Esq., M.D., was voted to the Chair.

The Minutes of the last Meeting were confirmed.

S. Wekey, Esq., Hon. Sec., announced to the Meeting, that in order to meet the wishes of several of its Members, it was resolved at the last Meeting of the Council that the Monthly Meeting of the Society should be held on the second Tuesday of the month instead of on the second Saturday.

New Members admitted since the last Monthly Meeting of the Society:—W. C. Rownsley, and Charles Gregory Feinagle, Esqs.

Dr. Mueller's paper,—"Definitions of rare and hitherto undescribed Australian Plants," was laid before the Meeting.

Clement Hodgkinson, Esq., read a paper on—"Engineering Earthworks, and Railway Cuttings," illustrated by tables and diagrams.

Dr. Eades having vacated the Chair, which was occupied by Dr. Iffla, brought forward an essay—"On the comparative Actions of Disinfecting Agents."

Dr. Eades showed that hypochlorite of lime should be considered as the true disinfecting agent. By the combination of the carbonic acid of the air with the base of this salt, hyponitrous acid ($Cl + O$) was eliminated. The elements of this acid being nearly equally negative electric repel each other, thus oxygen is set free, purifying the air, while the disengaged chlorine acting on aqueous vapour, an additional quantity of oxygen is set free, at the same time that other atoms of chlorine decompose the fœtid gases. After some further remarks on the part of Dr. Eades, some discussion took place, and Charles Feinagle, Esq., observed that upon the theory now proposed, the moisture of the air would be rapidly exhausted by decomposition, in which case the chlorine would cease to act.

To this it was replied that the chlorine was given off in its moist state.

Several of the Members expressed their opinions in reference to Dr. Eades' assertions, and the subject was then allowed to give place to the other business of the Meeting.

The President having arrived, Dr. S. Iffla vacated the Chair, and requested the President to occupy the same. The progress made with reference to the contemplated exploring expedition having been brought forward before the Meeting by the President, it was moved by Richard Eades, Esq., M.D., seconded by R. Brough Smyth, Esq., and carried—"That the Council be instructed to pre-

pare petitions to his Excellency the Lieutenant Governor and to the Honorable the Legislative Council, requesting them to assist in carrying out the object aimed at."

S. Iffla, Esq., M.D., brought before the Meeting the advisability of an application for a Royal Charter, in reference to which it was moved by J. H. Brooke, Esq., seconded by Dr. Iffla, and carried—"That the Council be instructed to make the necessary arrangements to prepare the form of application for the incorporation of the Society by a royal charter, and their report be laid before a General Meeting of Members as soon as possible."

December 12th, 1854.

MONTHLY MEETING. D. E. Wilkie, Esq., M.D., in the Chair.

The Minutes of the last Meeting were confirmed.

New Members admitted since the last Meeting:—Major Norman Campbell, the Right Rev. Dr. Goold, Roman Catholic Bishop of Melbourne, Sir William A'Beckett, Chief Justice, the Right Rev. Dr. Perry, Lord Bishop of Melbourne, the Very Rev. Dr. Fitzpatrick, Dr. McKenna, W. H. Campbell, T. Pardoe, and S. Hanaford, Esqs.

The following memorials in compliance with the resolution of the last Meeting were unanimously agreed upon.

To His Excellency Sir Charles Hotham, Knight, Commander of the Bath, Lieutenant Governor of Victoria, &c.

The memorial of the Members of the Philosophical Society of Victoria in General Meeting assembled,

Humbly sheweth:—

That your Memorialists, deeply impressed with the necessity of eliciting the fullest information relative to the available sources of industry, which exist in the Colony, would beg to draw the attention of your Excellency to the following suggestive scheme, which, in the judgment of your Memorialists, is adequate to the end proposed.

That your Memorialists having seen with regret the inutility of individual exertions in prosecuting researches for auriferous fields, coal and other minerals, have devised and proposed that duly qualified agents should be sent to explore such parts of the Colony as are most likely to possess mineral or metallic wealth; and that these agents, on the completion of such examinations, should report to your petitioners of the same for the information of themselves and the public. That these agents should also collect specimens which might seem to them of practical value or of peculiar scientific interest.

That your Memorialists have brought this matter before the inhabitants of Victoria, and have sought to induce their co-operation, but

without practical effect; and as the resources of the Philosophical Society are insufficient for the prosecution of these researches, your Memorialists are therefore led to beg Your Excellency's consideration of the great and incalculable benefits that might result from such inquiries, pursued under the supervision of your Memorialists; and if it should appear of similar importance to Your Excellency, your Memorialsts would earnestly pray for such support as your Excellency may deem advisable to extend,

And your Memorialists will ever pray, &c.

To the Honourable the Legislative Council of the Colony of Victoria

The Memorial of the Members of the Philosophical Society of Victoria in General Meeting assembled,

Humbly sheweth :—

That your Memorialists, mindful of the onerous duties which devolve upon them as citizens, and as Members of a Scientific Institution, have endeavoured to enlist the support of the inhabitants of Victoria in the prosecution of inquiries, tending to the discovery of the various natural productions which are held to be the chief sources of wealth in all countries.

That your Memorialists have proposed to establish, on a broad basis, a system of discovery replete with benefits to the Colony at large, and of high and significant importance to the scientific world.

Your Memorialists propose to send to the interior, or to such districts as they shall determine, suitably-qualified persons to examine and report upon the mineral as well as other natural resources of such districts, and to collect specimens in natural history of a practical value, so that the wealth of this country in these departments may become available to the inhabitants.

Your Memorialists have not received as yet that support from the public which would warrant them to attempt the realisation of this scheme; and therefore your Memorialists would respectfully draw the attention of your Honourable House to the consideration of this matter, relating as it does to the immediate prosperity of the country.

That your Petitioners feeling the responsibility which attaches to a work of the magnitude here indicated, would beg the support of your Honourable House in the furtherance of the object aimed at.

And your Petitioners will ever pray, &c.

J. H. Brooke, Esq. moved, and S. Wekey, Esq. seconded; and it was agreed,—

That the memorial to His Excellency the Lieutenant Governor be presented by a deputation consisting of Captain Clarke, R.E., Dr. Hutchinson, and Dr. Iffla.

Dr. E. Davey read an essay "On the construction of an instrument for ascertaining the mean temperature of any place."

Ludwig Becker, Esq., read a paper "On Meteorological Observations at Bendigo."

Presents acknowledged,—Collection of Crystals of Gypsums from the Salt Water River—Edward Wilson, Esq.

January 9th, 1855.

MONTHLY MEETING. The President in the Chair.

The minutes of the last Meeting were read and confirmed.

The Honorary Secretary informed the Meeting that in compliance with the resolution agreed to at the last General Meeting, respecting the application to His Excellency the Lieutenant-Governor, for a grant, for the purpose of carrying out the scheme of an Exploring Expedition contemplated by the Society, the following correspondence has taken place between His Excellency the Lieutenant-Governor and one of the Honorary Secretaries:—

Museum of Natural History, Melbourne,
December 14th, 1854.

Sir,—I have the honour to enclose the copy of a memorial of the Members of the Philosophical Society of Victoria to His Excellency the Lieutenant-Governor, and request you will be pleased to ascertain when it will be convenient to His Excellency to meet the deputation, consisting of the Surveyor-General, Dr. Hutchinson, and Dr. Iffla, appointed to present the said memorial.

I have the honour to remain, Sir,
Your most obedient Servant,
S. WEKEY, Hon. Sec.

Captain J. H. Kay, R.N., Private Secretary.

To the above letter the following reply was received:—

Government Offices,
Melbourne, 18th December, 1854.

Sir,—I am directed by the Lieutenant-Governor to acknowledge the receipt of your letter of the 14th inst.; and in replying to it His Excellency trusts that the Philosophical Society of Victoria will not think him inattentive to their wishes, if he conveys his views to them in writing.

The Lieutenant-Governor regrets that the insufficiency of the public funds to meet the public requirements renders it imperative upon him to stay every possible expense; but that with regard to gold, the numerous prospecting parties (which are searching the length and breadth of

the land), in the Lieutenant-Governor's opinion, fully encompasses the end sought by the Society; whilst with regard to coal, it is reported that the fields at Western Port are sufficient to last a generation.

At a future time the Lieutenant-Governor will be most happy to lend his aid in furthering the important objects which the Philosophical Society of Victoria has in view.

I have the honour to be, Sir,
Your most obedient Servant,
S. Wekey, Esq. J. H. Kay, Private Sec.

Some of the members did not seem to understand the proper meaning of the letter of the Private Secretary, as the latter part of the said letter appeared to be contradictory of its former part. In the first part of the letter it is stated, "that as the length and breadth of the land is searched by prospecting parties, and as it is reported the coal-fields at Western Port are sufficient to last a generation," therefore, in the Lieutenant-Governor's opinion, this circumstance fully encompasses the end sought by the Society, which is as much as to say that the objects of the Philosophical Society are unnecessary,—whereas in the concluding sentence of the letter it is stated, that "at a future time the Lieutenant-Governor will be most happy to lend his aid in furthering the important objects which the Philosophical Society of Victoria has in view."

The subject however dropped.

It was announced by the Honorary Secretary that a proposal had been received from the Victorian Institute, to amalgamate with the Philosophical Society; but as yet nothing definite has been done.

On the subject of the amalgamation a discussion arose, when it was moved by Dr. Iffla, seconded by Mr. S. Wekey, and carried:—

"That as soon as the correspondence between the Victorian Institute and the Philosophical Society is complete respecting the proposal of the amalgamation of the two societies, a Special General Meeting be called to consider the matter."

D. E. Wilkie, Esq., M.D., read a paper "On the probable Failure of the Yan Yean Reservoir."

After an ananimated discussion as to whether the paper be published or not, on the motion of Dr. Iffla, seconded by Dr. Eades, it was resolved:—

"That a commission, consisting of F. C. Christy, Esq., Frederick Acheson, Esq., and Clement Hodgkinson, Esq., Engineers, and S. Wekey, Esq., Secretary, be appointed to enquire into the statements set forth by Dr. Wilkie, respecting the Yan Yean Reservoir, and to report to the Society at the General Meeting."

Balfour Stewart, Esq., then read a paper "On the Influence of Gravity on the Physical Condition of the Moon's Surface." And also a second essay "On the Adaptation of the Eye to the Nature of the Rays which emanate from Bodies."

February 20th, 1855.

Monthly Meeting.

The President of the Society having been detained, Mr. Justice Barry was invited to take the chair.

The reading of the minutes of the last meeting was postponed to the next meeting.

The following Gentlemen were announced to have been admitted members of the Society, since the last meeting:—

The Honourable the Attorney-General, W. F. Stawell, Esq.; Captain Pasley, R. E., Colonial Engineer; Wm. M'Crea, Esq., Colonial Surgeon; W. H. Archer, Esq., A. Registrar-General.

The Honorary Secretary, informed the meeting that, in compliance with the resolution of the last meeting, the commission appointed to investigate the statements set forth in a paper read by Dr. Wilkie, on the Yan Yean Reservoir, went up to that district and examined the reservoir, as well as the Plenty River and its sources. They made measurements of the Plenty at various parts, with the view of ascertaining the average quantity of water the river is capable of discharging. They likewise made measurements of the main tributaries, viz., the western and eastern arms, and traced the source of the latter to the top of Mount Disappointment. The report of the commission, however, as it involved a vast amount of calculation, as well as actual experiments upon the evaporation, could not be laid before this meeting with all the necessary details. He stated further that the commissioners had furnished Dr. Wilkie with the result of their measurements, founded on which data his present paper was enlarged and amended.

Dr. Wilkie then read a paper on the Yan Yean Reservoir, founded on the data above referred to. He endeavoured to show that there would not be sufficient water in the reservoir, after deducting the evaporation, to supply more than 75,000 individuals at forty gallons per head per diem; and he argued that on the constant-service principle, the supply might be found altogether insufficient even for that number; he stated that it had been found by the experience of other cities that forty gallons could not be depended on as a sufficient supply. He showed that from fifty to 100 gallons per head per day were frequently used, and that several cities in England have been obliged to abandon the constant-service principle altogether from an insufficient supply of water. Dr. Wilkie also strongly objected to the principle of storing water in a swamp, and thought that it would become very much deteriorated and incurably infected with animalculæ and vegetable productions which no filtration could remove. He entered at great length into

the question of the probable amount of the water-shed of the Plenty, which he estimated, according to Dr. Thomson's method, at one-ninth (1-9) part of the rain; and showed that the evaporation in this country was so enormous that if the whole water-shed of the Plenty could be secured for the reservoir it would be nearly all evaporated in twelve months.

After the reading of the paper the Chairman called on the members to offer their remarks upon its contents.

Mr. Acheson stated on the part of the committee the result of their calculations.

Mr. Christy observed that about the same quantity of water reached the river here as in England.

Dr. Wilkie said he was exceedingly sorry that the members of the commission had not brought up their report- He was also much surprised to find that, instead of availing themselves of the actual measurements, and from them deducing the supply for the reservoir, they had merely given some theoretical views with respect to the probable amount, and which were founded upon the deductions of Mr. Dempsey, whose name he had never heard. The late Mr. Blackburn had, in his evidence before the Select Committee, given 5,000 gallons per minute as the average discharge of both branches of the river above the swamps, and he, Dr. Wilkie, had founded all his calculations upon that estimate, although, before the river reaches Yan Yean, one half was lost by evaporation in the swamps. He had, however, allowed an increase of one-third in the volume of the river for the six winter months, independent of floods; and now argued that, as the climate of Australia was exceedingly dry, and there were very few rivers, and those had but a small quantity of water in them, a much less proportion of rain reached the rivers here than in England. It was utterly impossible, he considered, that out of an inch of rain three-fourths could reach the river from every part of the drainage area; but his opinion was, that from the geological formation of the Plenty Ranges, a very large proportion of the rain was absorbed, and that it was because the ranges retained the winter rain and gave it out during the summer, that the stream was permanent.

Dr. Iffla directed the attention of the meeting to the importance of the purity of water to the health of the inhabitants; for when filled with a great quantity of vegetable matter it was likely to be contaminated by a large quantity of animalculæ. This was the more likely to take place in a reservoir, where the water could not freely flow, and where it was constantly under the action of the solar rays.

The President of the Society who in the mean time arrived, said that the thanks of the public were due to Dr. Wilkie, for having directed public attention to this most important subject in a paper written with so much care. The meeting could not come to any

decision until the report of the commission had been laid before the members; and he thought that the present paper should not be published without the report. He hoped that the gentlemen appointed on the committee would furnish to the society such complete and detailed information as would be likely to settle the subject.

The Honorary Secretary, stated that Mr. Hodgkinson one of the members of the committee, having met with an accident, was unable to act, and asked whether it would not be necessary to appoint another in his stead.

The President said that the committee, as he understood, having already completed the measurements and agreed upon the data, they could finish their report, and it would not be necessary to put a new member upon the committee.

The Chairman then asked the members whether Dr. Davey's paper "On the Meteorology of Melbourne" should be read that evening. It was, however, owing to the late hour, determined, that the reading of the paper should be postponed till the next meeting, and then to be considered in priority to any other business.

Thanks were then voted to the Chairman, and the meeting separated.

March 13*th*, 1855.

MONTHLY MEETING. The President in the chair.

The minutes of the last two meetings were read and confirmed.

New members, elected since last meeting, were introduced, viz., Alexander Kennedy Smith, Arthur Dobree and F. Phillips, Esqs.

According to the resolution of the last meeting, Dr. Davey's paper "On the Meteorology of Melbourne" was read first.

The Honorary Secretary, on laying before the meeting the report of the Committee, appointed to investigate the Yan Yean water scheme, announced that he considered it his duty to mention that he had reason to ask at the last meeting whether instead of Mr. Hodgkinson being obliged to retire from the Committee, it would be necessary to appoint another? He stated as his reasons, that the remaining members of the Committee did not agree upon various important points contained in the report, and in his opinion it was desirable that the statements set forth by the Committee, upon such an important question as the water' scheme, should have been considered by a larger number of members than the present Committee consisted of. For reasons above stated, he did not feel justified in signing the document now being submitted to the meeting, and he believed that had his request at the last

meeting been complied with, the doubts entertained by the public on the Yan Yean water scheme would have been more likely removed he believed than will be by the present report.

The report of the Committee appointed at a meeting held on the 9th of January last, to investigate the Yan Yean water scheme, was read, and the statements illustrated by diagrams, shewing the physical character of the country in the neighbourhood of Yan Yean, with the tributaries and sources of the River Plenty and various measurements.

Clement Hodgkinson, Esq., read a paper, "On the Cause of the enormous difference between the Ratio of available Rainfall in the Plenty District as adopted by Dr. Wilkie and that approved by the Commission."

Dr. Wilkie then read his additional observations on the statements of the committee, eontained in the reports. He enlarged upon the committee having taken as an authority the estimate of available rainfall of Mr. Dempsey, which is quite inapplicable to this case.

Mr. Acheson, on behalf of the committee, stated that the committee was not guided by the calculations of Mr. Dempsey; but, that having arrived to the same result with the above named author, this fact corroborated that the committee was correct in this calculation.

Letters received from the Victorian Institute, having reference to the proposal of the Institution to be amalgamated with the Philosophical Society, were referred to the consideration of the council.

The Hon. Secretary announced, that at the last meeting of the council of the Society, it was proposed to petition the Hon. the Legislative Council, requesting that hon. house, in case the Government should not continue to maintain the Museum of Natural History, to place it under the custody of the Philosophical Society, and the society will try to do all they can to keep up that only national institute existing.

The President, in reference to the proposal of the Council, stated, that the Legislative Council, having taken the matter under consideration, this proposal should be deferred until the final decision of the House with reference to the maintenance of the Museum of Natural History should be known.

March 27, 1855.

Special General Meeting. A. K. Smith, Esq., in the Chair.

The minutes of the last meeting were read and confirmed.

The Chairman, after having stated that the meeting was convened in compliance with the resolution passed at a monthly meeting of

the society, held on the 9th of January last, when it was resolved that the correspondence with reference to the amalgamation of the Victorian Institute with the Philosophical Society, when complete, be laid before a special general meeting for their consideration, called on the Secretary to read the correspondence referred to.

After the correspondence had been read, Mr. S. Wekey, the Hon. Secretary, laid before the meeting the statements having reference to the comparative relation of the two societies. He said, that according to the report of the Victorian Institute read before a half-yearly meeting held on Thursday, 8th March, 1855, it was stated that the Victorian Institute had a balance in hand of £68 9s. 8d.; while the Philosophical Society at the same time had available funds from members' subscriptions to the amount of £170, which, in case of an amalgamation, will leave, in favour of the Victorian Institute, £100.

At a meeting of the Victorian Institute, held on the 8th of March it was reported, that up to that date six papers had been read, while on the other hand, the Philosophical Society, during the same period of time, had received seventeen papers, which, in case of an amalgamation, would leave in their favour eleven papers.

As to the officers of the Victorian Institute, an amalgamation *de facto* has already taken place, since the President of the Institute, with several members of the council, are now actually members of the Philosophical Society; and, although this society had no opportunity as yet to open a wider field, for the exertions and attainments of those who, previously members of the Victorian Institute have afterwards joined the Philosophical Society, as far as he can judge, the members of the Society are anxiously waiting for the first opportunity, at the next anniversary meeting, to be held in August, to invite the co-operation of some of them to occupy such a post in the society as will give them an opportunity of exerting themselves in behalf of the interests of the society, as well as the advancement of science in Victoria.

As to the annual subscription, there is some difference between the Victorian Institute and the Philosophical Society. The entrance fee and the subscription to the Philosophical Society is considered by some high; but although in one instance its reduction was contemplated, the council did not deem it expedient to reduce the same.

A discussion on the subject then took place, and on account of the small attendance the meeting was adjourned, and the subject referred to the next monthly meeting of the society.

April 10*th*, 1855.

MONTHLY MEETING. Dr. Wilkie in the Chair.

The minutes of the last meeting were confirmed.

R. Brough Smyth, Esq., read a paper "On the Influence of the Physical Character of a Country on the Climatology."

He endeavoured to show how far the physical character and geological formation of a country react upon the climatology, and how the course of rivers and creeks are influenced by it. He next showed, by diagrams and sections, the principal geological features of Victoria, and compared the formation of the ranges as influencing the course of the main streams of the rivers running parallel with them, and mentioned the following rivers as examples:—The La Trobe, the Goulburn, the Snowy River, and the Yarra.

He next showed that little reliance could be placed on meteorological observations, made at a certain place, either with regard to the quantity of rain or the evaporation, as the greater portion of Victoria consisted of alternate ranges and plains.

After referring to the origin of springs and their effects, in this climate, he concluded with practical applications on the formation of reservoirs, pointing out the absolute necessity of a due recognition of scientific principles in opposition to empirical knowledge in all such undertakings.

William Blandowski, Esq., laid before the meeting specimens of rocks, containing fossil remains, forwarded by F. Acheson, Esq., through him. The peculiarity of these rocks were, that they were discovered in the vicinity of one of the first gold-fields of Victoria, though the fossil remains were those of oceanic animals usually found at a great depth below the surface; these were discovered between layers of hard blue slate, in a vein about fifteen inches thick.

On the subject of the amalgamation of the Philosophical Society and the Victorian Institute, the Chairman stated that at a special general meeting held a fortnight ago, the subject was adjourned to this meeting, on account of the small attendance; and he now begged to suggest that the subject be referred to the council of the society, and that they should report to a general meeting their opinion as to the best course of proceeding.

Dr. Iffla agreed with the views of the Chairman.

Mr. Blandowski thought it better to discuss the subject at once. When it was moved by R. Brough Smyth, Esq., Hon. Sec., and seconded by Wm. Blandowski, Esq. and carried. "That six

members of the Philosophical Society should meet a committee of six of the members of the Victorian Institute, to arrange matters on the subject of the amalgamation of the two societies, such committee to consist of Drs. Wilkie, Iffla, and Eades, and Messrs. Blandowski, Wekey, and the mover."

Presents acknowledged.—Specimens of the clay slate formation with fossil remains, F. Acheson, Esq.; specimens of basalt and fine crystals of carbonate of lime, R. B. Smyth, Esq.

May 18*th*, 1855.

MONTHLY MEETING.

In the absence of the President, S. Iffla, Esq., M.D., was voted to the chair.

The minutes of last meeting were read and confirmed.

The Honorary Secretary announced the names of the following new members, elected since the last monthly meeting of the society:—Hugh Culling E. Childers, Esq., Ralph Lowe, Esq., William Thomson, Esq., and Professors McCoy and Wilson, of the Melbourne University.

Clement Hodgkinson, Esq., read a paper entitled "Practical Hints on the best Method of Guaging Rivers accurately," with a brief description of a modification of the hydrometrical pendulum, adopted by the writer, with an original table.

W. Blandowski, Esq., read a paper, "On the Primary Upheaval of the Land around Melbourne," illustrated by a large number of specimens from that locality.

D. E. Wilkie, Esq., M.D., read a paper, "On the Data on which we have to depend for our Water Supply."

The Honorary Secretary read the following report of the committee appointed to consider the propriety of the proposed amalgamation with the Victorian Institute.

Report.

The members of the Philosophical Society and of the Victorian Institute, appointed to confer upon terms of amalgamation of the two bodies have the honour to report to their respective societies as follows:—

They have held four meetings, have considered the fundamental principles and present position of the two societies, and find no impediment to amalgamation. They accordingly recommend—

That the two societies be amalgamated, under the title, pending the grant of a royal charter, of "The Philosophical Institute of Victoria."

That the following gentlemen be office-bearers of the Philosophical

Institute of Victoria:—President, Captain Clarke, R.E.; vice-presidents, his Honor Mr. Justice Barry and Godfrey Howitt, Esq., M.D.; council, the present members of the council of the Philosophical Society and of the Victorian Institute; treasurer, D. E. Wilkie, Esq., M.D.; honorary secretaries, S. Wekey, Esq., R. B. Smyth, Esq., W. S. Gibbons, Esq,

That the members of the Philosophical Institute of Victoria shall consist of fellows, resident and honorary members. That fellows shall be elected from among the resident members by ballot, at the monthly meetings of the society; the proportion of votes for deciding the election of fellows to be at least four-fifths of the members voting. That resident members be admitted on application to, and approval by the council.

That honorary membership shall be considered one of the highest marks of distinction the society can confer.

That the objects of the Philosophical Institute shall be as stated in the prospectus of the Philosophical Society, viz.:—The objects of the society shall embrace the whole field of science, with a special reference to the cultivation of those departments that are calculated to develope the natural resources of the country.

That the mode of operation stated in the prospectus of the Philosophical Society be adopted, with some addition, viz.:—The objects of the society will be carried out by original researches conducted by the members, and by original papers, to be read at the periodical meetings, and published under the direction of the society; and by such other means as may be deemed expedient.

That the principle set forth in the paragraph headed "Bye laws and Regulations," in the prospectus of the Philosophical Society, viz.:—"The society shall be definitely established on the principle of the Royal Society of London, as far as the existing bye-laws and regulations of that Society may be applicable to the present local circumstances of Victoria,"—be rejected, inasmuch as the regulations of the Royal Society of London forbid the discussion of papers read at general meetings,—such discussion being deemed desirable, and forming an essential part of the scheme of the Victorian Institute. That bye-laws and regulations be therefore framed hereafter by the Philosophical Institute.

That with regard to the property of the society, the specimens of natural history contributed to the society shall be considered the property of the National Museum until otherwise ordered and resolved by the annual general meeting of the society.

That the resolution of the annual general meeting, shall not extend to those specimens that are found in actual possession of the society at the time of such resolution being brought in, such specimens being already the property of the National Museum; but merely to such specimens as may be collected after the date of the said resolution being made.

That every paper, plan, model, &c., presented to the society shall be considered the property thereof, unless there shall have been made some previous arrangements with the donor; and the council may publish such paper, and a description of such plan or model, any time they think proper.

No member shall publish on his own account, or give his consent for publication of, any written communication read to the society, without the previous consent of the council.

These recommendations are based on the four paragraphs headed "The Property of the Society," in the prospectus of the Philosophical Society. Some alterations, however, it will be seen have been made, because it was not deemed desirable that models and books presented to the society should pass out of their hands, because the first of these paragraphs, literally interpreted, would deprive the society of all property whatsoever, even in their own transactions, and because such interpretation contradicts the third paragraph, which has been adopted verbatim.

That the subscriptions at present payable by the members of the Philosophical Society and of the Victorian Institute respectively, be considered the subscriptions due to the Philosophical Society of Victoria for the current year, after which the subscription to the Philosophical Institute can be fixed by that body.

In recommending that the Victorian Institute and Philosophical Society be amalgamated on the above general terms, the fact has been borne in mind that, after amalgamation, these terms would be subject to complete revision by the Philosophical Institute, and that all details can be most properly adjusted by general vote of the united body. In conclusion, therefore, the members of the conference appointed to consider the terms of the proposed amalgamation, strongly recommend that to bring about that desirable end, minor objections should be waived and concessions freely made on both sides, as such concessions will merely be required to permit the preliminary difficulties to be overcome, and will not be permanent unless hereafter approved by the members of the Philosophical Institute of Victoria.

FRED. SINNETT, CHAIRMAN.

The following presents were acknowledged :—

A large number of specimens with numerous fossil remains, from the Anderson's Creek Gold Diggings, collected by Messrs. Blandowski, Acheson, and Wekey. These specimens are of great scientific interest as they may be considered to furnish data for determining the geological age of our earliest gold field.

Fifty specimens of different species of Mollusca, collected at Sealer's Cove, and forwarded by Dr. F. Mueller, for the Museum Dr. Mueller likewise exhibited a very singular specimen of phosphorescent plant, the *luminous agaricus*. The plant although now dead, on being moistened exhibited considerable luminosity.

June 12th, 1855.

MONTHLY MEETING. Clement Hodgkinson, Esq., in the Chair.

The minutes of the last Meeting were read and confirmed.

Dr. F. Mueller read a paper :—"Definitions of hitherto undescribed Plants from the Australian Alps," illustrated by carefully arranged specimens.

R. Brough Smyth, Esq., Hon. Sec., laid before the Meeting a

Meteorological Table for the months of April and May, informing the Meeting that such Meteorological Table will be laid before the Society at each monthly meeting.

Clement Hodgkinson, Esq., requested the secretary to read his observations "On the statements of Dr. D. E. Wilkie and Charles Griffith, Esq., concerning himself, with reference to the Yan Yean Water Scheme, pointing out the several errors into which they had fallen."

July 10*th*, 1855.

MONTHLY MEETING. Dr. J. Maund in the chair.

This was the first general meeting of the members of the Philosophical Society and the Victorian Institute, since the preliminary arrangements, to effect the amalgamation of both societies, under the name of the Philosophical Institute of Victoria, were completed. The papers read at this meeting having been written by members of the Philosophical Society, with the view of being laid before the meeting of the Philosophical Society; in order to complete the Transactions for the past year, these papers as well as the proceedings of the meeting are given in this volume.

Dr. Eades, in proposing that Dr. Maund should take the chair, remarked that as this was the first meeting of the united societies, and as the newly-formed society, under the title of the Philosophical Institute, met in the room where the late Philosophical Society held their meetings, he felt it, as a matter of delicacy and courtesy, that, in the absence of the President, one of the members of the late Victorian Institute should take the chair. Accordingly he felt happy in proposing Dr. Maund.

The Chairman, in opening the meeting, remarked that it was the first meeting of the body, composed of the members of the late Philosophical Society and of the Victorian Institute. He trusted that the members of the Philosophical Institute would cooperate for the attainment of the objects contemplated by the society.

The Honorary Secretary, announced the admission of new members since the last meeting of the Philosophical Society, viz.:—A. B. Johnson, Esq., Robert Sloane, Esq., resident members: and Robert Scott, Esq., corresponding member of the society.

A report On the physical character of the county of Heytesbury, to the Surveyor-General, Captain Clarke, R.E., by the Resident Surveyor, Robert Scott, Esq., was read by Fred. Acheson, Esq., C.E.

This paper embodied the observations of the author during a professional tour through the country drained by Gellibrand's

River and Curdie's Creek. For the better illustration of the author's journey, a map of the county of Heytesbury was exhibited, showing the main geographical features as far as they have been laid down on the maps issued by the general survey. The author commenced by a detailed description of Lake Elingamite, which is supposed to be the source of Brucknell's Creek. This lake is about four miles in circumference, and is situate six miles and a half south-west from the parish of Colongulac. He started from thence on foot, surveying the whole course of Curdie's Creek and its numerous tributaries. He describes the soil in that neighbourhood as poor in quality, but well grassed and heavily timbered with stringy bark, and other species of *Eucalypti*. Many of the valleys are of a richer description, well clad with lightwood, gum, &c. The formation generally appears to be basaltic or volcanic. The "Stony Rises," on the east side of Lake Purrumbeet are described as irregularly piled masses of trappean rocks. Numerous marshes and swamps, in this tract of country, supply Curdie's Creek, and the soil is of a light chocolate colour, supporting various species of the eucalyptus and the acacia. Some of the higher lands, bordering on Curdie's Creek, present the remarkable fact of the existence of marine shells, intermixed with fragments of limestone quartz, &c. The land southward of this is of an undulating character, and it is in some parts covered with thick scrub and strong grass, from whence has arisen a considerable surface deposit of decomposed vegetable matter, which the author seems to think might be used as peat. After supplying much useful information respecting the inland district of Heytesbury, the author describes his journey southwards to the coast, and notices the different kinds of rocks, which form the cliffs, near the mouth of Gellibrand's river. The strata, it appears, is nearly horizontal, and, from the author's allusions to its calcareous nature, and the presence of calcareous concretions, it may be presumed that it does not differ, in any remarkable degree, from the tertiary formations in other parts of the coast. The author's subsequent remarks on the navigation of the streams, near this part of the coast, were of a practical character, and could not be properly entered into without explanatory charts.

The Chairman observed that the conference of councils had divided on the advisability of admitting discussion on each paper.—The late Philosophical Society had followed the practice of the Royal Society of England, which forbids discussion. It was, however, deemed advisable that free discussion should be admitted on every subject that was introduced, so that every possible light might be thrown upon it; he therefore invited the members to offer any remarks they may have with reference to the statements contained in the paper.

Mr. Acheson adverted to the great importance of the discovery of peat mentioned as existing in the locality described. He ques-

tioned, however, whether it was not mistaken for decayed vegetable matter, which often resembles peat, but is quite distinct from it.

Mr. Hodgkinson alluded to the discovery of the chalk formation by the writer, he was, however, of opinion that the geological formation of the district would not bear out the existence of chalk in those localities.

The chairman stated that chalk and other salts, when held in solution, were frequently deposited on evaporation ; and that rich crops of natural crystals were frequently found in caverns. Something of this kind was mentioned in the paper.

Mr. Blandowski believed that the writer did not furnish sufficient evidence in proof of his statements concerning the chalk formation

Dr. Maund suggested that the difference of view might arise from the change by natural causes of limestone, the oxide of calcium, into chalk, the carbonate of lime. The lime might have been held in solution as a bicarbonate, and the other equivalent of carbonic acid have been taken up from the air.

Mr. Blandowski disagreed with the views of Dr. Maund, andsaid that although the chemical composition of lime and chalk is similar, the term *chalk* could not be applied to all decomposed limestone, and they were different in a geological point of view.

Clement Hodgkinson, Esq., read a paper "On the favourable geological and chemical nature on the principal rocks and soils of Victoria, in reference to the production of ordinary cereals and wine." Mr. Hodgkinson, after making some general allusions to the geological configuration and soils of the other Australian colonies, arrived at the conclusion that soil in general derived from volcanic rocks in Australia was more fertile than that derived from aqueous or plutonic rocks. The writer gave an analysis of soil derived from disintegrated basalt near Melbourne. He referred to the important fact, that, near Sydney, there was some land on trap dykes which was under culture and cropped during the past half century, without manuring or fallowing, while its fertility remained undiminished. Mr. Hodgkinson attributed this to the intensity of the disintegrating action that has been maintained in the soil, and which action, in his opinion, had set free during the period that the land had been cultivated as large a quantity,of alkalies, phosphates, &c., as had been consumed by the crops. He maintained that soil of this favourable quality occurs in large numbers of isolated patches omong the volcanic rocks of Victoria. Mr. Hodgkinson next explained the important influence of the inorganic constituents of the soil of the vineyard on the quality of its wine. He demonstrated that the disintegration of clayslate was exceedingly favourable for the production of superior wine. He referred to the large quantity of land of this description in the basin of the Yarra, at an easy distance from Melbourne, which he stated to be analogous to that of the celebrated vineyards on the schistoze mountains of the Valley of the Rhine.

In reference to the paper of Mr. Hodgkinson, a letter was read from R. B. Smyth, Esq., one of the hon. secretaries, who was unable to attend.

Melbourne, July 9th, 1855.

Dear Sir—I have to thank you for having permitted me to peruse a manuscript of yours on the soils, and general agricultural properties of the lands in Victoria. You have handled the subject so carefully, and displayed such a large amount of practical knowledge in that department of science, that I dare not venture to offer a criticism.

Your analysis of the volcanic soils is borne out by the facts elicited by Klaproth, Vauquelin, Rose, and others, in reference to the minerals which these rocks contain; and you have done great service to agriculture by pointing out the causes of the remarkable fertility of soils of such a character.

Let me offer a few remarks, in addition to what you have stated in your paper, in elucidation of the facts there put forth.

One great cause of the fertility of volcanic soils is due to the colour, consistency, and the consequent comparative rapidity with which such soils radiate heat absorbed during the day. Experiment has shown that the general temperature of rich black mould is some degrees higher than wet clay during the solar heat; and a regular scale of temperatures is found between white clay saturated with moisture and black earth. Now, in addition to this, it is found that a rich black soil, radiating heat as it does with such rapidity, necessarily condenses a larger amount of dew than a clay soil, thus supply the plant with an absolute necessary in comparative abundance. This property is really an objection in a climate such as England, if in excess; but in this climate it must be held as a prime consideration in choosing land for agricultural purposes.

I do not hold that this applies in strictness, or with equal force, to all volcanic soils. It is, however, the characteristic of the volcanic soils in this country. For the growth of cereals—wheat for instance—where the roots are fine and radiating, and the stalk high and heavy, possibly volcanic soil of the richest kind is not to be chosen. It is perhaps better adapted to horticultural products.

Another cause of the fertility of this soil is to be found in the vast amount of decaying and decayed vegetable matter which it contains.—This, I need not remind you, has the property of absorbing carbonic acid from the atmosphere, and in itself, almost indestructible, is a never-failing storehouse for this essential ingredient in vegetable substance.—When engaged in experimenting in England, in 1850 and 1851, I repeatedly raised crops from pounded charcoal. The plants were kept in pots, regularly watered, and subjected to different temperatures, and the results were most satisfactory. I may venture to say that almost any soil may be rendered productive by the addition of pounded charcoal, or coal dust, or soot.

It is the vulgar opinion of agriculturists that charcoal in this shape is really appropriated by the plant, but this is now utterly exploded wherever experiment has taken the place of vague conjecture.

Having devoted a considerable portion of my leisure time in England, some three or four years ago, to the consideration of these questions,

perhaps I may be competent to express an opinion as to the justness of your general conclusions. The subject is so important, that I venture to suggest that you should extend your experiments, with a view to compare the different soils in this country from distinct geological formations; possibly the information so gained might be viewed with distrust by the agriculturists in Victoria, and tardily brought to bear upon their practice, but my experience has shown that agriculturists readily accept anything simple, suited to their limited views of these matter; and whenaided by the really able and learned agriculturists in England, (where there are now many,) working on scientific principles, the less informed grasp at the empirical results, and thus great good is the consequence, though perhaps in an objectionable form.

Whoever assists in imparting a knowledge of the resources of our beautiful and highly-favoured country—second to none on the face of the earth—will find in pleasing reflections, perhaps, his only reward—not small—not to be despised—a reward sufficient for him who can find delight in the toil of discovery; and he will be laying the foundation for our future national greatness.

I am,
With every sentiment of respect,
Your most faithful servant,
R. Brough Smyth,
Mining Engineer.

Mr. Wekey stated that he could not exactly agree with Mr. Smyth's views that the colour contributes to the fertility of the soil, although he admitted that it is an important medium in promoting germination. He proceeded to say that every one who has made the common experiment of transmitting the solar rays through a prismatic spectrum, will have observed the variety of colours that by such means are thrown on a piece of white paper or other material. Among the colours thus distinguished, one observes the violet, indigo blue, yellow, red, &c. Of these, the blue, or chemical ray, called also the actinic ray, which is of much importance in exciting germination, and any medium, may it be the colour of the soil or of dark blue glass, &c., through which most of the blue rays can be transmitted and conveyed to the seed will materially contribute to prompt germination. Consequently, from seed sown in a black soil it is likely that a greater per centage will germinate than from light coloured soils. Mr. Wekey did not think that the colour of the soil would be of importance in forwarding the growth of the plant after it was above ground, when all action of the chemical ray ceases. He continued, stating that after the plant is above ground, the yellow or luminous ray conduces to develop the woody fibres, so as to prepare it ultimately for the action of the red or heating rays which ripen and develope the saccharine matter in the fruit. Mr. Wekey agreed with Mr. Hodgkinson so far that the disintegration of rocks forms the best soil for the vine, as it furnishes an additional supply of ingredients absorbed by the plant from the previously decomposed soil. Mr. Wekey attributed also some other importance to fragments of stones being mixed with the soil, viz., that of pre-

venting it from becoming too tenacious to admit a due amount of oxygen to the roots of the plant. As to other details referred to in Mr. Hodgkinson's paper with regard to the vine, Mr. Wekey said that having already given his opinion elsewhere in rather a wholesale way on this subject, he did not think it necessary to enter into details on this occasion. In concluding, he mentioned, as his opinion, that in places referred to by Mr. Hodgkinson, if due care be taken in selecting a sheltered site, a very much superior wine may be grown than in Brighton and the coast line, where the rapid changes of temperature and high winds act as a great drawback to obtain the object aimed at by some cultivators.

Dr. Maund agreed with Mr. Wekey, as to the importance of oxygen being admitted to the roots of the plant, as most conducive to forward its growth.

A meteorological table, by Mr. Smyth, of the climatology of the month of June was laid before the meeting. The following is an abstract of the principal observations :—

Rainfall, in inches	1·84
Evaporation (still water exposed to the sun and air)	2·27
Lowest temperature on the morning of the 12th June, when snow was seen on the Dandenong Ranges	35 °
Highest temperature on the evening of 1st June ...	65 °
Mean temperature of month	50·3

Mr. Blandowski exhibited several natural history specimens recently obtained for the Museum, viz. :—

A new species of bush rat, nearly allied to *Perameles Obesuda*. Locality—near Melbourne.

New species of bush mouse. M'Ivor.

The Australian pipit, generally called the Australian lark, *Anthus Australis*. Locality—near Melbourne.

Small sized Australian lark, from Hobson's Bay.

The whistling lark of the colonists, nearly allied to *Cincloramphus rufescens*. Arthur's Seat.

A variety of large sized sponges, from Port Alberton.

Boxes of minerals, containing rare specimens from the basalt formation of Victoria, viz. :—Analzime, zeolites, wax opal, tripoly, calkspar, magnesite, phonolite, the last being the stone from which the natives prepare their tomahawks.

Among the specimens exhibited were some highly interesting fossil remains, obtained from Creswick's Creek, and forwarded by the President of the society, the Surveyor-General.

Mr. Kentish stated that many persons lived at a distance from town, and it would be a great convenience if their evenings of meeting were to be as near the period of full moon as possible.

Mr. Gibbons said, that the plan pursued by the late Victorian Institute was to hold their meetings on the first Thursday in each month, which generally occurred at a time when the moon was nearly full.

Mr. Wekey said that such trivial subjects were never brought before a general meeting of the Philosophical Society, and he hoped will not be discussed here. He had no doubt that the wishes of members would be attended to by the council, if referred to the same.

Before the close of the meeting, Mr. Wekey addressed the chairman on behalf of Dr. Mueller, a member of the society. Mr. Wekey said that he was requested to express Dr. Mueller's thanks for the kindness with which his exertions in connection with the society had been received. He stated that although Dr. Mueller's absence is uncertain, and his return will greatly depend on the more prosperous state of the colony, nevertheless he expressed his desire to retain his connection with the society. Dr. Mueller hoped to be able to send to the society accounts during his contemplated expedition to the interior. The Honorary Secretary also intimated to the meeting that the Linnæan Society, of London, to which a copy of the first number of the Philosophical Society's transactions had been sent, acknowledged the receipt of same, and express their desire to be in communication with the Philosophical Society of Victoria.

Several of the members expressed their regret at having lost the valuable services of Dr. Mueller, and it was proposed that in acknowledgment of the services rendered by him to the society he should be elected honorary member of the Philosophical Institute.

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