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Art. I.—*Notes on the Eocene Strata of the Bellarine Peninsula with brief references to other deposits.*

(With Plate I.)

By T. S. Hall, M.A., and G. B. Pritchard.

[Read 9th March, 1893].

Our chief inducement for visiting the Bellarine Peninsula was the object of settling on palæontological evidence whether the small outcrop marked on the maps (¼ sheet 23 S.W.) belongs to eocene or to miocene age, the two sets of beds having been elsewhere confused. Certain peculiarities of the deposits however induced us to extend our observations to other portions of the district where similar beds are exposed.

The Peninsula consists of a central mass of the Jurassic fresh-water series, an outlying portion of the Barrabool and Otway beds. Overlying these beds in their northern area occurs the Older Basalt, affording by its decomposition the rich soil for which that part of the district is so well known. Surrounding this central mass is a ring of marine eocene beds. Exposures of the latter occur on the northern and southern boundaries where-ever the natural conditions afford an opportunity of seeing them. On the eastern and western sides no exposures are to be seen as the thick mantle of upper tertiary beds covers the slopes and flats and hides the underlying series from view. There is little doubt however that the ring is complete, as to the westward the Geelong eocenes, as represented by the Corio Bay, Moorabool Valley and Belmont beds are well developed, while to the eastward the Mornington beds occur just across the bay, and as Mr. Daintree reports* similiar beds were passed through in the Queenscliff bore.

The jurassic rocks, although occuping such a large extent of the peninsula, show only one small outcrop just to the westward of Portarlington.† A syncline occurs between the Bellarine beds

* Parl. Rep., 1861-62, A 43. † ¼ Sheet 23 N.E. Note.

and those of the Barrabools, the latter dipping easterly and showing in a series of outcrops the beds proved in the Bellarine bores.*

The Older Volcanic.

Along the cliffs at Portarlington the older volcanic rock occurs on both sides of the pier and exhibits various degrees of decomposition. In one place it is quarried for road metal, while to the east it is a soft unctuous clay which can be traced along the cliffs gradually showing more and more its true character till it disappears below sea level. In this locality it is overlain by coarse ferruginous grits which are probably of upper tertiary age. Near the Clifton Springs it forms the greater part of the cliffs. Here, at about thirty feet above sea level, it is covered by a conglomerate consisting of sub-angular and well rounded pebbles up to four or five inches in diameter, and comprising quartz in various forms, hard blue metamorphic sandstones, nodular schists, and other altered argillaceous rocks with beds of sand and clay. Towards the top it gradually becomes finer and more sandy. At the Drysdale Pier hard ferruginous grits come down to the water's edge, the volcanic rock having been here, as elsewhere, deeply denuded. At the next point, about a quarter of a mile west of the pier, the beach floor and cliffs consist of a volcanic ash or breccia, full of angular fragments of scoriaceous basalt up to an inch in diameter. The deposit is well and evenly bedded and has a dip some degrees west of north at about 20°. Decomposition has considerably affected the strata and the colours are very variable, being blue, gray, dark-green, fawn and chocolate. From here, for about $2\frac{1}{2}$ miles westward, these ash beds are almost continuously exposed to view on the beach floor with intermissions to be mentioned presently. In some places the cliffs are seen to be almost entirely composed of ash overlain by a variable thickness of upper tertiary clays and grits. The ash beds gradually sink to sea level and disappear near the boundary between the parishes of Bellarine and Moolap, where they are overlain by eocene beds. These continue for nearly half a mile, when ash beds again appear from beneath them with a north-easterly dip. We roughly estimated a thickness of 300 feet of

* $\frac{1}{4}$ Sheet 24 S.E. Note 7.

ash to be exposed here. At the place marked Ad 12 on the ¼ Sheet, which is the most prominent point between Clifton and Point Henry, a dyke of fine, dense basalt occurs in the ash. The included fragments in the ash beds here are of larger size, some being upwards of two feet in diameter, and consist principally of masses of basalt, though a few embedded blocks of brownish sandstone, and of an altered yellow argillaceous rock were visible. The latter are probably derived from the underlying mesozoic rocks, though considerably altered in appearance and hardness, they at any rate do not resemble any of our Silurian rocks. From the size of the ejected masses, and from the presence of the dyke, it is probable that we are here close to a vent of the Older Volcanic rock, the greater part of the core having been removed by denudation. Overlying the ash at this point and on its eroded surface occurs a sheet of polyzoal rock. That it does not consist of ejected fragments is clear from its well bedded structure and from its constant dip. It occurs in large tabular masses and is nowhere seen overlain by the volcanic rock. It has for the most part been removed on the higher parts of the beach, where loose blocks of it occur; but at low-tide it may be seen to form a fairly continuous sheet passing out under water to the north. In most places it is altered to a crystalline reddish rock, the weathered surfaces of which are crowded with fossils standing up in relief, and the usual cream colour, which characterises the rock in other localities, prevails. The fossils are principally polyzoa though brachiopods, lamellibranchs and gastropods occur. Similar rock occurs at Sutherland's Creek, near Maude, and again in the Moorabool Valley,* and is at the latter place not associated with igneous rock. At the parish boundary, (Locality 1) where we first noted the eocene beds, the dip of the ash beds and of the former is approximately to the north-west and the volcanic series can be seen passing beneath the fossiliferous strata. So that in these two places we have evidence, that here, the older volcanic rocks are antecedent to the eocene series, and not overlying them as indicated in Daintree's report on the district† and by the colouring and lettering on ¼ sheets 23 S.E. and 23 S.W.

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* Proc. Roy. Soc. Vic., vol. iv, N.S., p. 11. † Parl. Report, 1861-62, A 43.

In the ¼ sheets (23 S.W. and 23 S.E.) dealing with this portion of the district, some confusion exists as to the volcanic rocks. The large outcrop forming the Bellarine Hills is marked as older volcanic, of which it is regarded as forming a typical locality. On the west side of the road from Portarlington to Drysdale, the lettering in the two places indicates newer pliocene overlying older volcanic in one case close to the cliff, while the cliff section shows an outcrop coloured to represent lower volcanic ('pliocene'), but not lettered. On ¼ sheet 23 S.W. the same outcrop is shown running along past Clifton Springs, with one intermission, to a short distance past the dyke we have alluded to. This intermission should not occur, as the ash beds crop out continuously along the beach at this place. Both these separated portions of the same outcrop are marked V. 1, 2, 3, that is, as the legend shows, lower volcanic ('pliocene') basalt dolerite, anamesite and lava, while V. 4 (ash, conglomerate, &c.) is omitted, although a section of over two miles in length is exposed. This is not all, for a note near the parish boundary and close to the volcanic outcrop states that "the basalt outcrop of the Bellarine Hills probably underlies the pliocene tertiary sands and ironstones as far south as the heads of the creeks falling into Corio Bay." So that this outcrop is coloured 'pliocene' and alluded to as 'miocene;' while the true state of the case is that it is unconformably overlain by the clays which were then called miocene or oligocene but which are now regarded as eocene.

The Curlewis Eocenes.

This will be a convenient name for this section, as the hamlet of Curlewis is situated on the Portarlington Road, about a mile to the southward.

It is probable, as will presently appear, that the sequence of eocene beds here is similar to what occurs in the Moorabool Valley,* that is, that the polyzoal rock, where it occurs, is the underlying member of the series, though we were unable to absolutely prove the succession.

At the first place where we noted the eocene beds (parish boundary), they consisted of blue clays resting on ash beds, the

* Proc. Roy. Soc. Vic., vol. iv., N.S., pp. 9 et seq.

dip of both deposits being to the seaward. This dip is the most marked peculiarity of the beds in this locality. There occurs a band of about six feet in thickness of marked character which can be traced, with but few intermissions, for two miles along the coast. Its upper portion consists of about three feet of dark-brown earthy limestone, very sandy, and containing casts of fossils; below this, is about 18 inches of gray clay and then about the same thickness of a rock similar to the upper band, but more easily weathered and of a lighter hue. Both above and below this band, occur stiff blue clays similar to those of Mornington, Spring Creek and the Gellibrand. The angle of dip averages about 25°. In some places it is as low as 10° and near the western end of the section for about 30 yards it dips at 45°. Dipping as the beds do, this hard band stands out from the softer clays like a wall, usually from two to three feet above the almost level floor of the beach. The beds as shown by this band are contorted and faulted. At the parish boundary, we can on ascending the low cliff, see the band coming in to the shore from the north-east and winding with a serpentine curvature. It sweeps round the point in one curve, the dip swinging through an arc of 90°, from a few degrees east of north to a few degrees north of west. Numerous small faults occur, trending north-west, the throw being usually a few inches and rarely exceeding a foot, and the hade nearly vertical. In one place we counted six faults in about 50 yards Along this outcrop the easterly beds are shifted to the north, or in other words, the downthrow is to the south-west. We thus have displayed a beautiful series of step faults. In one place on the curve however, the band between two faults has gone out into deep water, and although the tide was low we could not find any trace of the band *in situ.* Actual measurement showed a lateral displacement of over 30 feet while the loose blocks in the water, which stopped further measurement, showed the direction in which displacement had taken place.

The clay above and below the band is full of nodules of iron pyrites. In places slight hollows on the beach are full of loose pieces washed out, and covered with a crust of limonite. Occasionally, below the band the pyrites has oxidized *in situ*, and has stained the clay yellow. This decomposition is however more frequent in the clay overlying the band and the general tint is consequently of a lighter hue.

Blocks of the earthy limestone band occur on the beach at this point, above high-water mark, and lithologically closely resemble eocene rocks forming the cliffs on the western shores of Corio Bay. From these blocks we procured the following fossils :

Dimya dissimilis, Tate.
Pecten Yahlensis, T. Woods.
Spondylus pseudoradula, McCoy.
Waldheimia divaricata, Tate.
Polyzoa.
Echini spines.

The clays of this place (Locality 1) however, yielded a far greater number of forms, as shown by the following list, which is the result of but a few hours work.

List of Fossils from Locality 1.

Class, Zoantharia.
Placotrochus deltoideus, Duncan.
Flabellum Victoriæ, Duncan.
Conosmilia anomala, Duncan.

Class, Echinodermata.
Cidaroid spines.

Class, Polyzoa.
Numerous genera and species.

Class, Palliobranchiata.
Terebratulina Scoulari, Tate.

Class, Lamellibranchiata.
Pecten dichotomalis, Tate.
,, Foulcheri, T. Woods.
,, (Amussium) Zitteli, Hutton.
Lima Bassii, T. Woods.
Limea transenna, Tate.
Modiolaria singularis, Tate.
Crenella n. sp. aff. globularis.
Nucula tumida, T. Woods.
,, Atkinsoni, Johnston.
Leda Huttoni, T. Woods.
,, apiculata, Tate.
,, obolella, Tate.

Pectunculus laticostatus, Quoy and Gaimard.
Macrodon Cainozoicus, Tate.
Cucullæa Corioensis, McCoy.
Cardita sp.
Chama lamellifera, T. Woods.
Chione? n. sp.
Myadora tenuilirata, Tate.

Class, Gastropoda.

Ranella Prattii, T. Woods.
Triton tortirostris, Tate.
Fusus craspedotus, Tate.
Peristernia lintea, Tate.
,, sp.
Zemira præcursoria, Tate.
Voluta antiscalaris, McCoy.
,, McCoyii, T. Woods.
,, n. sp. = Spring Creek.
,, (Volutoconus) n. sp. aff. conoidea.
Lyria harpularia, Tate.
Mitra atractoides, Tate.
Marginella propinqua, Tate.
,, sub-Wentworthi, Tate.
,, micula, Tate.
,, sp.
Ancillaria hebera, Hutton.
,, pseudaustralis, Tate.
Columbella clathrata, Tate, m.s.
,, sp.
Cancellaria Etheridgei, Johnston.
,, n. sp.
Pleurotoma sp.
Drillia sp.
Mangilia sp.
? ,, sp.
Raphitoma n. sp.
Pusianella aff. hemiothone.
,, n. sp.
Conus heterospira, Tate.
Cypræa brachypyga, Tate.

Semicassis transenna, Tate.
Cassidaria gradata, Tate.
Natica Hamiltonensis, T. Woods.
Crepidula sp.
? Scalaria sp.
Turritella Murrayana, Tate.
,, sp.
,, sp.
Vermetus sp.
Niso psila, T. Woods.
Cerithiopsis n. sp.
Delphinula aster, T. Woods.
Scaphander fragilis, Tate, m.s.
Ringicula sp.
Cylichna exigua, T. Woods.

Class, Scaphopoda.

Entalis Mantelli, Zittel.
,, subfissura, Tate.

Class, Pisces.

Otoliths.

SUMMARY FOR LOCALITY 1.

Class.	No. of Species.
Zoantharia - - - - -	3
Palliobranchiata - - -	1
Lamellibranchiata - - -	19
Gastropoda - - -	46
Scaphopoda - - - -	2
Pisces - - - - -	1
Total - - - -	72

At the point where the polyzoal rock occurs, and on the west side of the gully two intersecting faults, trending N.E. and N., are distinctly traceable on the beach, as they have lowered the eocene blue clay into the ash beds. Each of these faults is visible for several yards, as the clay, being softer than the volcanic rock at this point, has been removed by the waves to about a foot below the level of the latter. A third fault, completing the triangle and having the N.W. trend of all the other faults observed, probably occurs to the westward, but was not visible. The position of the clay beds here, lends force to the view already stated that the polyzoal rock underlies the clay, as close at hand the limestone is seen *in situ* in contact with the volcanic rock; while the downthrow of a fault has been necessary to bring the clay to its level.

About two hundred yards west of this point (Locality 2 on plan) we again find the band, described above, making its appearance, and being traceable for nearly half-a-mile along the shore before disappearing beneath the upper tertiary beds to the west. At the former place where we described it, it has a northerly dip and the lowest beds are on the landward side. Here however, the dip is reversed and the lower beds are to the seaward, a syncline running N.E. and S.W. The strata can be fairly termed contorted. A system of faults with a north-westerly trend is again developed, with the same average throw. Our time did not allow us to work out the directions of the downthrow, the matter being complicated by the contortion of the strata.

To show the way in which contortion has taken place a few examples may be given. At one place the band dips W.—S.—E. at 10°, the radius of curvature of the outcrop being about 20 feet and the upper beds being inside the curve. Then the western end of the band curves round, dipping S.E.—S.—S.W. at 25°, the radius of curvature being 30 feet and the upper beds being on the outside of the curve. The band is curved three or four times in a similar manner to the westward of this point within a distance of a few hundred yards, and it is at this end of the section that we noted the dip as 45° for 30 feet of strike.

Although the beds are so much disturbed the number of crushed shells does not seem greater than usual. Even close to the faults, large shells were perfect. Some specimens which were in contact with pyrites nodules were crushed, but for the most part the fossils were beautifully preserved. From the earthy limestone band of this locality (2) we gathered the following forms:—

Waldheimia divaricata, Tate.
,, insolita, Tate.

Dimya dissimilis, Tate.
Pecten Foulcheri, T. Woods.
Chione Cainozoica (?), T. Woods.
Leda sp. (cast).
Pectunculus laticostatus, Quoy and Gaimard.
Cypraea leptorhyncha, McCoy.

As before, however, the clay beds were the most prolific in fossils, and we give a list of the species gathered, together with references showing their occurrence in some other localities. In this table, the forms gathered at Locality 1 but which were not obtained at Locality 2 are marked with the sign †.

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Class, Rhizopoda.				
Order, Foraminifera.				
Biloculina sp.	-	X	-	X
? Miliolina sp.	-	X	X	X
? Orbitolites sp.	-	-	-	X
Other genera and species	-	X	X	X
Class, Actinozoa.				
Order, Zoantharia.				
Flabellum Victoriæ, Duncan	X	X	X	X
Placotrochus deltoideus, Duncan	X	X	X	X
Conosmilia anomala, Duncan	X	X	X	X
Class, Echinodermata.				
Lovenia Forbesi, Duncan	-	-	X	-
† Cidaroid spines	X	X	-	X
Class, Polyzoa.				
Numerous genera and species	-	X	X	X
Class, Palliobranchiata.				
Waldheimia divaricata, Tate	-	-	-	-
† Terebratulina Scoulari, Tate	-	X	X	X
Class, Lamellibranchiata.				
Ostræa ? n.sp.	-	-	-	-
Dimya dissimilis, Tate	X	X	X	X
Pecten dichotomalis, Tate	-	X	-	-
,, Yahlensis, T. Woods	-	X	X	X
,, Foulcheri, T. Woods	X	X	X	X
† ,, (Amussium) Zitteli, Hutton	X	X	X	X
Lima Bassii, T. Woods	X	X	-	X
† Limea transenna, Tate	-	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Spondylus pseudoradula, McCoy -	-	X	-	X
Septifer fenestratus, Tate - -	X	X	-	X
† Modiolaria singularis, Tate - -	-	X	-	X
† Crenella n.sp. aff. globularis - -	-	-	-	-
Nucula tumida, T. Woods - -	-	X	X	X
,, Atkinsoni, Johnston - -	-	X	-	X
,, Morundiana, Tate - -	X	-	X	X
† Leda obolella, Tate - - -	-	X	-	X
,, Huttoni, T. Woods - -	X	X	X	X
,, apiculata, Tate - - -	X	X	? X	X
,, praelonga, Tate - - -	-	X	-	X
Limopsis Belcheri, Adams and Reeve	X	X	X	X
Pectunculus laticostatus, Quoy and Gaimard - - - -	X	X	X	X
Macrodon Cainozoicus, Tate - -	X	X	X	X
Cucullæa Corioensis, McCoy - -	X	X	X	X
Crassatella astartiformis, Tate -	X	X	X	X
Cardita polynema, Tate - -	? X	X	X	-
,, delicatula, Tate - -	X	X	X	X
Chama lamellifera, T. Woods - -	X	X	X	X
Chione Cainozoica ? T. Woods -	-	X	X	X
† ,, ? n.sp. - - -	-	-	-	-
† Myadora tenuilirata, Tate - -	-	X	X	X
,, n.sp. - - - -	-	-	-	-
Corbula ephamilla, Tate - -	X	X	X	X
,, pixidata, Tate - -	X	X	X	-
Class, Gastropoda.				
Murex velificus, Tate - - -	X	X	X	X
,, rhysus, Tate - - -	-	X	-	X
,, Dennanti, Tate - -	-	-	-	X
,, Eyrei, T. Woods - -	X	X	X	X
,, n.sp. - - - - -	-	-	-	-
Typhis acanthopterus, Tate - -	X	X	-	-
Rapana aculeata, Tate - -	X	X	? X	X
Ranella Prattii, T. Woods - -	X	X	-	X
Triton cyphus, Tate - - -	-	X	-	X
,, Woodsii, Tate - - -	X	X	X	X
,, tortirostris, Tate - -	X	X	X	X
,, gemmulatus, Tate - -	X	X	-	X
Fusus acanthostephes, Tate - -	X	X	X	X
,, craspedotus, Tate - -	X	X	-	X
,, dictyotis, Tate - - -	-	X	-	X
,, n.sp. - - - -	X	-	-	-
,, n.sp. - - - -	-	X	-	-
Latirofusus aciformis, Tate - -	-	X	-	X
Siphonalia longirostris, Tate - -	X	X	-	X
,, n.sp. aff. longirostris -	-	-	-	-
Fasciolaria decipiens, Tate - -	X	-	-	X
Peristernia Morundiana, Tate -	-	-	-	-
,, lintea, Tate - -	-	-	-	X

	Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
	Peristernia n.sp.	-	-	-	-
	" n.sp. aff. crassilabrum	? X	-	-	-
	Dennantia Ino, T. Woods	X	X	-	X
	Zemira præcursoria, Tate	-	-	-	X
	Phos, n.sp.	-	-	X ?	-
	Voluta Hannafordi, McCoy (frag.)	-	X	-	X
	" ancilloides, Tate	-	X	X	X
	" McCoyii, T. Woods	? X	X	-	X
	" cathedralis ? Tate	-	-	-	X
	" antiscalaris, McCoy	X	X	-	X
	" strophodon, McCoy	X	X	-	X
	" n.sp. 1. aff. lirata	? juv.	-	-	-
	" n.sp. 2.	? juv.	-	X	-
	" n.sp. 3. aff. n.sp. Muddy Creek	-	-	-	-
†	" n.sp. 4. aff. conoidea	-	-	-	-
	Lyria harpularia, Tate	X	X	-	X
	Mitra alokiza, T. Woods	X	X	-	X
	" othone, T. Woods	X	X	-	X
	" atractoides, Tate	X	-	-	X
	" n.sp. aff. leptalea	-	-	-	-
	Marginella Woodsii, Tate	-	-	-	X
	" propinqua, Tate	X	X	X	X
	" micula, Tate	X	X	X	X
	" Wentworthi, Tate	X	X	X	X
	" sub-Wentworthi, Tate	X ? frag.	X	-	-
†	" sp.	X	X	X	X
	Ancillaria hebera, Hutton	-	-	X	X
	" semilævis, Tate	X	X	-	X
	" pseudaustralis, Tate	-	X	-	X
	Columbella clathrata, Tate m.s.	X	X	-	X
†	" sp.	? X	X	-	-
	" sp. aff. clathrata	? X	-	-	-
	Cancellaria Etheridgei, Johnston	X	-	X	-
	" caperata, Tate	X	X	-	-
†	" n.sp.	X	-	-	-
	Pleurotoma paracantha, T. Woods	X	X	X	X
	" Claræ, T. Woods	X	X	-	X
	" sp.	X	X	X	X
	" sp.	-	-	X	-
	Drillia, sp.	? X	? X	-	X
	Mangilia bidens, T. Woods	X	X	-	X
	" sp.	-	-	-	X
† ?	" sp.	-	-	-	-
	Bela sculptilis, ? Tate	-	-	X	X
	" sp. aff. sculptilis	-	-	-	-
	Raphitoma n.sp.	-	-	-	-
	Pusianella sp. aff. hemiothone	-	-	-	-
	" n.sp.	-	-	-	-
	Daphnella tenuisculpta, T. Woods	-	X	-	X
	Conus heterospira, Tate	X	X	-	X

Fossils from Curlewis.	Belmont.	Schnapper Point.	Spring Creek.	Muddy Creek.
Conus Dennanti, Tate	-	X	X	X
,, n.sp. aff. heterospira	-	-	-	-
Cypræa contusa, McCoy	-	X	-	X
,, pyrulata (?), Tate	-	X	-	X
,, brachypyga, Tate	X	X	-	X
,, leptorhyncha, McCoy	-	X	X	X
,, Mulderi, Tate	X	-	-	-
Trivia avellanoides, McCoy	X	X	X	X
† Semicassis transenna, Tate	-	X	-	X
Cassidaria gradata, Tate	-	X	-	X
Natica Hamiltonensis, T. Woods	X	X	-	X
,, polita, T. Woods	X	X	-	X
Crepidula sp.	-	X	-	-
† ? Scalaria sp.	-	-.	-	-
Turritella Murrayana, Tate	X	X	-	X
,, sp.	X	X	X	X
,, sp.	X	X	-	X
,, sp.	X	-	X	-
Siliquaria squamulifera, Tate m.s.	X	X	-	X
Vermetus conohelix, T. Woods	X	X	X	X
,, sp.	X	X	-	-
Eulima sp.	? X	-	-	-
Niso psila, T. Woods	X	X	-	X
Odostomia sp.	X	-	-	-
,, sp.	X	-	-	-
Cerithium crebarioides, T. Woods	X	X	X	X
,, n.sp. aff. crebarioides	-	-	-	-
† Cerithiopsis n.sp.	X	-	-	-
,, n. sp.	-	-	-	-
Triforis Wilkinsoni, T. Woods	X	X	-	X
,, sp.	-	X	-	X
? Calliostoma sp.	-	-	-	? X
Delphinula aster, T. Woods	X	X	-	X
Fissurellidæa malleata, Tate	-	X	-	X
Hemitoma occlusa, Tate, m.s.	X	X	-	X
Emarginula cymbium, Tate, m.s.	-	X	-	X
† Scaphander fragilis, Tate, m.s.	X	X	-	X
† Ringicula sp.	X	X	-	X
Cylichna exigua, T. Woods	X	X	X	X
Class, Scaphopoda.				
Entalis Mantelli, Zittel	X	X	X	X
,, subfissura, Tate	X	X	X	X
Dentalium aratum, Tate	-	X	X	X
Class Cephalopoda.				
Nautilus sp. 1.	-	X	-	-
Nautilus sp. 2.=Gellibrand R. species	-	-	-	X
Class Pisces.				
† Otoliths	X	X	X	X

Summary for Locality 2.

Class.	No. of Species.
Actinozoa - - -	3
Echinodermata - -	1
Palliobranchiata - -	1
Lamellibranchiata - -	25
Gastropoda - - -	102
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	137

The following are the only previous records we have seen of fossils from this locality.

Prod. Pal. Vic., Dec. I., p. 28—*Voluta antiscalaris*, McCoy, recorded as "Common in the Tertiary Clays of A$^{d.}$ 14, parish of Moolap."

Id. Dec. III., p. 38—*Trivia avellanoides*, McCoy "very rare and of small size in blue clay (A$^{d.}$ 14) Outer Geelong Harbour."

Id. Dec. IV., p. 14—*Pecten Yahlensis*, T. Woods, "of large size A$^{d.}$ 12;" also *id.*, p. 26—*Voluta strophodon*, McCoy, "Abundant in blue Oligocene Tertiary Clays of Moolap (A$^{d.}$ 14)."

Id. Dec. VI., p. 40—*Lovenia Forbesi*, Duncan, "from Miocene beds of beach at Outer Geelong Harbour, (A$^{d.}$ 12)."

Taking only the Mollusca proper from the two localities we have recorded 150 species distributed as follows:—

Class.	No. of Species.
Lamellibranchiata - -	25
Additional Lamellibranchiata from Locality 1. - -	8
Gastropoda - - -	102
Additional Gastropoda from Locality 1. - -	10
Scaphopoda - - -	3
Cephalopoda - - -	2
Total - - -	150

Of these 150 species only three are represented in living-creation, which, therefore, gives us only two per cent. of living species. Several of the species however have not yet received specific names, but so far as the study of them has gone up to the present, it does not seem possible to refer any of them to living species.

By an inspection of the above list it will be seen to include many of our most characteristic Eocene fossils, and from the accompanying table the close relationship to other characteristic Eocene localities is obvious.

The fossils throughout the dark clays are in a very good state of preservation though the clays are very wet, and this which much increases their tenaceous character also greatly increases the difficulty in procuring specimens without damage, and it is of very little use to attempt to clean the specimens for purposes of identification until they have dried considerably.

A few remarks on some of the fossils might not be out of place. Two of the species namely, *Waldheimia divaricata*, and *Peristernia Morundiana*, have hitherto only been obtained from the River Murray Cliffs, and it is a very interesting fact to find them also in this locality. There can be no doubt whatever about these identifications, as they have been carefully compared with actual specimens from the typical locality.

Pecten dichotomalis is an interesting shell which is at present only recorded from Schnapper Point and the Gellibrand River and is not particularly common at either of these localities.

A new *Fusus* should be noted, examples of which have also been obtained from Schnapper Point. This remarkable shell will no doubt form the type of a sub-genus as it possesses such marked characters of its own, the whorls are wholly disjoined, the canal is almost closed, and the whole shell roughly speaking is somewhat like the columella of some fusoid shell divested of the whorls, the embryonic whorls are however in contact and are terminated by a projecting apex.

Some specimens of a new species of *Phos* were obtained which show strong affinities to the undescribed species occurring at Spring Creek, but owing to the fact that the Spring Creek examples are not in a very good condition nothing very definite about their identity can be said at present. The new species of

Voluta are worth mention. The first is a shell of the type of *V. lirata*, Johnston, but it differs from this species in many points, amongst others the absence of costæ is conspicuous.

The second shell is identical with a new species occurring at Spring Creek, which, in the adult form is quite seven inches in length with a characteristic long and slender spire terminated by an embryo with a markedly exsert tip.

The third, though an incomplete example, shows sufficient characters to designate it a new species with certain affinities to an undescribed species from Muddy Creek, which is related to *V. Stephensi*, Johnston, of Table Cape.

The fourth species belongs to the sub-genus *Volutoconus* and has its nearest ally in *V. conoidea*, but it is readily distinguishable from this species as the spire is much shorter and the whorls more tumid.

Cypræa Mulderi, Tate, is a shell we were not at all sorry to see turn up, as the only two examples previously found were obtained in sinking a deep well in Belmont. The type specimen is in the Adelaide University Museum and the second one is the property of Mr. Mulder of Geelong. Two additional examples were obtained.

A small and very pretty undescribed species of *Nautilus* turned up, which is apparently identical with the one occurring at the Gellibrand River and Muddy Creek.

The amount of disturbance in eocene strata as shown here is apparently unparalleled in Southern Australia and is evidently merely local. The polyzoal rock in M'Cann's quarry at Waurn Ponds dips S. 10° E. at 3° or 4°. The sandy limestones at Belmont, on the river bank just above Barwon bridge, dip E. 40° S. 10°. While between these two localities in the bed of the Waurn Ponds Creek, about 300 yards below where the Geelong to Colac road crosses it, the dip is N. 25° W. 7°. The Muddy Creek beds are stated by Mr. J. Dennant* to be horizontal, while Professor Tate, speaking generally of the Older Tertiaries of Southern Australia, says† that "for the most part secular elevation of the Older Tertiary sea bed has been of small amount and uniform."

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* Trans. Roy. Soc. S.A., 1888, p. 33. † Proc. Roy. Soc. N.S.W., 1888, p. 241.

An instance of a high dip in older tertiary strata is however recently quoted by Mr. T. S. Hart* as occurring on the cliff-section near Mentone, and is given as S. 20° E. at 30°, with fractures and slight faulting. The rest of the section shows a very low dip, this high angle being noted in one fold only.

The high dip, contortion and the changed character of the small area of polyzoal rock exposed, point to subsequent volcanic disturbance, though no trace of igneous rock overlying the fossiliferous strata was found. Possibly no great discharge of solid material took place, but heated gases caused the slight metamorphism of the limestones.

The Clifton Mineral Springs, plentifully charged with carbonic acid gas, possibly represent the dying, or solfatara stage, of this outburst.

To the westward of the Curlewis section, the Bellarine Hills rapidly drop to the level of the plain, that separates them from the Geelong Hills, and the eocenes disappear from view. The upper tertiary beds are very thick and apparently form the greater part of the cliffs about the west end of the section, as the gully exposures gave no indication of the existence of any of the older beds, but showed mottled clays sands and conglomerates, and were, as far as we saw, unfossiliferous.

As almost the whole of the visible portion of the eocene beds of this section is exposed only between tide marks, advantage must be taken of low-tides to thoroughly examine the deposit, and this materially shortens the time available for work ; besides which, only small portions of shells are visible above the surface as the pebbles and pyrites nodules soon destroy the projecting portions of the fossils. The clay beds, as at Mornington, are inhabited by great numbers of *Barnea australasiae* and *B. similis.* One peculiar feature of the beach is the manner in which the seaweed and shells are consolidated into a peaty mass, the pieces of wood enclosed looking like lignite.

A note on the ¼ sheet (23 S.W.) states that a shaft to the east of Fenwick's Gully showed 61 feet of ferruginous sands and clays overlying seven feet of black sandy clay with nodules of pyrites and fragments of lignite. This latter is called 'miocene,' presumably

* Vict. Nat., vol. ix., p. 157.

as it was thought to resemble the other plant beds of the colony which are ascribed to that age. Now these plant beds at Flemington, Berwick, Dargo High Plains and other places* where they are associated with the Older Volcanic rock, underlie it. However there are certainly good grounds for doubting the age ascribed to the volcanic rock. At Flinders, a small patch of polyzoal rock lies on the deeply eroded surface of the igneous series. The limestone being crowded with foraminifera such as Amphistegina (very common) Operculina and Orbitoides shows an approach in character to the Orbitoides limestone which we showed† lay at the base of the Moorabool Valley beds. At Eagle's Nest, near Airey's Inlet, the so called miocene also, as shown by the sections of the Survey, overlies the volcanic rock. Palæontological evidence is gradually accumulating to show that the ferruginous beds of Royal Park, near Melbourne, also belong to the eocene series, and these beds, as the cutting, for instance, in the park shows, lie also on the deeply eroded surface of the volcanic rock. Here at Curlewis, we show the same sequence. Selwyn‡ says that "the products of both volcanic periods are often contemporaneous, and interstratified, with the marine limestones." The only specific instances we can find quoted of this intercalation, in reference to the Older Volcanic, are the Maude sections on the Moorabool River, and Sutherland's Creek. As a rule then, there has been a considerable lapse of time between the volcanic flows and the deposition of the marine eocene beds. Should the Survey reading of the Maude section prove the correct one, some subdivision of the Older Volcanic series will be required, as a rock, the surface of which is deeply eroded before being covered with a marine deposit, can hardly be ascribed to the same age as a sheet intercalated with the latter. That the officers of the Survey have felt the need of some such division is shown by the legend attached to the older volcanic rock of the Bellarine Hills (¼ sheets 23 N.E. and 23 S.E.) namely 'miocene or older.' That it certainly is older is shown by the fact that the clays which are marked as miocene on the map, but which were subsequently stated by Prof. McCoy to be Oligocene,§ distinctly overlie it. The lower tertiary beds of this

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* Murray, Geol. and Phys. Geog. of Vict., p. 104, et seq.

† Proc. Roy. Soc. Vict., vol. iv., N.S., p. 11.

‡ Exhib. Essays, 1866, p. 31. § Prod. Pal. Vic., Dec. iv., p. 26.

area are clearly of the same age as the typical eocenes of Muddy Creek. The plant beds then must come in, either at the base of the eocene series, or may possibly be even of cretaceous age.

Professor Tate has already indicated his discovery in South Australia of beds containing plant remains, which were orginally referred to Miocene age, occurring in conjunction with marine Cretaceous fossils, giving us a somewhat parallel case to the famous Laramie Beds of North America. In the vicinity of Adelaide, beds containing carbonaceous matter are also known to occur directly underlying the Eocene Tertiary as proved by the Adelaide bore.

Plant beds are extensively developed in New South Wales, and Wilkinson* states that they show "a perfect resemblance to the Lower Miocene leaf beds of Bacchus Marsh in Victoria; some of the impressions in the form seem to be undistinguishable from the Victorian fossils." Some of the New South Wales plant beds have been referred by Baron von Ettingshausen† to eocene age, apparently solely based upon the plant remains themselves. The discussions on the age of the New South Wales coal series and of the Laramie Beds of North America, go to show that very little weight can be attached to the evidence afforded by terrestrial or freshwater forms of life. The evidence which has been obtained in South Australia and Victoria is of a more definite nature, and at present seems to point to the Cretaceous age of the older deposits containing plant remains.

From Clifton Springs to Lake Connewarre, the surface is covered everywhere with a thick mantle of Upper Tertiary rocks, consisting of clays, loose sands and quartz gravels. Along the lake margin, and extending some distance inland, ferruginous grits are the almost universal representatives of these beds. They are of a dark-brown hue, coarse grained, fairly hard, and afford the common road metal of the southern part of the district, About a mile N.E. of Drysdale occurs a coarse sandstone with a siliceous cement which is used as road metal near Portarlington. The quartz is glassy and in some cases shows crystalline faces. The rock is of a whitish colour, somewhat cavernous, the cavities being sometimes coated with limonite.

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* Notes on the Geology of N.S.W., 1882, p. 56.

† Mem. Geo. Surv. N.S.W., Pal. No. 2. Contributions to the Tertiary Flora of Australia, 1888, p. 7.

From near the place at which the Barwon enters the lake, to the south end of Kissing Point, which is the Southern termination of Leopold Hill, basalt flanks the hill but does not rise much above the level of the lake. It is clearly a severed portion of the flow forming the plain to the south and west on the southern side of the lake. At Barwon Heads, the same rock is seen to be overlain by the Dune limestone of Mount Colite, and is referred on the $\frac{1}{4}$ sheet to Mount Duneed.

At the south end of Kissing Point, and overlying the basalt, occurs a bed of shells consisting of large oysters and *Barbatia trapezia*. It is about 20 feet above the lake level and is possibly a native shell-mound.

The great mass of the hill at this point is formed of a peculiar sandy limestone, in which no identifiable fossils could be detected. The officers of the Survey, in default of fossils, refer it doubtfully to miocene age. In appearance it somewhat resembles a dune limestone, though as we could not find a good section, we could not detect any false bedding in it. A similiar rock is marked as occurring at Bald Hill across the lake, but we did not visit it. We could not come to any conclusion about the age of this rock, but have not seen any eocene strata which resemble it closely.

From Campbell's Point to the north-west corner of the lake, gray clays constantly appear on the beach floor, and are overlain by yellow earthy limestone just above water level. Apparently the beds do not rise to any height on the cliffs as we saw no exposure anywhere.

Fossils from Point Campbell.

Class, Actinozoa.

Order, Zoantharia.

Balanophyllia Australiensis, Duncan.

Class, Polyzoa.

Numerous genera and species.

Class, Lamellibranchiata.

Ostrea sp.

Dimya dissimilis, Tate.

Nucula Atkinsoni, Johnston.

Limopsis Belcheri, Adams and Reeve.

Pectunculus laticostatus, Quoy and Gaimard.
Cucullæa Corioensis, McCoy.
Crassatella Dennanti, Tate.
Cardita polynema, Tate.
Chione sp. (?)
Corbula ephamilla, Tate.
„ pixidata, Tate.

Class, Gastropoda.

Triton Woodsii, Tate.
Fusus senticosus, Tate.
Fasciolaria exilis, Tate.
Dennantia Ino, T. Woods.
Dolichotoma atractoides, Tate, m.s.
Conus heterospira, Tate.
Cypræa sp. (? platypyga).
Natica polita, T. Woods.
Solarium acutum, T. Woods.
Turritella platyspira, T. Woods.
Vermetus conohelix, T. Woods.
„ sp.
Cerithium crebarioides, T. Woods.

Class, Scaphopoda.

Entalis Mantelli, Zittel.
„ subfissura, Tate.

Class, Pisces.

Otoliths.

Fossils from Point Campbell.

Summary.

Class.	No. of Species.
Actinozoa - - -	1
Lamellibranchiata - -	11
Gastropoda - - -	13
Scaphopoda - - -	2
Pisces - - - -	1
Total - - -	28

From here to Fenwick's Gully, only Upper Tertiary beds were seen along the shore. On following up the gully the yellow earthy limestone, which forms the upper portion of the eocenes in the Geelong district, was seen outcropping frequently. It is overlain by a white earthy travertin, which is derived from it, and is burned for lime in the district. To the north of the Queenscliff Road, is a quarry on the side of the gully, which has for many years supplied the road with metal.

The hard rock occurs in narrow irregular bands, varying from a foot to a few inches in thickness. The rest of the deposit consists of yellow earthy limestone of a softer texture. The hard bands are composed of a fawn-coloured, granular, siliceous limestone which rings under the hammer and breaks with a clean sharp fracture. Sir Richard Daintree, who analysed it, states its composition to be as follows*.

Carbonate of lime	75·20
,, ,, magnesia	3·00
Silica	15·79
Alumina and peroxide of iron ...	3·00
	96·99

The following are the fossils obtained from this locality, owing however to the very hard nature of the rock, it is a somewhat difficult matter to collect any number of specimens.

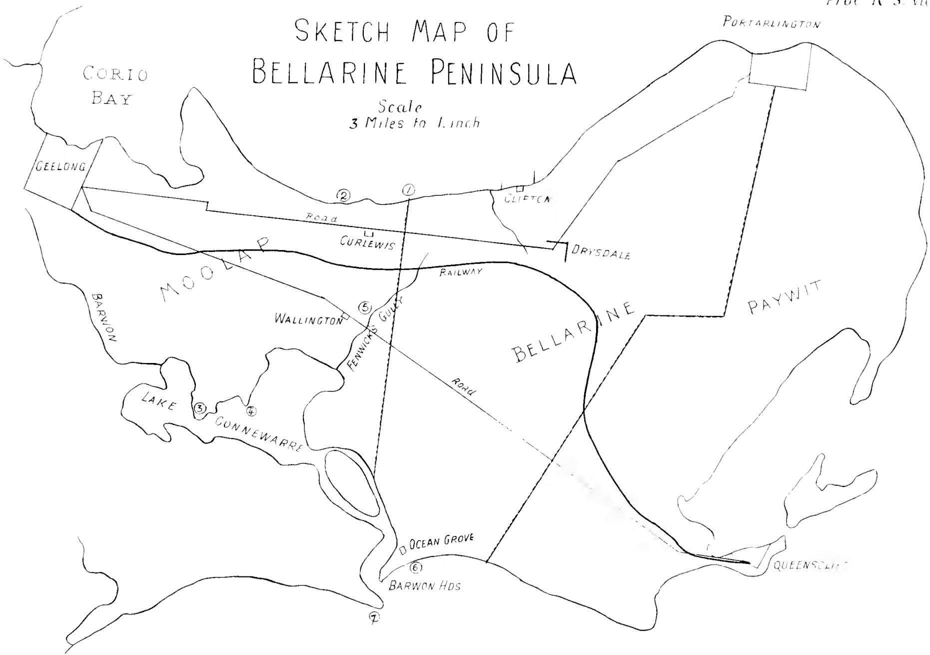
Placotrochus deltoideus, Duncan.
Lovenia Forbesi, Duncan.
Dimya dissimilis, Tate.
Marginella propinqua, Tate.
? Ancillaria sp.
Cypræa sp. (cast probably leptorphyncha).
Turritella sp.

From an inspection of the above list, the horizon to which these rocks belong will be readily recognised as eocene.

Between the mouth of the gully and Ocean Grove the ¼ sheet (29 N.W.) marks a continuous outcrop of lower tertiary strata. Although we followed the margin of the lake between these two

* Selwyn and Ulrich, Ex. Essays, 1866, pp. 35 and 73.

Proc R S Victoria Plate I



points, the time at our disposal was too short for any detailed examination, and we saw no exposure of these beds till we neared Ocean Grove. The hills are covered with a thick deposit of ferruginous grits, quartz gravels and mottled clays while still more recent deposits from the beach of the lake. Near Ocean Grove a well sinking on the flat showed that the earthy limestone lay at no great distance beneath the surface. The sea cliff gave a section showing an earthy sandy limestone varying in colour from yellow to brown and containing flakes of black mica. After spending considerable time in endeavouring to obtain some fossils from the limestone which crops out on the cliff-face just below the Coffee Palace, we managed to get *Terebratulina Davidsoni*, (Eth. fil.), fragments of Echinoderms and of a species of pecten.

The same rock crops out on the sandy shore of the beach below high water mark, and Mr. J. Bracebridge Wilson stated* that he has dredged up fragments of it at some distance off the shore here. Eocene fossils are occasionally washed ashore on tne beach a couple of miles west of Barwon Heads, where one of us has found about half-a-dozen specimens while gathering recent shells.

We have to express our indebtedness to the collecting of Mr. Mulder of Geelong for some of the information as regards the fossils from Belmont.

REFERENCES TO SKETCH MAP.

(Plate I).

1. Number 1 station. } The Curlewis section.
2. Number 2 station. } The Curlewis section.
3. Kissing Point.
4. Campbell's Point.
5. Quarry, Fenwick's Gully.
6. Cliff section, Ocean Grove.
7. Mount Colite.

* Proc. Roy. Soc. Vic., vol. iv., N.S., p. 221 (discussion).

Art. II.—*The Lizards indigenous to Victoria.*

(With Plate II.)

By A. H. S. Lucas, M.A., B.Sc., and C. Frost, F.L.S.

[Read 13th April, 1893].

The arrangement which we have adopted is that followed by Mr. G. A. Boulenger in the *Catalogue of the Lizards in the British Museum*, 2nd Edition, London, 1885. The characters of the Families, of the Genera, and of most of the Species have been taken from that work, in some cases verbatim, and in others in a slightly modified form. In all cases we have carefully verified the descriptions by the examination of as many specimens as we could obtain, and the modifications and additions which we have made have been suggested by our own observations, frequently made upon the living animals. We have included all the information which we have been able to gather as to the habits and the distributions of the lizards. The colouration of adult lizards we find to vary within wide limits in the case of many of the species, but the colour and pattern of the adults can often be explained and understood if considered as derived from the colour and pattern of young individuals, in which they are usually much more marked and constant. We have therefore, when able, described in some detail the colouration of young specimens. We have had the advantage of studying all the specimens preserved in the National Museum of Victoria, and we have to acknowledge, gratefully, the kindness and courtesy of Sir Frederick McCoy in placing the collection at our disposal for examination. We desire also to thank the following gentlemen who have assisted us in obtaining material: Professor W. B. Spencer, Dr. Dendy, C. French, Esq., F.L.S., Dudley Le Souëf, Esq., Assistant Director of the Melbourne Zoological Gardens, W. von Fremersdorff, Esq., Director of the Maryborough School of Mines, Thomas Steel, Esq., F.C.S., the Rev. E. H. Hennell, Geo. Lyell, Junr., Esq., C. C. Brittlebank, Esq., F. Reader, Esq., C. French, Junr., Esq., G. Morton, Esq., C. Martin, Esq., H. Giles, Esq., and R. Embleton, Esq.

GECKONIDÆ.

Characters of the Family.

External Form.

Head and *body* more or less depressed, sometimes bordered by cutaneous expansions. *Tongue* fleshy, moderately elongate, very feebly incised anteriorly, capable of protrusion out of the mouth.

Tail presenting almost every possible shape, sometimes prehensile, almost always extremely fragile and rapidly reproduced. If reproduced it generally assumes an abnormal form and scaling.

Limbs, both pairs well developed, pentadactyle. The digits vary considerably and furnish the characters upon which the systematic arrangement is based.

Eye and *Ear*.—The eye generally large, with vertical pupil, covered as in Snakes, by a transparent lid under which it moves freely, the valvular lids being in most cases rudimentary. The tympanum usually more or less exposed.

Teguments.

Skin nearly always soft, with numerous tubercles or granules on the dorsal surface, and small, imbricated, cycloid or hexagonal scales on the ventral surface. Plate-like scales of the head only around the margin of the gape. The skin of the head usually free from the skull-bones.

Endo-skeleton.

Skull generally much depressed, with thin bones. Distinct nasals. Jugal rudimentary, the orbit not being bounded posteriorly by a long arch. No postfronto-squamosal arch. Pterygoids widely separated, without teeth. A columella cranii. Mandible of five bones, the angular and articular having coalesced.

Teeth pleurodont, small, numerous, closely set, with long, slender, cylindrical shaft and obtuse point. The new teeth hollow out the base of the old ones.

Vertebræ amphicœlous. Ribs long, and so prolonged as to form more or less ossified hoops across the whole abdominal region.

Limb-arches.—Clavicle dilated, perforated proximally. Interclavicle subrhomboidal to cruciform. Bones of the limbs, including those of the digits, well developed.

Mode of reproduction.

Oviparous. Eggs round, with a hard shell.

GYMNODACTYLUS, Spix.

Digits not dilated, clawed, cylindrical or slightly depressed at the base; the two or three distal phalanges compressed, forming an angle with the basal portion of the digits; the claw between two enlarged scales, (a superior and an inferior), of which the inferior is more or less deeply notched under the claw; digits inferiorly with a row of more or less distinct transverse plates.

Body variously scaled. Pupil vertical. Males with or without præanal or femoral pores.

The genus as defined ranges over Australia; the islands of the Pacific; Tropical America; the borders of the Mediterranean; Southern Asia. The species with greatly swollen or broadened tails, forming the section *Phyllurus*, Fitzing, are confined to Australia.

GYMNODACTYLUS MILIUSII, Bory.

Phyllurus miliusii, Gray, Cat., p. 176.

Phyllurus miliusii, Bory de St. Vincent, Dict. Hist. Nat. vii., p. 183, pl.—fig. 1; Gray, Zool. Erebus and Terror, pl. xvii., fig. 2; McCoy, Prodr. Zool. Vict., pl. 132.

Cyrtodactylus nilii, Gray, Griff, A.K. ix. Syn., p. 52.

Gymnodactylus miliusii, Dum. and Bibr. iii., p. 430, pl. xxxiii., fig. 1; Peters, Mon. Berl. Ac., 1863, p. 229.

Gymnodactylus (Anomalurus) miliusii, Fitz. Syst. Rept., p. 90.

Description.—"Head large oviform; snout a little longer than the diameter of the orbit, as long as the distance between the eye and the ear-opening; forehead and loreal region concave; ear-opening elliptical, vertical, about three-fifths the diameter of the eye. Body moderate. Limbs long, slender; digits rather short, subcylindrical. Snout covered with granules of unequal size; hinder part of head with minute granules intermixed with round tubercles; rostral subquadrangular, three times as broad as high; nostril directed posteriorly, separated from the rostral and first labial by two nasals; labials small, eleven to fourteen upper and ten to twelve lower; mental broadly trapezoid; no regular chin-shields; gular granules minute. Body and limbs covered above with small granules intermixed with small round conical tubercles; belly covered with flat granules. Tail short, thick, swollen, and nearly as broad as the body in its anterior half, depressed, tapering to a fine point posteriorly; it is covered with small granules, and, on the upper surface, small conical tubercles arranged in transverse series. *Colour.*—Chestnut-brown above, with white cross bands on the back and tail; head and limbs white-spotted; lower surfaces white.

Total length	135 mm.	
Head	25 ,,	
Width of head	19 ,,	
Body	65 ,,	
Fore-limb	36 ,,	
Hind-limb	43 ,,	
Tail	55 ,,	"—Boulenger.

Distribution.—Victoria: Bendigo, Kangaroo Flat, Castlemaine, Mount Tallangower (Melb. Museum); Maryborough, Dimboola, Baringhup (L. and. F.).

Range outside Victoria.—Western Australia (Melb. Mus.); Sydney, Champion Bay, N.W. Australia (Brit. Mus.).

Phyllodactylus, Gray.

Digits more or less slender, free, all clawed, with transverse lamellæ or tubercles inferiorly; the extremity more or less dilated, with two large plates inferiorly, separated by a longitudinal groove in which the claw is retractile; the distal expansion covered above with scales strongly differentiated from those on the basal portion of the digit.

Upper surfaces covered with juxtaposed scales, uniform or intermixed with larger tubercles; abdominal scales generally imbricate.

Pupil vertical.

Males with neither præanal nor femoral pores.

The genus extends over Australia; Africa; islands of the Mediterranean; Tropical America.

PHYLLODACTYLUS MARMORATUS, Gray.

Diplodactylus marmoratus, Gray, Cat., p. 149.

Diplodactylus marmoratus, Gray, Zool. Erebus and Terror, pl. xv., fig. 6; McCoy, Prodr. Zool. Vict., pl. 132.

Phyllodactylus porphyreus, part, Dum. and Bibr. iii., p. 393.

Phyllodactylus peronii, Fitz. Syst. Rept., p. 95.

Description.—"Head oviform, much longer than broad; snout rounded, a little longer than the distance between the eye and the ear-opening, once and two-fifths the diameter of the orbit; forehead very slightly concave; ear-opening small, roundish or oval, its diameter one-third to one-half that of the eye. Body rather elongate; limbs moderate. Digits not much depressed; digital expansions moderate, rounded, subtrapezoid; the diameter of the disk of the fourth toe equals two-thirds the diameter of the eye; the slender part of the digit with regular transverse lamellæ inferiorly, which are broken up into small scales a short distance in advance of the distal expansion; seven or eight entire lamellæ under the fourth toe. Upper surfaces covered with uniform small granules, largest on the snout, smallest on the hinder part of the head. Rostral pentagonal or hexagonal, the posterior angle being truncate, the latero-superior angles touching the nostril; the latter is pierced posteriorly to the suture of the rostral and first labial, and between the latter and three nasals; eight or nine upper and as many lower labials; mental trapezoid or pentagonal, not larger than the adjacent labials; no regular chin-shields, but small polygonal scales, passing gradually into the minute granules of the gular region. Abdominal scales moderate, smooth subhexagonal, slightly imbricate. Tail long, cylindrical, tapering in its posterior half, covered with uniform small smooth scales, rather large inferiorly, arranged in rings. *Colour.*—Greyish or reddish-brown above, variegated with dark-brown; whitish inferiorly.

Total length	119 mm.	
Head	13 „	
Width of head	10 „	
Body	38 „	
Fore-limb	17 „	
Hind-limb	21 „	
Tail	68 „	"—Boulenger.

Habits.—Usually met with under logs and flat stones.

Distribution.—Victoria: Heathcote, Goulburn Valley, Murray District, Pyramid Hill, Gunbower, Murchison, Echuca, Western District (Melb. Mus.); Castlemaine, Maryborough, Dimboola, Grampians (L. and F.).

Range outside Victoria.—Western Australia, Houtman's Abrolhos, Kangaroo Island (Brit. Mus.).

DIPLODACTYLUS, Gray.

Digits free, not dilated at the base, slightly at the apex, all clawed, the claw retractile between two plates under the extremity of the digits; the basal portion of the digits inferiorly with transverse lamellæ or tubercles; the upper surface of the digits covered with uniform small tubercular scales.

Upper surfaces covered with juxtaposed scales, uniform or intermixed with larger tubercles; abdominal scales juxtaposed.

Pupil vertical.

Males with or without præanal pores, without femoral pores.

The genus extends over the whole of Australia, but is not met with outside of the Continent.

DIPLODACTYLUS STROPHURUS, Dum. and Bibr.

Phyllodactylus strophurus, Dum. and Bibr., iii., p. 397, pl. xxxii., fig. 1.

Discodactylus (Strophurus) dumerilii, Fitz. Syst. Rept., p. 96.

Description.—Head oviform, convex; snout rounded, rather longer than the distance between the eye and the ear-opening, longer than the diameter of the orbit; eye large; ear-opening small, roundish. Body and limbs moderate. Digits much depressed, with large transverse lamellæ inferiorly, about seven under the fourth toe, the middle ones chevron-shaped, the distal one heart-shaped, the basal ones divided into two rounded plates; the plates under the apex of the digit large, together cordiform. Upper surfaces covered with minute granules, with two somewhat irregular longitudinal series of large very obtusely conical tubercles along the back and tail. Rostral pentagonal, completely divided medially; nostril pierced between the rostral, the first labial and three or four nasals; thirteen or fourteen upper labials, about the same number of lower labials; mental small, trapezoid, scarcely larger than the adjacent labials; no chin-shields. Lower surfaces covered with small juxtaposed granules. Males with a doubly arched series of eleven to fourteen praeanal pores, and three or four large conical tubercles at the base of the tail. Tail short, subcylindrical, prehensile, covered with small granules; on each side of its upper surface the series of tubercles above-mentioned. *Colour.*—Upper surfaces olive-grey, speckled or pencilled with black; tubercles brown; head with dark undulations of which two are longitudinal on each side of the snout, one passing through the eye, the other meeting its fellow above on the snout.

Distribution.—Victoria: Kewell, near Dimboola, Murray District (Melb. Mus.); Lake Albacutya (L. and F.).

Range outside Victoria.—New South Wales, Sydney (Brit. Mus.).

Diplodactylus vittatus, Gray.

Diplodactylus vittatus, Gray, Cat., p. 148.

Diplodactylus ornatus, Gray, Cat., p. 149.

Diplodactylus vittatus, Gray, P.Z.S., 1832, p. 40 and Zool. Erebus and Terror, pl. xvi., fig. 3.

Phyllodactylus vittatus, Dum. and Bibr. iii., p. 400.

Diplodactylus furcosus, Peters, Mon. Berl. Ac., 1863, p. 229.

Diplodactylus ornatus, Gray, Zool. Erebus and Terror, pl. xvi., fig. 2.

Description.—"Head short, very convex; snout rounded-acuminate, measuring the diameter of the orbit or the distance between the eye and the ear-opening; latter rather small, round. Body short; limbs moderate. Digits short, depressed, with small apical dilatation, inferiorly with a series of transversely oval tubercles, some of them breaking up into two rounded tubercles; the extremity of the digit is raised and bears inferiorly two roundish plates separated from the large tubercles of the basal part by three or four rows of small granules. Upper surfaces covered with uniform small granular scales. Rostral four-sided, twice as broad as high, with median cleft above;

nostril pierced between the rostral, the first labial and five or six nasals, the anterior or upper largest and generally in contact with its fellow, the others granular; ten or eleven upper and as many lower labials; mental trapezoid, a little larger than the adjacent labials; no chin-shields. Abdominal scales granular, scarcely larger than those on the upper surfaces. Tail short, swollen, root-shaped, with rings of uniform small squarish scales. Male with a small group of conical tubercles on each side the base of the tail. *Colour.*—Brown above; a light dark-edged festooned vertebral band, bifurcating on the nape, sometimes broken up into angular spots; sides and limbs with light spots; lower surfaces dirty-white.

Total length	88 mm.	
Head	15 ,,	
Width of head	12 ,,	
Body	40 ,,	
Fore-limb	19 ,,	
Hind-limb	24 ,,	
Tail	33 ,,	"—Boulenger.

Habits.—This lizard is usually met with under thin flat stones near the tops of mountains.

Distribution.—Victoria: Bendigo, Upper Murray, Dimboola (L. and F.).

Range outside Victoria.—Western Australia, Champion Bay, Houtman's Abrolhos, Sydney (Brit. Mus.); Deniliquin, New South Wales (Melb. Mus.).

Diplodactylus tessellatus, Günther.

Stenodactylopsis tessellatus, Günth., Zool. Erebus and Terror, p. 16.

Description.—"Head large, oviform, very convex; snout rounded, as long as the diameter of the orbit or the distance between the eye and the ear-opening; latter small, round. Body short; limbs long, slender. Digits rather long, slender, feebly depressed, not dilated at the end, inferiorly with small granules; apical plates small, oval. Head with small granular scales; rostral four-sided, emarginate above, more than twice as broad as high, with trace of median cleft; nostril pierced between the rostral, the first labial, and six nasals; latter, anterior large, posterior very small granules; nine upper and ten lower labials; mental elongate, not larger than the adjacent labials; no chin-shields. Back covered with flat tessellated juxtaposed scales, much larger on the middle of the back. Abdominal scales flat, subimbricate, not half the size of the larger dorsal scales. Male with a group of conical tubercles on each side of the base of the tail. *Colour.*—Greyish-white above, with faint irregular brownish variegation; white beneath.

Total length	... ...	69 mm.
Head	... ...	14 ,,
Width of head	... ...	9 ,,
Body	... ...	34 ,,
Fore-limb	... ...	19 ,,
Hind-limb	... ...	23 ,,
Tail	... ...	21 ,, "—Boulenger.

Distribution. — Victoria: Kewell, near Dimboola, Western District (Melb. Mus.); Dimboola (L. and F.)

GEHYRA, Gray.

Digits strongly dilated, free or webbed at the base, inferiorly with undivided or medially divided transverse lamellæ; distal phalanges free, elongate, compressed, clawed, raised from within the extremity of the dilatation; inner digits without free distal phalange, clawless, or with a very indistinct retractile claw.

Upper surfaces covered with granular scales; belly with cycloid imbricated scales.

Pupil vertical.

Male with femoral or præanal pores.

The genus extends over the East Indies; Australia; islands of the Indian and South Pacific Oceans; while one species, *G. mutilata*, Wiegm., reaches Western Mexico.

GEHYRA VARIEGATA, Dum. and Bibr.

Peripia variegata, Gray, Cat., p. 159.

Hemidactylus variegatus, Dum. and Bibr., iii., p. 353.

Peropus (*Dactyloperus*) *variegatus*, Fitzing, Syst. Rept., p. 103.

Peripia torresiana, Günther, A.M.N.H. (4), xix., 1877, p. 415.

Description.—"Head longer than broad; snout longer than the distance between the eye and the ear-opening, about once and a half the diameter of the orbit; forehead with a median groove; ear-opening moderately large, suboval. Body and limbs moderately elongate, depressed, without cutaneous folds. Digits short, free or with a very slight rudiment of web: the inferior lamellæ angular, divided by a median groove. Tail depressed, tapering, the sides rounded. Upper surfaces and throat covered with very small granular scales; abdominal scales moderate. Rostral quadrangular, broader than high, with a median cleft superiorly; nostril pierced between the rostral, the first labial, and three nasals; seven to nine upper and six to eight lower labials; mental moderately large, pentagonal; chin-shields three pairs, inner largest, elongate, outer small, frequently broken up into small scales; these shields considerably shorter than in *G. mutilata.* The upper surface of the tail covered with very small flat scales, the lower surface with a median series of large transversely dilated scales."—Boulenger.

A short angular series of præanal pores, ten to sixteen altogether (in the males).

Colouration of half-grown specimen (in spirit).—Greyish-lavender above, browner on the head and limbs, with a pattern formed by darker narrow longitudinal and transverse wavy bands. One of these bands commences at the nostril, passes along the canthus rostralis and over the orbit, then curves inwards towards its fellow at the back of the head; these bands are darker and more definite on the snout, and are connected by a transverse band just above the nostrils, and by a second commissure less well defined higher up on the snout; the median surface included between the two curved bands is vermicularly marked and spotted. A second band on either side passes along the side of the snout below the first, crosses the eye, and continues as a longitudinal dorso-lateral band along the whole length of the trunk, becoming indistinct along the tail. A third much broken band still lower down on the side is indicated by a streak below the orbit, another through the ear-opening, and by a fainter more or less continuous band on the trunk and tail, below and parallel to the dorso-lateral band. A number of transverse wavy bands are plainly marked across the back and proximal portion of the tail, becoming broken up on the sides into lines and spots. The upper surfaces of the limbs are variegated with irregular wavy bands and spots. The lower surfaces are of a nearly uniform greyish-white, the lamellæ of the digits darker.

In adult specimens of the dark markings the most persistent are the two upper bands on the sides of the head and neck, and the bands across the back.

Distribution.—Victoria: A single half-grown male specimen (with fourteen præanal pores) found by Dr. Dendy on the steam-boat between Swan Hill and Mildura, which may have come on board from either the Victorian or New South Wales bank of the Murray. The species at all events reaches the borders of Victoria.

Range outside Victoria.—Houtman's Abrolhos, Champion Bay, Peak Downs, islands of Torres Straits, Murray I., Sunday I. (Brit. Mus.); Queensland (L. and F.).

[Since writing the above, two specimens of this lizard have been obtained from under the bark of a tree in the public park at Echuca.]

PYGOPODIDÆ.

Characters of the Family.

External Form.

Body elongate, snake-like. *Tongue* fleshy, papillose, elongate, more or less feebly incised anteriorly, extensible.

Tail long and fragile.

Limbs extremely reduced; no fore-limbs; hind-limb visible externally only as a scaly flap without distinct digits.

Eye and *Ear.*—The eye rather small, with broadly elliptical, vertical pupil, not protected by movable lids, usually with a circular scaly rudimentary lid. The tympanum either exposed or concealed under the scales.

Teguments.

The body is covered with roundish, imbricate scales, and the head is more or less regularly plated with larger scales. The skin of the head quite free from the subjacent skull-bones.

Endo-skeleton.

Skull rather depressed. Præmaxillary single, narrowed, much produced posteriorly between the nasals. Nasals distinct. Frontal single. Præfrontals and postfrontals in contact, separating the frontal from the orbit. Jugal rudimentary, there being no postorbital arch. No postfronto-squamosal arch. Pterygoids widely separated, without teeth. Mandible of four bones, the angular, supra-angular and articular having coalesced.

Teeth pleurodont, small, numerous, closely set.

Limb-arches.—Pectoral arch very rudimentary. The ischium appears externally as a small spur on each side behind the anal cleft. Bones of hind-limb, including phalanges of five toes, present but small.

Pygopus, Merr.

Parietal bones distinct. Tongue slightly nicked at the tip, with rows of large round papillæ inferiorly. Ear exposed. Rudiments of hind-limbs externally. Head with large symmetrical plates. Scales cycloid-hexagonal, imbricate, those on the back keeled, the two median series on the belly and the median series under the tail transverely enlarged, hexagonal. Præanal pores in both sexes.

The distribution of this monotypic genus is the same as that of the single species, Australia and Tasmania.

Pygopus lepidopus, Lacépède.

Pygopus lepidopus, Gray, Cat., p. 67.

Pygopus squamiceps, Gray, Cat., p. 68.

Bipes lepidopus, Lacép., Ann. Mus. iv., 1804, p. 209, pl. lv., fig. 1; Guérin, Icon. R. A., Rept., pl. lxi., fig. 1; Duvern. R. A., Rept., pl. xxii., vis. fig. 2.

Sheltopusik novæ-hollandiæ, Oppel. Ordn., p. 40.

Pygopus lepidopus, Merr. Tent., p. 77; Günther, Ann. Mag. N.H. (3) xx., 1867, p. 45; McCoy, Prodr. Zool. Vict., pl. 152, 153.

Hysteropus novæ-hollandiæ, Dum. and Bibr. v., p. 828, pl. lv.

Pygopus squamiceps, Gray, Zool. Erebus and Terror Rept., pl. viii., fig. 3.

Description.—"Snout scarcely prominent, rounded, as long as the distance between the orbit and the ear-opening; canthus rostralis obtuse; eye small, with rudimentary circular scaly lid; ear-opening oval, oblique. Tail, when intact, at least twice as long as the body. Rudimentary hind-limbs measuring about the distance between the eye and the end of the snout in females, more than the distance between the posterior border of the eye and the end of the snout in males. Ten to fourteen præanal pores. Rostral low, from twice and a half to thrice and a half as broad as high; nostril between the first labial and three nasals, the two anterior of which are band-like and extend across the upper surface of the snout, where they form a suture with their fellows, or are separated by one or two small azygos plates; a large polygonal præfrontal, separated from the nasals by two (or one) pairs of small transverse plates, its transversely truncate posterior border forming a suture with the frontal, which is pentagonal and about once and two-thirds as long as broad; the posterior angle of the latter plate wedged in between the pair of parietals, which are nearly as large as the frontal, and sub-hexagonal; sometimes a narrow band-like plate on the outer side of the parietals; two large supraorbitals; loreal region with numerous small polygonal plates, from four to seven in a row, between the orbit and nasal; five to seven upper labials, separated from the orbit by a row of scales; mental large, broadly trapezoid; four to six lower labials, the first or the first two much dilated vertically. Keels of the dorsal scales forming regular lines on the body, alternate on the tail. Twenty-two or twenty-three (in one specimen twenty-one) longitudinal series of scales round the middle of the body, ten smooth and twelve or thirteen (or eleven) keeled. The enlarged ventral scales twice as broad as long, in seventy to eighty-five longitudinal series. Two enlarged anal scales separated from the perforated præanal scales by one or two rows of scales. *Colour.*—Coppery-grey above, uniform or with three or five longitudinal series of blackish dots or elongate quadrangular spots; lower surfaces more or less marbled or pulverated with grey.

	MALE.		FEMALE.	
Head	16	...	16 mm.	
Width of head ...	10	...	10 ,,	
Body	165	...	155 ,,	
Hind-limb ...	11	..	6 ,,	
Tail	400	...	345 ,,	"—Boulenger.

Distribution.—Victoria: Kewell in Western District, Gippsland (Melb. Mus.); common in northern part of the colony (McCoy); Murray District (L. and F.).

Range outside Victoria.—New South Wales, North and North-West Australia, Tasmania.

Delma, Gray.

Parietal bones distinct. Tongue slightly nicked at the tip, with rows of large round papillæ inferiorly. Ear exposed. Rudiments of hind-limbs externally. Head with large symmetrical plates. Scales smooth, cycloid hexagonal, imbricate, the two median series on the belly and the median series under the tail transversely enlarged, hexagonal. No præanal pores.

Both species of the genus are confined to Australia.

Delma fraseri, Gray.

Delma fraseri, Gray, Cat., p. 68.

Delma fraseri, Gray, Zool. Misc., p. 14, and in Grey's Travels Austral. ii., p. 427, pl. iv., fig. 3; Günth. Ann. and Mag. N. H. (4) xii., 1873, p. 145; McCoy, Prodr. Zool. Vict., pl. 153.

Delma grayii, Smith, Ill. S. Afr. Rept., pl. lxxvi., fig. 2.

Delma mölleri, Lütken, Vidensk. Meddel., 1862, p. 296, pl. i., fig. 2.

Nisara grayii, Gray, Liz. Austr., p. 3.

Description.—"Snout not prominent, as long as the distance between the orbit and the ear-opening; canthus rostralis obtuse;

eye with distinct circular scaly lid; ear-opening elliptical, oblique, its diameter equal to that of the eye. Tail, when intact, three or four times as long as the body. The rudimentary hind-limbs measure about the length of the snout in males, considerably less in females. Rostral triangular or pentagonal, nearly twice as broad as high; nostril pierced between the first labial and three nasals (two in the specimen described as *D. mölleri*, in which the naso-rostral and upper nasal have fused) the two anterior of which form a suture with their fellows on the snout; exceptionally, however, the upper nasal is separated from the nostril; a pair of fronto-nasals; præfrontal large, a little broader than long, seven-sided, the antero-lateral sides very short, in contact with a large loreal; frontal as broad as or a little narrower than the præfrontal, longer than broad, seven-sided, its posterior angle wedged in between the pair of parietals, which are considerably larger than the frontal; a pair of enlarged scales on the outer side of the parietals; two large supraorbitals; a large loreal and four or five small plates between the orbit and the nasal; five or six upper labials, fourth much elongate and situated under the orbit from which it is separated by a row of small scales; mental large, triangular, broader than long; four lower labials, the two anterior much dilated vertically, the first forming a suture with its fellow behind the mental. Sixteen longitudinal rows of scales round the middle of the body. The enlarged ventral scales vary considerably in width, being sometimes not quite twice as broad as long, whilst in most specimens they are more than twice as broad as long; they form forty-five to sixty pairs. Two large and a smaller median anal scales. Olive above; head generally with four more or less confluent black cross bands, which may be separated by whitish bands; in two specimens these bands are indistinct, and the sides of the head and body are vertically barred with darker and whitish; one specimen uniform olive without any markings. Lower surfaces yellowish.

Head	13 mm.	
Width of head	7 ,,	
Body	85 ,,	
Hind-limb	4·5 ,,	
Tail	355 ,,	"—Boulenger.

Habits.—Found a few inches below the surface of the ground where it is often turned up by the plough.

Distribution.—Victoria: Melbourne, Wimmera, Kewell, near Dimboola (Melb. Mus.); Murray District (L. and F.).

Range outside Victoria.—Western Australia: Perth, Champion Bay, Nichol Bay; Queensland.

Delma impar, Fischer.

Pseudodelma impar, Fischer, Arch. f. Naturg., xlviii., 1882, p. 287, pl. xvi., figs. 1-4; McCoy, Prodr. Zool. Vic., pl. 161.

Description.—"Tail twice as long as head and body. Rudimentary limbs small. Rostral pentagonal; nostril pierced in the lower portion of the nasal, which forms a suture with its fellow on the snout; a pair of large plates between the nasals and the præfrontal; latter seven-sided, a little larger than the frontal, which is also seven-sided and smaller than the parietals; a band-like plate on the outer side of the latter; two supraorbitals; a large loreal and four small plates between the orbit and the nasal; seven upper labials, fourth elongate and situated below the orbit, from which it is separated by a row of small scales; mental large, triangular; six lower labials, the first forming a suture with its fellow behind the mental. Fifteen longitudinal rows of scales round the middle of the body. Two enlarged præanal scales. *Colour.*—Olive-green, lighter beneath; on each side of the back two light, dark-edged longitudinal lines. From snout to vent 80 mm.; tail 167 mm."—Boulenger.

Habits.—Found coiled up like a snake under stones in Spring. Large numbers were turned up by the pick and shovel in removing the surface soil in the construction of the sewers at Werribee.

Distribution.—Victoria: Melbourne district, Werribee River (Melb. Mus.); Maryborough (L. and F.)

Not recorded from outside Victoria.

Aprasia, Gray.

Parietal bones distinct. Tongue rounded and slightly nicked at the tip. Ear concealed. Slight rudiments of hind limbs externally. Head with large symmetrical plates; no parietal plates. Scales smooth, cycloid, imbricate, those on the belly scarcely enlarged. No præanal pores.

The single species is confined to Australia.

Aprasia pulchella, Gray.

Aprasia pulchella, Gray, Cat., p. 68.

Aprasia pulchella, Gray, Ann. and Mag. N. H. ii., 1839, p. 332, and in Grey's Trav. Austral. ii., pl. iv., fig. 2; Lütken, Vidensk. Meddel., 1862, p. 300, pl. i., fig. 3; Günther, Ann. and Mag. N. H. (4), xii., 1873, p. 145; McCoy, Prodr. Zool. Vict., pl. 161, fig. 1.

Description.—"Head very small, with very prominent rounded snout; eyes well developed, with circular scaly rudimentary lid. Body calamiform. Tail shorter than the body, of subequal diameter throughout, its end obtuse, rounded. Rudiments of hind limbs extremely small, hardly distinct. Rostral very high, narrow, the portion seen from above the snout triangular; nostril pierced between the first labial and a very large nasal, which forms a suture with its fellow on the snout; a pair of large præfrontals, forming a suture with the second labial; a large hexagonal frontal, the posterior angle of which is rounded off; four or five enlarged occipital scales, but no parietals; a supra-orbital; a narrow præorbital; no loreal; five or six upper labials, third and fourth entering the orbit; mental large, broadly trapezoid; two or three lower labials, anterior very large. Twelve series of scales round the body. Three slightly enlarged anal scales. *Colour.*—Yellowish or pinkish, with eight dark-brown lines above following the longitudinal series of scales, or with series of brown dots arranged in four widely separated longitudinal series on the back and very crowded on the sides.

Head	6 mm.	
Body	112 ,,	
Tail	64 ,,	
Diameter of Body ...	3·5 ,,	"—Boulenger.

Distribution.—Victoria: Portland, Lake Wallace (Melb. Mus.). Range outside Victoria.—Western Australia (Brit. Mus.).

LIALIS, Gray.

Parietal bones coalesced. Teeth sharply pointed, directed backwards. Tongue elongate, narrowing towards the end, bifid. Ear exposed. Slight rudiments of hind limbs externally. Head covered with small plates. Scales soft, smooth, cycloid, imbricate, the two median series on the belly and the median series under the tail transversely enlarged, hexagonal. Præanal pores in both sexes, frequently indistinct in females.

This monotypic genus is found in Australia and in New Guinea.

LIALIS BURTONII, Gray.

Lialis burtonii, Gray, Cat., p. 69.

Lialis bicatenata, Gray, Cat., p. 69.

Lialis punctulata, Gray, Cat., p. 69.

Lialis burtonii, Gray, Proc. Zool. Soc., 1834, p. 134 ; Dum. and Bibr. v., p. 831 ; Gray in Grey's Trav. Austral. ii., p. 437, pl iii., fig. 1, and Zool. Misc., p. 52, and Zool. Erebus and Terror Rept., p. 5, pl. viii., fig. 2 ; A. Dum. Cat. Méth. Rept., p. 194 ; Günther, Ann. Mag. N. H. (3) xx., 1867 p. 46 ; McCoy, Prodr. Zool. Vict. pl., 162.

Lialis bicatenate, Gray, Zool. Misc., p. 52, and Zool. Erebus and Terror, p. 5 ; Peters, Mon. Berl. Ac., 1873, p. 606.

Lialis punctulata, Gray, Zool. Misc., p. 52, and Zool. Erebus and Terror, p. 5, pl. viii., fig. 1 ; Günther, l.c.

Lialis leptorhyncha, Peters, l.c., p. 605.

Description.—" Snout narrow, depressed, long, acuminate, truncate at the tip, with angular canthus rostralis ; eye small, with circular scaly rudimentary lid ; ear-opening elliptical, oblique. Tail, when intact, nearly as long as head and body, gradually tapering to a fine point. Rudiments of hind-limbs extremely small, scarcely distinct, especially in females. Four or five præanal pores, frequently indistinct in females. Snout covered with small plates, variable in number and arrangement ; three supraorbitals, median large ; loreal region covered with numerous small scales ; the rest of the head with equal scales ; rostral very low ; nostril pierced in the posterior portion of a nasal ; thirteen to seventeen upper labials, all very small, separated from the orbit by two or three rows of scales; mental rather large, trapezoid or pentagonal; twelve to sixteen lower labials; a series of dilated gular scales on each side, separated from the lower labials by one or two rows of scales. Nineteen or twenty-one (occasionally twenty, according to Peters) longitudinal rows of scales round the middle of the body; the dilated ventral scales in seventy to one hundred pairs. Three or five anal scales. *Colour.* — Ground-colour brown, gray, reddish, or yellowish, variously marked or uniform.

Head	...	...	...	27	mm.
Body	...	...	...	220	,,
Tail ...	...	...	...	270	,,

This lizard varies extremely in the degree of elongation of the snout, in the scutellation of the head, in the number of rows of scales, and in colour; but I am satisfied that the several forms hitherto described should be united into one species, which I divide into numerous varieties of colouration."—Boulenger.

Distribution.—Victoria: Wimmera.

Range outside Victoria. — Distributed over the whole of Australia and adjacent islands.

AGAMIDÆ.

Characters of the Family.

External Form.

Somewhat variable but usually with large *Head* and *Body* and long much tapering tail. Ornamental appendages, such as crests, gular pouches, braids and frills, are often present, either in males only or in both sexes. *Tongue* thick, entirely attached or slightly free in front, not or but slightly nicked anteriorly.

Tail usually long and not fragile.

Limbs, both pairs well-developed, almost always pentadactyle. The digits are usually keeled inferiorly or denticulated laterally.

Eye and *Ear*.—The eye small with circular pupil, protected by well-developed upper and lower movable eyelids. The tympanum exposed or concealed under the skin.

Teguments.

The skin always covered with scales, of which some are often conical or spinose. The head is not plated. The skin of the head quite free from the bones of the skull.

Endo-skeleton.

Skull not much depressed, strongly ossified. Premaxillary single. Nasals distinct. Frontal single. Parietal single. Postorbital arch present. Postfronto-squamosal arch present. Pterygoids widely separated, without teeth. A columella cranii and os transversum. Mandible.

Teeth acrodont, usually of three kinds, viz., incisors, canines and molars.

Limb-arches well-developed. Clavicle not dilated. Interclavicle T-shaped or anchor-shaped, frequently small. Sternum usually presents two fontanelles. Bones of limbs including those of digits, well developed.

Mode of reproduction.—Oviparous.

AMPHIBOLURUS, Wagler.

Tympanum distinct. Body more or less depressed. Dorsal crest absent or feebly developed. No gular sac; a strong transverse gular fold. Tail round or feebly compressed. Præanal and femoral pores.

Australia.

AMPHIBOLURUS ADELAIDENSIS, Gray.

Grammatophora angulifera, var. 2, Gray, Cat., p. 253.

Grammatophora muricata, var. adelaidensis, Gray in Grey's Trav. Austr. ii., p. 439.

Grammatophora adelaidensis, Gray, Zool. Erebus and Terror Rept., pl. xviii., fig. 2.

Description.—"Habit stout. Head short; snout nearly as long as the diameter of the orbit; nostril equally distant from the eye and the end of the snout; tympanum scarcely half the diameter of the orbit; upper head-scales strongly keeled; small spinose tubercles on the back of the head; sides of neck strongly plicate; a more or less distinct dorso-lateral fold. Gular scales smaller than ventrals, keeled. Body much depressed, covered with irregular strongly keeled scales, largest on the vertebral region, intermixed with enlarged trihedral spinose scales forming very irregular longitudinal series; a more or less regular vertebral series of enlarged scales; ventral scales keeled. Limbs short, the adpressed hind-limb reaching the shoulder or the neck in females, the tympanum or a little beyond in males; scales on upper surface of limbs unequal, strongly keeled. A series of twenty to thirty pores extending on more than the proximal half of the thighs, continuous or interrupted on the præanal region. Tail round, depressed at the base, not once and two-thirds the length of head and body; scales strongly keeled at the base with four or five longitudinal series of enlarged ones, the outer series, on the side, composed of large trihedral tubercles. *Colour.*—Pale olive-grey above, with a regular series of angular dark-brown, white-edged spots on each side of the vertebral region, and another more or less regular along each side; head with symmetrical dark markings; limbs with irregular dark cross bars; tail with two series of dark spots; lower parts white, the throat marbled with black in the male, less distinctly with grey in the female; in the male an elongate black spot on the chest and blackish variegations on the chest and belly.

Total length	126 mm.	
Head	13 ,,	
Width of head	11 ,,	
Body	35 ,,	
Fore-limb	21 ,,	
Hind-limb	33 ,,	
Tail	78 ,,	"—Boulenger.

Distribution.—Victoria: Dimboola (L. and F.).

Range outside Victoria.—Western Australia (Swan River); var. *tasmanensis*, from Tasmania (Brit. Mus.).

AMPHIBOLURUS PICTUS, Peters.

Amphibolurus ornatus (non Gray) Peters, Mon. Berl. Ac., 1863, p. 230.

——— *pictus*, Peters, Mon. Berl. Ac., 1866, p. 88.

Grammatophora picta, Günth., Zool. Ereb. and Terr. Rept., p. 18.

Description.—" Habit stout. Head very short, snout shorter than the diameter of the orbit ; nostril equally distant from the eye and the tip of the snout ; tympanum large, nearly two-thirds the diameter of the orbit; upper head-scales subequal, tubercular, smallest on the supraorbital region ; a series of enlarged scales from the nostril to above the tympanum, passing below the eye. Sides of neck strongly plicate ; no dorso-lateral fold. Gular scales smaller than ventrals, smooth. Body much depressed, covered with very small uniform feebly keeled scales smallest on the sides ; a slight ridge along the middle of the back ; ventral scales smooth. Limbs and digits rather short, the adpressed hind-limb reaching the tympanum or between the latter and the orbit; scales on upper surface of limbs small, equal, keeled. A series of thirty-two to forty-five pores extending along the whole length of the thighs, continuous or interrupted on the præanal region. Tail round, a little depressed at the base, not twice as long as head and body, covered with equal, feebly keeled scales. *Colour.*—Grey-brown above, with small darker and lighter spots ; a series of transverse black spots on the back separated or connected by a black vertebral line ; throat and chest mottled with blackish."—Boulenger.

Total length	150 mm.
Head	15 ,,
Width of head	13 ,,
Body	42 ,,
Fore-limb	23 ,,
Hind-limb	42 ,,
Tail	93 ,,

Habits.—A single female specimen of this lizard was obtained by Mr. F. M. Reader, of Dimboola. On dissection, the oviduct was found to contain three eggs, in none of which was there any trace of an embryo.

Distribution.—Victoria : Dimboola.

Range outside Victoria.—South and West Australia.

AMPHIBOLURUS ANGULIFER, Gray.

Grammatophora angulifera, var. 1, Gray, Cat., p. 252.

Grammatophora muricata, var. *diemensis*, Gray, Grey's Trav. Austr. ii., p. 439.

Agama aclaticeps, Smith, Ill. S. Afr. Rept., pl. lxxiv.

Grammatophora angulifera, Gray, Zool. Erebus and Terror, pl. xviii., fig. 3.

Description—" Habit stout. Head short, snout as long as the diameter of the orbit; nostril equally distant from the eye and the tip of the snout, tympanum measuring nearly half the diameter of the orbit, upper head-scales rough, strongly keeled. Sides of neck strongly plicate and studded with small spines; a distinct dorso-lateral fold. Gular scales a little smaller than ventrals, keeled. Body much depressed, covered above with very irregular strongly keeled scales intermixed with enlarged spinose ones; the latter form a zig-zag series on each side of the vertebral region, the scales of which are not enlarged, and a longitudinal series following the dorso-lateral fold; they are irregularly scattered on the flanks; ventral scales strongly keeled and mucronate. Limbs and digits short; the adpressed hind-limb reaches the tympanum or between the latter and the orbit; spinose scales scattered on the limbs. Femoral pores four to six on each side, not extending beyond the basal half of the thighs; præanal pores two to five on each side. Tail round, depressed at the base, once and two-thirds to once and three-fourths as long as head and body, above with five longitudinal series of strongly enlarged spinose scales. *Colour.*—Brown above, sides darker; a festooned dark-brown, black-edged band along the back; lower surfaces pale-brown, usually dotted or reticulated with darker.

Total length	...	...	199	mm.
Head ...	...	...	20	,,
Width of head	...	...	17	,,
Body ...	...	..	56	,,
Fore-limb	...	...	32	,,
Hind-limb	...	...	47	,,
Tail ...	...	...	123	,, "—Boulenger.

Habits.—Met with amongst rocks at considerable elevations in the mountains.

Distribution.—Victoria: Mount Wellington in N. Gippsland, Walhalla, Harrietville in Australian Alps (L. and F.).

Range outside Victoria.—Tasmania, Sydney, Port Denison (Brit. Mus.); Mt. Lofty, South Australia.

Amphibolurus muricatus, White.

Grammatophora muricata, Gray, Cat., p. 251.

Lacerta muricata, White, Journ. N. S. Wales, App., p. 244, pl. xxxi., fig. 1; Shaw, Zool. iii, p. 211, pl. lxv., fig. 2.

Agama muricata, Daud, Rept. iii., p. 391.

Agama jacksoniensis, Kuhl, Beitr. Zool. Vergl. Anat., p. 113; Guérin, Icon. R. A. Rept., pl. iii.

Grammatophora muricata, Kaup, Isis, 1827, p. 261; Dum. and Bibr. iv., p. 475; McCoy, Prodr. Zool. Vict., pl. 111.

Amphibolurus muricatus, Wiegm. Herp. Mex., p. 17; Girard, U. S. Expl. Exp. Herp., p. 414.

Amphibolurus maculiferus, Girard, Proc. Ac. Philad., 1857, p. 198, and U. S. Expl. Exp. Herp., p. 417.

Description.—"Habit moderate. Head rather elongate, snout longer than the diameter of the orbit; canthus rostralis angular; nostril equally distant from the eye and the end of the snout; tympanum measuring nearly half the diameter of the orbit; upper head scales strongly keeled; back of head and borders of the tympanum with small spines. Sides of neck strongly plicate; a more or less distinct dorso-lateral fold frequently disappearing altogether in the adult. Gular scales a little smaller than ventrals, feebly keeled. Body moderately depressed, covered above with very irregular small keeled scales intermixed with some very numerous, enlarged, strongly keeled, spinose scales, some of which form regular series along the back; a low serrated vertebral ridge or crest; ventral scales feebly keeled, shortly mucronate. Limbs moderately elongate, the adpressed hind-limb reaching the eye or between the latter and the tympanum; limbs with strongly keeled scales of unequal size. Femoral pores three or four on each side, not extending beyond the proximal half of the thigh, præanal pores two on each side. Tail round, twice or more than twice as long as head and body, covered above with strongly keeled scales of unequal size. *Colour.*—Brown above, with a series of angular darker spots along the middle of the back; sometimes a lighter band along each side of the latter; lower surfaces lighter brown, uniform or indistinctly spotted with darker.

Total length	... ...	307 mm.	
Head	... ...	29 ,,	
Width of head	... ...	24 ,,	
Body	... ...	73 ,,	
Fore-limb	... ...	41 ,,	
Hind-limb	... ...	76 ,,	
Tail	... ...	205 ,,	"—Boulenger.

Habits.—Usually met with on the trunks or branches of trees and shrubs. In colour closely resembles the bark. Very common in the sandy districts on the south coast, especially on the Leptospermum scrub. "It is fond of basking in the sun on sandy paths . . . . In confinement feeds readily on flies."—"The eggs are laid in the sand."—(McCoy).

Distribution.—Victoria: Melbourne, Caulfield, Plenty River, Upper Yarra, Damper Creek, Gippsland, Goulburn River, Stawell (Melb. Mus.); Drysdale, Tallarook, Rutherglen (L. and F.).

Range outside Victoria.—Western Australia, Tasmania, Sydney (Brit. Mus.).

Amphibolurus barbatus, Cuvier.

Grammatophora barbata, Gray, Cat., p. 252.

Agama barbata, Cuv. R. A. 2nd ed. ii., p. 35; Duvern. R. A., Rept., pl. xiv., fig. 1.

Grammatophora barbata, Kaup. Isis, 1827, p. 621; Dum. and Bibr. iv., p. 478; Gray, Zool. Erebus and Terror Rept., pl. xviii., fig. 1; McCoy, Prodr. Zool. Vict., pl. 121.

Amphibolurus barbatus, Wieg. Herp. Mex., p. 7.

Description.—"Habit stout. Head large, swollen at the sides; snout a little longer than the diameter of the orbit, with angular canthus rostralis; nostril large, directed backwards, nearly equally distant from the eye and the end of the snout; tympanum nearly half the diameter of the orbit; upper head-scales keeled, largest on the snout; a transverse series of larger scales borders the head posteriorly, forming a right angle with another series above the ear. Sides of neck with group of spines; no distinct dorso-lateral fold. Gular scales as large as ventrals, feebly keeled, more or less mucronate, sometimes produced into spines. Body much depressed; scales on the middle of the back largest, unequal, keeled, the enlarged ones sometimes forming transverse series; on the sides, the scales almost granular and intermixed with numerous erect conical spines; ventral scales feebly keeled. Limbs, and especially digits, short; the adpressed hind-limb reaches the axilla or the shoulder; four or five femoral and two or three præanal pores on each side. Tail round, depressed at the base, once and a half to twice as long as head and body, above with large unequal strongly keeled or spinose scales forming more or less regular cross series. *Colour.*—Brown above, uniform or with symmetrical darker markings; usually a black spot on each side of the neck; lower surfaces brown or brownish, uniform or with lighter or darker spots; the throat blackish in the adult male.

Total length	530	mm.	
Head	67	,,	
Width of head	65	,,	
Body	163	,,	
Fore-limb...	92	,,	
Hind-limb	123	,,	
Tail	300	,,	"—Boulenger.

Habits.—Usually found on the ground, or fallen trees and fences. When irritated, it raises its head, opens its mouth and extends the frill, at the same time expanding its ribs so that the body assumes almost the form of a disk. It will then bite savagely, but the result is rarely more than a hard pinch.

Mode of reproduction.—Eggs usually twelve or fourteen. The oviduct of one captured in October contained fourteen full-size eggs with definite groups of two other sizes, one the size of small peas and the other about the size of millet seed. This seems to point to three consecutive layings.

Distribution.—Victoria: "Rare near Melbourne but becomes gradually more abundant in all the more northern warm localities up to the Murray boundary" (McCoy, Prod. Zool. Vict.); North of the Divide (L. and F.)

Range outside Victoria: New South Wales, Queensland, West and North West Australia.

Tympanocryptis, Peters.

Tympanum hidden. Body depressed, covered above with heterogeneous scales. No dorsal crest. No gular sac; a strong transverse gular fold. Tail round. A præanal pore on each side, sometimes absent in the female; no femoral pores.

Australia.

Tympanocryptis lineata, Peters.

Tympanocryptis lineata, Peters, Mon. Berl. Ac., 1863, p. 230; McCoy, Prodr. Zool. Vict., pl. 181.

Description.—" Habit very stout. Head short; nostril nearer to the eye than the tip of the snout; upper head-scales moderately large, very strongly keeled, with slightly enlarged ones on the occiput. Dorsal scales very strongly keeled, the enlarged ones nail-shaped, raised, not or scarcely mucronate; gular and ventral scales indistinctly keeled. The adpressed hind-limb reaches the shoulder or the neck. Tail rather slender, covered with very strongly keeled scales, not more than once and a half the length of head and body. *Colour.*—Brownish above, with regular darker transverse spots, and five interrupted longitudinal light lines, three on the back and one on each side; limbs and tail with dark bars.

Total length	122	mm.
Head	15	,,
Width of head	14	,,
Body	43	,,
Fore-limb...	23	,,
Hind-limb	33	,,
Tail	64	,, "—Boulenger.

Habits.—" Inhabiting stony plains and retreating into small holes, like those of the 'Trap-door Spider,' in the ground when alarmed." (McCoy, l.c.) Often met with under loose basalt boulders.

Distribution. — Victoria: Salt-water River, Maryborough, Rutherglen (F. and L.); Sunbury (McCoy).

Range outside Victoria. — South Australia: Kangaroo I. (Brit. Mus.)

PHYSIGNATHUS, Cuvier.

Tympanum distinct. Body more or less compressed. Nuchal and dorsal crests present. No gular sac, a strong transverse gular fold. Tail more or less compressed. Toes not lobate. Femoral pores present, at least in the male.

Australia and Papuasia ; Siam and Cochin China.

PHYSIGNATHUS LESUEURII, Gray.

Physignathus lesueurii, Gray, Cat., p. 248.

Lophura lesueurii, Gray, Griff., A. K., ix., Syn., p. 60.

Istiurus lesueurii, Dum. and Bibr., p. 384, pl. xl.

Amphibolurus heterurus, Peters, Mon. Berl. Ac., 1866, p. 86.

Physignathus lesueurii, Günth., Ann. Mag. N.H. (3) xx., 1867, p. 51.

Physignathus lesueurii, var. *howittii*, McCoy, Prodr. Zool. Vict., pl. 81.

Description.—" Head moderately elongate, large and thick in the male ; snout slightly longer than the diameter of the orbit ; nostril nearer the end of the snout than the orbit ; canthus rostralis, supraciliary and supraorbital borders forming slight ridges ; tympanum half the diameter of the orbit ; upper head-scales very small, very strongly keeled ; occiput and temple with numerous conical and compressed tubercles. Gular scales subimbricate, indistinctly keeled, intermixed on the sides with enlarged suboval tubercles forming irregular longitudinal series ; some of the hindermost of these tubercles conical ; a row of slightly enlarged shields on each side, parallel with the infralabials. Nuchal crest composed of a few triangular compressed spines ; dorsal crest a serrated ridge. Dorsal scales minute, granular or subimbricate, keeled, intermixed with enlarged, roundish, keeled tubercles forming irregular transverse series ; ventral scales larger than dorsals, imbricate, keeled. Limbs long, scaled like the back ; the adpressed hind-limb reaches between the eye and the end of the snout. Sixteen to twenty-two femoral pores on each side. Tail strongly compressed, crested like the back, twice and a half times as long as the body ; superolateral scales very small, intermixed at the base of the tail with enlarged tubercles; lower scales larger. *Colour.*—Dark-olive above, with darker and lighter cross bands; a broad black band from the eye to above the shoulder, involving the tympanum; belly pale-olive, dotted with black; throat with black longitudinal lines in the young."—Boulenger.

Total length	... ...	466 mm.
Head	... ...	46 ,,
Width of head	... ...	39 ,,
Body	... ...	120 ,,
Fore-limb...	... ...	80 ,,
Hind-limb	... ...	150 ,,
Tail	... ...	330 ,,

Habits.—Semi-aquatic; found basking in the sun on rocks and fallen logs at the water-side.

Distribution.—Victoria: Aberfeldie, Buchan, Upper Wellington, and Snowy Rivers.

Range outside Victoria:—Queensland.

VARANIDÆ.

Characters of the Family.

External Form.

Tongue smooth, very long and slender, bifid, retractile into a sheath at the base.

Tail very long, not fragile.

Limbs, both pairs well developed, pentadactyle.

Eye and *Ear.*—Eyelids well developed. Ear-opening distinct.

Teguments.

Head covered with small polygonal scales. No dermal cranial ossifications. Dorsal scales roundish, juxtaposed, surrounded by rings of minute granules. Ventral scales squarish, arranged in cross rows. No femoral or præanal pores. (The skin of the head attached to the skull-bones.)

Endo-skeleton.

Skull.—Præmaxillary single, narrowed and much prolonged posteriorly. Nasal bones coalesced, narrow. Two frontals; a single parietal. A supraorbital bone. Postorbital arch incomplete.

A bony postfronto-squamosal arch. Pterygoids and palatines widely separated. Infraorbital fossa bounded by the pterygoid, palatine and transverse bone, the maxillary being excluded.

Teeth large, dilated at the base which is fixed to the inner side of the jaws. Palate toothless.

Limb-arches.—Clavicle slender. Interclavicle anchor-shaped.

Mode of Reproduction.

Oviparous.

VARANUS, Merrem.

The only genus. Characters those of the Family.

VARANUS VARIUS, Shaw.

Hydrosaurus varius, Gray, Cat., p. 12; McCoy, Prodr. Zool. Vict., pl. 41.

Lacerta varia, Shaw in White's Voy. N.S. Wales, p. 246, pl. iii., fig. 2, and Zool. Misc. iii., pl. lxxxiii.

Tupinambis variegatus, Daud., Rept. iii., p. 76.

Varanus varius, Merr. Tent., p. 58; Dum. and Bibr. iii., p. 491.

Hydrosaurus variegatus, Wagl. Syst. Amph., p. 164.

Monitor varius, Gray, Griff. A.K. ix., Syn., p. 25; Schleg. Abbild., p. 78.

Varanus (*Hydrosaurus*) *mustelinus*, De Borre, Bull. Ac. Belg. (2), xxix., 1870, p. 125.

Description.—"Teeth acute, compressed. Snout depressed at the end, measuring the distance from the anterior border of the orbit to the ear; canthus rostralis obtuse. Nostril suboval, twice nearer the tip of the snout than the orbit. Digits long. Tail compressed, keeled above. Scales of head small, larger than those on the temples; supraocular scales equal, very small, granular. Scales on upper surfaces small, oval, tectiform. Abdominal scales feebly keeled, in one hundred and twenty to one hundred and thirty transverse series. Caudal scales keeled; the caudal keel with a very low, doubly-toothed crest. *Colour.*—Upper surfaces black, with yellow punctulations arranged in transverse bands on the back and lunate bands on the neck; limbs with large spots or annuli; lower surfaces yellow or greenish, with transverse black bands; tail alternately black and yellow in its posterior half.

Total length	1480 mm.	
Head	90 ,,	
Neck	130 ,,	
Body	330 ,,	
Fore-limb	190 ,,	
Hind-limb	250 ,,	
Tail	930 ,,	"—Boulenger.

Habits.—"Although the Lace Lizard is generally arboreal, climbing the forest trees with ease, and running well on the ground, it can swim nearly as well as a crocodile."—McCoy, Prodr. Z.V.

"They are very voracious, and eat living or dead animals." The particular food may be the smaller or even larger (if dead) mammals, birds, other lizards, and especially, as the settlers find to their cost, the eggs and young birds of the poultry yard.

"They lay about a dozen large, tough, flexible, white eggs, about two-and-a-half inches long, and one-and-a-half inches wide, the young in which are nine or ten inches long."—McCoy, l.c.

Distribution.—Victoria: In forest country whether in the warm Murray region or in Gippsland and the south; replaced in the Wimmera by *V. Gouldii.*

Localities.—Rutherglen, Beechworth, Walhalla, Moe, Cabbage Tree Creek, Anderson's Inlet (L. and F.).

Range outside Victoria: New South Wales, Queensland (Gayndah) (Brit. Mus.).

Varanus varius, *var.* bellii.

Hydrosaurus bellii, Gray, Cat., p. 13.

Varanus bellii, Dum. and Bibr., iii., p. 493, pl. xxxv.

"Black, with a few very broad yellowish cross bands, generally black-dotted; belly uniform yellowish."

Varanus gouldii, Gray.

Monitor gouldii, Gray, Cat., p. 12.

Hydrosaurus gouldii, Gray, Ann. N.H., i., 1838, p. 394, and in Grey's Travels Austr., ii., p. 422.

Monitor gouldii, Schleg. Abbild., p. 78; Gray, Zool. Erebus and Terror Rept., pl. iii.; Peters and Doria, Ann. Mus. Genov., xiii., 1878, pl. i., fig. 4; McCoy, Prodr. Zool. Vict., pl. 151.

Varanus gouldii, A. Dum., Cat. Méth. Rept., p. 52.

Description.—"Teeth acute, compressed. Snout depressed at the tip, long, the distance from its end to the anterior corner of the eye equalling the distance from the latter point to the anterior border of the ear; canthus rostralis sharp. Nostril round, nearer the tip of the snout than the orbit. Digits strong, moderately elongate. Tail strongly compressed, keeled above. Scales of head, including supraoculars, subequal, very small, not larger than those on the temples. Scales of upper surface of body and limbs small, oval, tectiform. Abdominal scales smooth, in one hundred and twenty-five to one hundred and forty transverse rows. Caudal scales keeled; the caudal keel with a very low doubly-toothed crest. *Colour.*—Brown above with more or less distinct round yellow spots or ocelli on the back and limbs and yellow annuli round the tail; temple with two yellow streaks, separated by a black band; these streaks extending more or less distinctly along the sides of the neck; lower surfaces yellowish, uniform or with small blackish spots. Young with the markings much accentuated.

Total length	1300	mm.
Head	80	,,
Neck	130	,,
Body	340	,,
Fore-limb...	200	,,
Hind-limb ...	220	,,
Tail	750	,, "—Boulenger.

Habits.—"Found only in the north-west part of the colony, in the hot mallee-scrub country, where it is common, far away from water, running swiftly about the herbage, and sheltering in holes in the ground." Hisses loudly if disturbed. "When irritated it inflates the skin of the body, swelling to a considerably greater size than before, and then the wrinkles disappear."

Distribution. — Victoria: Wimmera (McCoy), Rutherglen (L. and F.).

Range outside Victoria: W. Australia, N.W. Australia, Dirk Hartog I., Thursday I., Port Essington, Gayndah (Queensland), (Brit. Mus.).

SCINCIDÆ.

Characters of the Family.

External Form.

Head slightly depressed; body more or less round. Tongue moderately long, free, and feebly nicked in front; covered with imbricate scale-like papillæ.

Tail usually long, cylindrical, covered with scales similar to those on the body, rather fragile, slowly reproduced.

Limbs very various, from well-developed to rudimentary.

Eye and *Ear.*—Eye moderately large, pupil round, eyelids usually well developed, movable—except in *Ablepharus*—scaly or with a transparent disk. Tympanum, usually more or less exposed.

Teguments.

Skin covered with cycloid-hexagonal rarely rhomboidal imbricate scales, which may be either smooth or keeled, dorsals usually the largest, and laterals smallest. Head covered with symmetrical shields. No femoral pores.

Endo-skeleton.

Skull slightly depressed, præmaxillary bones two, sometimes incompletely separated; nasal double; frontal single or double; parietal single; postorbital and postfronto-temporal arches complete, osseous; interorbital septum and columella cranii well-developed; infraorbital fossa present, bounded by the maxillary, the transverse bone, the palatine, and often also by the pterygoid. Skull with bony dermal plates over-roofing the supratemporal fossa.

Dentition pleurodont; the teeth conical, bicuspid, or with sphæroidal or compressed crowns; the new teeth hollow out the base of the old ones. Pterygoid teeth may be present.

Vertebræ.

Limb-arches.—Pectoral and pelvic arches constantly present. Clavicle dilated and usually perforated proximally ; interclavicle cruciform. Ossified abdominal ribs are absent.

Mode of reproduction.

Oviparous or viviparous ; eggs oval, shell membranous, flexible.

EGERNIA, Gray.

Palatine bones not meeting on the middle line of the palate. Pterygoid teeth few or absent. Lateral teeth with compressed obtusely tricuspid crowns. Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in the nasal which may be divided by a vertical groove; no supranasals; præfrontals well developed; frontoparietals and interparietal distinct. Limbs well developed, pentadactyle ; digits cylindrical or compressed, with transverse lamellæ inferiorly.

This genus, which is confined to Australia, is represented by nine species, three of which occur in Victoria.

EGERNIA WHITII, Lacép.

Hinulia whitei, Gray, Cat., p. 79 ; McCoy, Prodr. Zool. Vic., pl. 191.

Scincus whitii, Lacép., Ann. Mus., iv., p. 192 ; Quoy and Gaim., Voy. Uranie, Zool., pl. xlii., figs. 2 and 3.

Tiliqua leucopsis, Gray, Ann. N. H., ii., 1838, p. 291.

Lygosoma molinigera, Dum. and Bibr. v., p. 736.

Lygosoma whitei, Peters, Mon. Berl. Ac., 1863, p. 230.

Euprepes whitei, Steindachn, Novara, Rept., p. 49.

Description.—" Head moderate. Curved groove behind the nostril absent or feebly marked ; a vertical suture below the nostril ; frontonasal in contact with the rostral and frequently also with the frontal ; prefrontals sometimes forming a median suture ; frontal not twice as long as broad, as long as or a little longer than the frontoparietal ; four or five supraoculars, second largest ; eight or ten supracilliaries ; fifth and sixth, or sixth and seventh upper labials below the eye ; three large temporals ; one or two pairs of nuchals. Ear-opening nearly as large as the eye-opening, with three or four obtuse lobules anteriorly. Scales smooth, laterals a little smaller than the dorsals and ventrals, thirty-two to forty round the middle of the body. The adpressed limbs overlap. Digits moderately elongate. Tail more or less distinctly compressed, once and two-fifths to once and two-thirds the length of head and body; caudal scales smooth. *Colour.*—Upper surfaces usually brown or olive-brown, with two dorsal black bands, each bearing a series of yellowish-white or pale-brown spots; sides with similar black-edged spots or ocelli; lower surfaces pale-olive, throat sometimes with black markings." —Boulenger.

In hilly country specimens are after met with on which the markings of the upper surfaces have entirely disappeared. The edge of the eyelids and ear lobules are constantly yellow.

Total length	295	mm.
Head	25	,,
Width of head	18	,,
Body	85	,,
Fore-limb	33	,,
Hind-limb	48	,,
Tail	185	,,

In Victoria this lizard rarely exceeds 250 mm. in length.

Habits.—This lizard is usually met with on open stony ground, and dry rocky hills. When disturbed it rapidly disappears under logs or stones. In confinement it makes an interesting little pet, soon becoming tame and readily taking insects from the hand. Its food consists chiefly of insects, although in captivity it will feed on smaller lizards, and in one instance within our knowledge one was known to swallow its own tail.

Distribution. — Victoria: Mordialloc, Caulfield, Sunbury, Keilor, Upper Yarra, Jan Juc, Mt. Hope, Grampians, Beaufort (Melb. Mus.). This species is distributed over the whole of the colony (L. and F.).

Range outside Victoria: South Australia, West Australia, Houtman's Abrolhos, Tasmania, King Island, Kent Group, Kangaroo Island, New South Wales, Queensland.

EGERNIA STRIOLATA, Peters.

Tropidolepisma striolatum, Peters, Mon. Berl. Ac., p. 642.

Description.—" Head moderate. A curved groove behind the nostril ; frontonasal in contact with the rostral ; præfrontals forming a median suture ; frontal not twice as long as broad, as large as or smaller than the interparietal ; four supraoculars, second largest ; seven supraciliaries ; fifth or sixth upper labial entering the orbit ; two or three pairs of nuchals. Ear-opening as large as the eye-opening, with three pointed lobules anteriorly. Twenty-eight to thirty-two scales round the middle of the body ; dorsals largest, quadri- or quinquecarinate, laterals smallest, tricarinate. The adpressed limbs overlap. Digits moderate. Tail cylindrical, a little longer than the head and body ; a series of large, transversely dilated scales on the upper as well as the lower surface of the tail, the former pluricarinate. *Colour.*—Brown above with lighter dots and a lighter dorso-lateral band ; longitudinal, more or less confluent blackish streaks on the vertebral region ; a blackish lateral band ; upper head-shields black edged ; labials yellowish, black-edged ; lower surfaces yellowish or greyish ; throat spotted or reticulated with blackish."

The above colouring applies to specimens from the northern parts of the colony, but on the rocky hills and mountains further south, the colour is uniform blackish-brown or with light dots. The upper labials constantly greyish-white.

Total length	190	mm.
Head	21	,,
Width of Head	15	,,
Body	69	,,
Fore-limb	27	,,
Hind-limb	36	,,
Tail	100	,,

Habits.—This lizard is usually found amongst the rocks on hills and mountains.

Mode of reproduction.—Young developed within the body of the parent, three or four being brought forth at a time.

Distribution.—Victoria : Gunbower, Pyramid Hill, Upper Yarra, Lilydale, Gippsland (Melb. Mus.) ; Dimboola, Croajingolong, Grampians, Pyramid Hill, Gembrook, Tynong (L. and F.).

Range outside Victoria.—Northern Queensland, Gayndah.

EGERNIA CUNNINGHAMI, Gray.

Egernia cunninghami, Gray, Cat., p. 105.

Tiliqua cunninghami, Gray, Proc. Zool. Soc., 1832, p. 40.

Egernia cunninghami, Gray, Ann. N.H., ii., 1838, p. 288, and in Stokes, Discov. in Austral., i., p. 499, pl. ii.

Tropidolepisma cunninghami, A. Dum., Cat. Méth. Rept., p. 177.

Egernia krefftii, Peters, Mon. Berl. Ac., 1871, p. 30.

Description.—"Head moderate. A curved groove behind the nostril; frontonasal in contact with the rostral; præfrontals usually forming a median suture; frontal not twice as long as broad, as large as or a little larger than the interparietal; four or five supraoculars, second largest; seven or eight superciliaries; sixth and seventh, or seventh and eighth upper labials entering the orbit; two or four pair of nuchals. Ear-opening as large as, or a little larger than the eye-opening, with four or five pointed lobules anteriorly. Nuchal scales pluricarinate, dorsals and laterals sharply unicarinate, ending in a point, the keel and the point becoming stronger towards the tail; dorsal scales largest, laterals smallest; thirty-six to forty-two scales round the middle of the body. The adpressed limbs largely overlap. Digits moderate. Tail cylindrical, a little longer than the head and body; upper caudal scales strongly unicarinate, ending in a spine." *Colour.*—Olive-brown above with irregular spots or blotches of a darker colour; in the young speckled with light dots, which usually disappear in the adult; head-shields edged with black; lower surfaces whitish or pale-olive spotted or blotched with dark-brown; throat whitish-olive.

Total length	...	...	330	mm.
Head ..	...	...	35	„
Width of head	...	...	25	„
Body ...	...	...	115	„
Fore-limb ...	...	...	46	„
Hind-limb	...	...	62	„
Tail ...	...	...	180	„

Habits.—Found in rocky places.

Distribution. — Victoria: Melbourne, Sunbury, Brighton, Castlemaine, Beechworth, Mt. Stanley.

Range outside Victoria.—West Australia, Sydney, Queensland.

Trachysaurus, Gray.

Palatine bones in contact on the middle line of the palate. Pterygoids toothless. Lateral teeth with subconical crowns. Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in a single nasal, with a curved groove behind; no supranasals; a complete series of shields between the orbit and the upper labials; præfrontals well developed; fronto-parietals and interparietal distinct, the latter shield in contact with an azygos occipital. Dorsal scales rhomboidal, rugose. Limbs short, pentadactyle; digits cylindrical; subdigital lamellæ mostly divided. Tail short, stump-like.

This genus, which is represented by only one species, extends over the whole of Australia to which it is confined.

Trachysaurus rugosus, Gray.

Trachydosaurus rugosus, Gray, Cat., p. 102.

——— *asper*, Gray, l.c., p. 103.

Trachysaurus rugosus, Gray, in King's Voy. Austral., ii., p. 430, Dum. and Bibr., v., p. 754; McCoy, Prodr. Zool. Vict., dec. xi., pl. 102; Haake, Zool. Anz., 1885, p. 435.

——— *peronii*, Wagl., Icon. Amph. (nec fig.)

Brachydactylus typicus, Smith, S. Afr. Quart. Journ., ii., 1835, p. 144, pl.—

Trachysaurus typicus, Gray, in Grey's Journ. Austral., ii., p. 423.

——— *asper*, A. Dum., Cat. Méth. Rept., p. 179.

Description.—"Head large, very distinct from neck; snout short, obtuse. Head-shields convex, more or less rugose. Fronto-nasal the largest head-shield; præfrontals forming a median suture; two or three supraoculars and five to seven supraciliaries; frontal and interparietal varying much in length; ear-opening about as large as the eye-opening, without lobules. Dorsal scales very large, rough, strongly imbricate, suggestive of the fruit of a pine; ventrals much smaller, smooth; twenty to thirty scales round the middle of the body. Limbs widely separated when adpressed; digits very short. Tail about as long as the head, stump-like, scaled like the body. *Colour.*—Dark-brown above, with yellowish spots or irregular cross-bands; lower surfaces yellowish, spotted or marbled with brown, or with longitudinal and transverse brown streaks.

Total length	...	...	353	mm.
Head	...	...	60	,,
Width of head	...	...	58	,,
Body	...	...	230	,,
Fore-limb...	...	...	56	,,
Hind-limb	...	...	57	,,
Tail	...	...	63	,, "—Boulenger.

Habits.—Found in dry open country; movements very sluggish. This lizard appears to subsist on a vegetable diet, the stomach of one found on the Grampians contained nothing but fungus and *Styphelia* berries.

Mode of reproduction.—Young developed within the body of the parent. "Brings forth in March a single young one of surprising size, about half the length of the parent."—McCoy, Prod. Zool. of Vict.

Distribution.—Victoria: Kewell, (Melb. Mus.).; Northern parts of the Colony, (McCoy); Grampians, Wimmera (L. and F.).

TILIQUA, Gray.

Palatine bones in contact on the middle line of the palate. Pterygoids toothless. Lateral teeth with spheroidal crowns.* Eyelids well developed, scaly. Tympanum distinct, deeply sunk. Nostril pierced in a single nasal, with a curved groove behind; no supranasals; a complete series of shields between the orbit and the upper labials; præfrontals well developed; frontoparietals and interparietal distinct. Limbs short, pentadactyle; digits subcylindrical or slightly compressed with undivided transverse lamellæ inferiorly.

The genus contains five species which range over Australasia, from Tasmania to the Indo-Malayan Islands. Three of the species occur in Victoria.

* Except in *T. adelaidensis*, which has the teeth more conical.

TILIQUA SCINCOIDES, White.

Cyclodus gigas, Gray, Cat., p. 103.

Lacerta scincoides, White Jour., Voy. N.S. Wales, p. 242, pl.—; Shaw, Nat. Miscell., v., pl. clxxix.

Scincus crotaphomelas, Lacép., Ann. Mus., iv., 1804, pp. 192, 209.

——— *tuberculatus*, Merr. Tent., p. 73.

Tiliqua tuberculata, Gray, Ann. Phil. (2) x., 1825, p. 201, and in Gray's Voy. Austr. ii., p. 429.

——— *scincoides*, Fitzing, N. Class Rept., p. 52.

——— *whitii*, Gray, Griff. A.K., ix., Syn., p. 67.

——— *crotaphomelas*, Gray, l.c., p. 68.

Cyclodus boddoertii, part., Dum. and Bibr. v., p. 752.

——— *gigas*, Girard, U.S. Explor. Exped., Herp., p. 233; Strauch, Bull. Ac. St. Pétersb., x., 1866, p. 454; McCoy, Prod. Zool. Vict., dec. viii., pl. lxxi.

——— *boddoertii*, Peters and Doria, Ann. Mus. Genova, xiii., 1878, p. 366.

Description.—"Frontonasal in contact with the rostral; præfrontals forming a median suture; four supraoculars, second largest; six or seven supraciliaries; interparietal narrower than the parietals; scales on the occiput not or but slightly broader than long; anterior temporals much larger than the others, about as long as the interparietal; ear-opening about as large as the eye-opening, with two or three large, obtuse lobules. Scales smooth, laterals a little smaller than the dorsals and ventrals, thirty-four to forty round the middle of the body. Fore-limb as long as or a little shorter than the head; its length in the adult, contained from three to four times in the distance between axilla and groin. Tail cylindrical, shorter than the body." *Colour.*—Olive above with seven or eight more or less distinct dark-brown cross bands; fine dark-brown lines marking the intersection of scales along the upper surface of the neck; usually with a dark-brown band extending from above the fore-limb to the eye, broken above the ear-opening; tail with six or seven dark-brown cross bands; sides and under surfaces greyish, or yellowish, with blackish transverse marblings; throat immaculate or with a few dark spots. Tongue bright Prussian-blue.

Total length	... .	585 mm.
Head	... ...	70 ,,
Width of head	...	58 ,,
Body	... ...	265 ,,
Fore-limb...	... ...	68 ,,
Hind-limb	... ...	67 ,,
Tail	... ...	250 ,,

Habits.—Met with in sandy heath country, and on the hill sides in lightly timbered districts. Movements very sluggish.

Mode of reproduction.—Oviparous, eggs round, twelve to fifteen laid about December. A female specimen captured in November, on dissection was found to contain fifteen full-size eggs, in none of which was there any trace of an embryo.

Distribution.—Victoria: Sunbury, Pyramid Hill (Melb. Mus.); Kew, Woodend, Werribee Gorge (L. and F.).

Range outside Victoria.—Tasmania, King Island, New South Wales, Port Essington, Cape York.

Tiliqua nigro-lutea, Gray.

Cyclodus nigroluteus, Gray, Cat., p. 104; Quoy. and Gaim., Voy. Uranie Rept., pl. xli.

Tiliqua nigroluteas, Gray, Griff. A. K., ix., Syn., p. 68.

Cyclodus nigroluteus, Dum. and Bibr., v., p. 750; Strauch, Bull. Ac., St. Petersb., x., 1866, p. 457.

Description.—"Frontonasal in contact with the rostral, and sometimes with the frontal; four supraoculars; four or five supraciliaries; interparietal narrower than the parietals; scales on the occiput not broader than long; anterior temporals not larger than the others; ear-opening smaller than the eye-opening, with two obtuse lobules; twenty-eight to thirty scales round the middle of the body, dorsals largest, rather rugose. Fore-limb as long as or slightly longer than the head, its length contained thrice to thrice and a half in the distance between axilla and groin. Tail not quite half the length of head and body, cylindrical."

Colour.—Upper surfaces of head and tail olive-brown, body dull-yellow with blackish-brown irregular longitudinal dashes and transverse bands, leaving the ground colour in from five to seven irregular patches extending from the neck to the base of the tail;

tail with from five to seven irregular dark-brown bands; sides and limbs greyish-olive, marbled with dark-brown; under surfaces yellowish; throat immaculate, belly variegated with dark-brown reticulations. Tongue bright Prussian-blue.

Total length	...	...	375	mm.
Head ...	...	...	45	,,
Width of head	...	..	35	,,
Body ...	...	...	210	,,
Fore-limb...	...	...	50	,,
Hind-limb	...	...	50	,,
Tail ...	...	...	120	,,

Habits.—In its habits this lizard is similar to *T. scincoides* but is much more active; when irritated it opens its mouth and snaps from side to side, at the same time making a sound similar to that made by blowing with a bellows. If allowed to seize one's hand it is some time before it can be made to relax its hold. Its food consists of insects, fungus, and probably the fruit of small shrubs. In confinement it will feed on bread and milk and bits of raw meat.

Mode of reproduction.—Young developed within the body of the parent, twelve or fourteen being brought forth at a time.

Distribution. — Victoria: Ringwood, Mordialloc, Frankston (Melb. Mus.); Oakleigh, Phillip Island, Plenty Ranges, Fernshaw, Grampians (L. and F.).

Range outside Victoria.—South Australia, Tasmania.

TILIQUA OCCIPITALIS, Peters.

Cyclodus occipitalis, Peters, Mon. Berl. Ac., 1863, p. 231; Strauch, Bull. Ac., St. Petersb., x., 1866, p. 456.

Cyclodus fasciatus, Lütken, Vidensk., Meddel., 1862 (1863), p. 292, pl. i., fig. 1; Strauch, l.c.

Description.—"Frontonasal in contact with the rostral and with the frontal; three (or two) supraoculars, first largest; four or five supraciliaries; interparietal narrower than the parietals; scales on the occiput longer than broad; anterior temporals not larger than the others; ear-opening a little larger than the eye-opening with three obtuse lobules. Scales smooth, forty to forty-two round the middle of the body, laterals a little smaller than the dorsals and ventrals. Fore-limb slightly longer than the head, its length contained twice and a half in the distance between axilla and groin. Tail not quite half the length of head and body, very slightly compressed." *Colour.*—Yellowish above with four or five dark-brown bands across the body, and three or four others encircling the tail, a broad dark-brown band from the eye to above the ear, limbs and under surfaces yellowish, the distal part of limbs darker above. Tongue bright Prussian-blue.

Total length	...	...	388	mm.
Head ..	...	...	50	,,
Width of head	...	...	34	,,
Body ..	...	...	204	,,
Fore-limb...	...	...	52	,,
Hind-limb	...	...	54	,,
Tail ...	...	...	134	,,

Distribution.—Victoria: Western district (Melb. Mus.)
Range outside Victoria.—South Australia, Swan River.

LYGOSOMA, Fitzing.

Palatine bones in contact mesially; pterygoid bones usually also in contact anteriorly, the palatal notch not extending forwards to between the centre of the eyes; pterygoid teeth minute or absent. Maxillary teeth conical or obtuse. Eyelids well developed. Ear distinct or hidden; if distinct, tympanum more or less sunk. Nostril pierced in the nasal; supranasals present or absent. Limbs more or less developed, rudimentary, or absent.

There are already over 150 known species belonging to this genus, which extends over the whole of Australia, East Indies, China, North and Central America, Tropical and South Africa.

LYGOSOMA.

Sub-genus HINULIA, Gray.

Limbs well-developed, pentadactyle; length of the hind-limb exceeds the distance between the centre of the eye and the fore-limb. Lower eyelid scaly. Tympanum distinct. No supranasals. Frontal not broader than the supraocular region. Frontoparietals distinct. A pair of enlarged præanals.

HINULIA LESUEURII, Dum. and Bibr.

Hinulia australis, Gray, Cat., p. 77.

Tiliqua australis, Gray, Ann. N.H., ii., 1838, p. 291.

Lygosoma lesueurii, Dum. and Bibr., v., p. 733.

——— *australe*, (non Gray), Peters, Mon. Berl. Ac., 1863, p. 231.

——— *schomburgkii*, Peters, l.c.

Euprepes australis, Steindachn, Novara, Rept., p. 49.

Lygosoma (Hinulia) pantherinum, Peters, Mon. Berl. Ac., 1866, p. 89.

Hinulia spaldingi, Macleay, Proc. Linn. Soc. N.S.W., ii., 1877, p. 63.

Description.—" Habit slender; the distance between the end of the snout and the fore-limb is contained once and a half to twice in the distance between axilla and groin; snout moderate, obtuse; loreal region nearly vertical. Lower eyelid scaly. Nostril pierced in a single nasal, no supranasal; no postnasal; rostral usually in contact with the frontonasal; latter broader than long; præfrontals forming a median suture; frontal as long as or a little longer than the frontoparietals and parietals together, in contact with three anterior supraoculars; four supraoculars; eight supraciliaries; first largest; frontoparietals distinct, as long as or shorter than the interparietal; parietals forming a median suture behind the interparietal; two to four pairs of nuchals; fifth and sixth or sixth and seventh upper labials below the eye. Ear-opening oval, about as large as the eye-opening, the anterior border with a fringe of four or five lobules. Twenty-four to thirty-four smooth scales round the body; dorsals, especially the two vertebral series, largest, laterals smallest. Two large præanals. The hind limb reaches the wrist or the elbow of the adpressed fore-limb. Toes long and slender, compressed; sub-digital lamellæ feebly unicarinate, twenty-two to twenty-six under the fourth toe. Tail more than twice the length of head and body. *Colour.*—Brown or olive-brown above, with a black, white-edged vertebral band, and a white, black-edged dorso-lateral streak; sides blackish, with regular series of white spots; a white streak from above axilla to groin. The ground colour may be black, with the usual white markings. Lower surfaces white.

Total length	...	...	275	mm.	
Head ...	...	...	16	,,	
Width of head	..	...	10	,,	
Body ...	...	...	69	,,	
Fore-limb	...	...	24	,,	
Hind-limb	...	...	40	,,	
Tail ...	...	...	190	,,	"—Boulenger.

Habits.—This lizard is usually found hidden under logs and stones, where it often forms channels in the soft ground.

Distribution.—Victoria: Prahran, Sunbury, Pyramid Hill (Melb. Mus.); Grampians, Bendigo, Brown's Plains, Castlemaine, Beechworth, Mount Stanley (L. and F.).

Range outside Victoria.—Fairly well distributed over the whole of Australia and adjacent islands.

Hinulia tæniolata, White.

Hinulia tæniolata, Gray, Cat., p. 78.

Lacerta tæniolata, White, Journ. N.S.W., p. 245, pl.—; fig. 1.

Scincus actolineatus, Daud., Rept., iv., p. 285.

——— *tæniolatus*, Merr. Tent., p. 72.

——— *undecimstriatus*, Kuhl, Beitr. z. Zool. u. Vergl. Anat., p. 129.

——— *multilineatus*, Lesson, Voy. Coquille, Zool., ii., p. 45, pl. iii., fig. 2.

Tiliqua tæniolata, Gray, Griff. A. K., ix., Syn., p. 68.

Lygosoma tæniolata, Dum. and Bibr., v., p. 733; Hallow, Proc. Ac. Philad., 1860, p. 490.

Hinulia tæniolata, Girard, U.S. Explor. Exped., Herp. p. 258.

Euprepes tæniolata, Steindachn. Novara, Rept., p. 49.

Description.—" Habit slender; the distance between the end of the snout and the fore-limb is contained once and a half to once and four-fifths in the distance between axilla and groin. Snout moderate, obtuse; loreal region nearly vertical. Lower eyelid scaly. Nostril pierced in a single nasal; no supranasal;

no postnasal; rostral sometimes in contact with the frontonasal; latter broader than long, forming a suture with the frontal; frontal as long as or a little longer than the frontoparietals and parietals together, in contact with the three anterior supraoculars; four supraoculars; seven to nine supraciliaries, first largest; frontoparietals distinct, as long as or shorter than the interparietal; parietals forming a suture behind the interparietal; three to five pairs of nuchals; fifth and sixth upper labials largest and below the eye. Ear-opening oval, a little smaller than the eye-opening, with a fringe formed by three to five lobules anteriorly. Twenty-four to twenty-six smooth scales round the middle of the body; dorsals, especially the two vertebral series, largest, laterals smallest. Two large præanals. The adpressed limbs slightly overlap, or the hind limb reaches the elbow. Toes long and slender, compressed; sub-digital lamellæ feebly unicarinate, twenty to twenty-six under the fourth toe. Tail about twice the length of head and body. *Colour.*—Yellowish-brown above, with three broad black bands and four white streaks along the back; sides without any spots, with alternating black and white longitudinal streaks; altogether eight white streaks on the body, the two on each side broadest; limbs with longitudinal black lines. Lower surfaces white."

Total length	... ...	230	mm.
Head	... ...	14	,,
Width of head	... ...	9	,,
Body	... ...	61	,,
Fore-limb	... ...	19	,,
Hind-limb	... ...	33	,,
Tail	... ...	155	,, "—Boulenger.

Habits.—Movements very quick. Found in open stony districts.

Distribution.—Victoria: A single specimen found at Beechworth.

Range outside Victoria.—Sydney, Parramatta.

Hinulia quoyi, Dum. and Bibr.

Quoy and Gaim., Voy. Uranie, Zool., pl. xlii., fig 1.
Lygosoma quoyii, Dum. and Bibr., v., p. 728.
Hinulia gastrosticta, Günth., Zool. Ereb. and Terr. Rept., p. 11.

Description.—"Body slightly depressed; the distance between the end of the snout and the fore-limb is contained once and one-fourth to once and a half in the distance between axilla and groin. Snout moderate, obtuse. Lower eyelid scaly. Nostril pierced in a single nasal; frontonasal broader than long, forming a narrow suture with the rostral; præfrontals forming a median suture or in contact with their inner angles; frontal as long as frontoparietals and interparietal together, in contact with the two or three anterior supraoculars; four supraoculars, usually followed by a very small fifth; nine supraciliaries; fronto-parietals and interparietal distinct, equal, or latter a little shorter than former; parietals forming a suture behind the interparietal; three enlarged shields on each side, bordering the parietals; sixth upper labial largest and below the eye. Ear-opening oval, nearly as large as the eye-opening; no auricular lobules. Thirty-six to forty scales round the middle of the body; ventrals largest, laterals smallest; dorsal scales smooth or tricarinate (young). A pair of large præanals. The hind-limb reaches the wrist or the elbow. Digits slightly compressed; subdigital lamellæ smooth, divided, twenty-seven to thirty-two under the fourth toe. Tail about twice as long as head and body. *Colour.*—Brown or olive-brown above, with small scattered black spots; sides black, with small whitish spots; a yellow dorso-lateral line; lower surfaces whitish; throat, and sometimes also belly, with longitudinal series of black dots."

Total length	285	mm.	
Head	24	,,	
Width of head	15	,,	
Body	71	,,	
Fore-limb	30	,,	
Hind-limb	46	,,	
Tail	190	,,	"—Boulenger.

Habits.—Usually found in open flats and gullies, often in or under hollow logs. In confinement it will feed on flies, termites, worms, caterpillars, and also on smaller lizards.

Whilst on a trip to Noojee recently, where this species is fairly numerous, a female, which appeared to contain ova, was selected and placed in a bag. A few days after, on opening the bag it was found she had given birth to four young ones. These with the parent were placed in a box containing some earth and flat stones, and covered partly with glass and partly with wire gauze. After a few days the young ones began to take food; they would readily seize anything moving, in the shape of a small grub or caterpillar, but were alarmed at the fluttering of a large moth. When the parent had made a capture the young ones would timidly approach and make a grab at whatever she held in her mouth, but she always seemed disinclined to surrender any portion of it. She showed no anxiety when the young ones were separated from her. Sometimes when trying to capture a fluttering moth, if one of the young ones appeared in front of her she would seize it, but having discovered her mistake, after a few seconds she would drop it unhurt.

What appears to be a remarkable exhibition of intelligence on the part of this lizard occured about this time. A large moth was placed in the cage and was immediately set upon by the lizard which it managed to elude for some time. At length the lizard seized it by the end of the abdomen. The wings being free it continued to flutter in spite of the efforts of the lizard to crush the life out of it by pushing it against the stones; at last she carried it to the end of the cage where there was a dish of water into this she plunged the moth and held it there for about twenty seconds; this completely damped the ardour as well as the wings of the moth, and for a time the fluttering ceased. She then carried it to the top of one of the stones, when the young ones, who had disappêared beneath during the struggle, emerged from their hiding places and timidly approached; presently one of them made a snap at the moth's leg and pulled it off, causing another flutter. The same method of crushing it against the stones and sides of the cage was again tried but without success. Failing in this she carried it to the water a second time, and held it under for about half-a-minute, after which she swallowed it, pushing the wings off in the operation.

Distribution.—Victoria: St. Kilda, Sunbury, Keilor, Upper Yarra, Yarragon, Toora, Gunbower (Melb. Mus.); distributed all over the Colony (L. and F.).

Range outside Victoria.—Kangaroo Island, Rockhampton, Queensland.

Lygosoma.

Sub-genus Liolepisma, Dum. and Bibr.

Limbs well developed ; the length of the hind-limb exceeds the distance between the centre of the eye and the fore-limb. Lower eyelid with an undivided transparent disk. Tympanum distinct. No supranasals. Rostral forming a suture with the frontonasal. Frontal not broader than the supraocular region. One or more pairs of enlarged nuchals.

Liolepisma mustelinum, O'Shaughn.

Mocoa mustelina, O'Shaugn., Ann. and Mag. N.H. (4), xiii., 1874, p. 299, and (5). iv., 1879, p. 300.

Lygosoma (Mocoa) lacrymans, Peters and Doria, Ann. Mus. Genova, xiii., 1878, p. 348.

——— (——) *sonderi*, Peters, Sitzb. Ges. Nat. Freunde, 1878, p. 191.

——— (——) *orichalceum*, Boettg. Ber. Offenb., Ver. Naturk., xvii.-xviii., 1878, p. 2, pl. i, fig 1.

Description.—" Habit slender, body elongate. The distance between the end of the snout and the fore-limb is contained once and two-thirds to twice in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal, which is quite lateral ; no supranasal ; frontonasal broader than long, forming a very broad suture with the rostral, and a narrower one with the frontal ; latter shield as long as or a little shorter than the frontoparietals and interparietal together, in contact with the two anterior supraoculars ; four supraoculars, second largest ; six or seven supraciliaries ; frontoparietals normally distinct (united in some specimens), as long as or a little longer than the interparietal ; parietals forming a suture behind the interparietal, bordered by a pair of nuchals and a pair of temporals ; fourth upper labial largest and entering the orbit. Ear-opening oval, not larger than the transparent palpebral disk. Twenty-two to twenty-four smooth scales round the middle of the body ; dorsals largest. Præanals not or but feebly enlarged. The adpressed limbs fail to meet. Digits cylindrical ; subdigital lamellæ smooth, sixteen to nineteen under the fourth toe. Tail twice as long as head and body. *Colour.*—Pale brown or yellowish-brown above, golden on the sides and on the tail; each dorsal scale with three or more brown lines; sides usually with interrupted brown longitudinal lines; a white brown edged spot or streak below the posterior border of the eye; lips brown dotted; lower surfaces yellowish-white, sides of throat and belly with fine brown lines or series of dots; two longitudinal lines of confluent brown dots under the tail.

Total length	135	mm.	
Head	10	,,	
Width of head	6	,,	
Body	35	,,	
Fore-limb	11	,,	
Hind-limb	16	,,	
Tail	90	,,	"—Boulenger.

Habits.—This lizard is usually found under logs, and amongst the herbage on the hillsides.

Distribution.—Victoria: St. Kilda, Mulgrave, Dandenong Ranges, Upper Yarra, Waterloo, Lakes Entrance (Melb. Mus.); Ringwood, Ferntree Gully, Healesville, Croajingolong (L. and F.).

Range outside Victoria.—South Australia, New South Wales.

LIOLEPISMA ENTRECASTEAUXII, Dum. and Bibr.

Mocoa entrecasteauxii, Gray, Cat., p. 82.

Lygosoma entrecasteauxii, Dum. and Bibr., v., p. 717.

Mocoa pseudocarinata, O'Shaughn., Ann. Mag. N.H. (4), xiii., 1874, p. 300.

——— *pseudotropis*, Günth., Zool. Ereb. and Terr. Rept., p. 13.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths to once and three-fourths in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with a very large transparent disk, nearly the whole of the eye being visible when the lid is closed. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield as long as or a little shorter than frontoparietals and interparietal together, in contact with the first and second supraoculars; four supraoculars, second largest; five or six supraciliaries; frontoparietals distinct, longer than the interparietal; parietals forming a suture behind the interparietal; two or three pairs of nuchals; fifth, rarely sixth, upper labial largest and entering the orbit. Ear-opening roundish, smaller than the transparent palpebral disk, without distinct lobules. Twenty-eight to thirty-two scales round the middle of the body; dorsals largest and usually more or less distinctly striated or obtusely pluricarinate. Præanals not or scarcely enlarged. The adpressed limbs usually meet or overlap. Digits cylindrical; subdigital lamellæ smooth, seventeen to twenty under the fourth toe. Tail once and one-third to once and two-thirds the length of head and body." *Colour.*—Olive above, with three black longitudinal bands, laterals broadest and edged above and below by a light streak; in some specimens both bands and streaks are absent, in which case the ground colour is much lighter and more or less spotted with dark brown or black. Lower surfaces greyish or greenish, sometimes dull reddish-orange.

Total length	...	...	124	mm.
Head ...	...	...	10	,,
Width of head	...	...	7	,,
Body ...	...	...	41	,,
Fore-limb	...	...	14	,,
Hind-limb	...	...	18	,,
Tail ...	...	...	73	,,

Habits.—Usually met with amongst the grass and herbage in open scrubby districts. Movements very quick.

Mode of reproduction—Oviparous, eggs oval, three to five laid in January.

Distribution.—Victoria: Melbourne (Melb. Mus.); Sandringham, Carrum, Tynong, Mt. Baw Baw (L. and F.).

Range outside Victoria.—Tasmania.

Liolepisma trilineatum, Gray.

Mocoa trilineata, part., Gray, Cat., p. 81.

Tiliqua trilineata, Gray, Ann. N.H., ii., 1838, p. 291.

Lygosoma duperreyi, Dum. and Bibr., v., p. 715; A. Dum., Cat. Méth. Rept., p. 167.

Euprepes duperreyi, Steind. Novara, Rept., p. 47.

Description —" Body much elongate; the distance between the end of the snout and the fore-limb is contained once and a half to twice and a half in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal forming a suture with the rostral, the width of which suture is considerably less than the width of the frontal, and a narrower one with the frontal; latter shield as long as, or shorter than, the frontoparietal, in contact with the two anterior supraoculars; four supraoculars, second largest; five or six supraciliaries; frontoparietal single (rarely divided); a very small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, about as large as the transparent palpebral disk, without or with one or two obtuse lobules. Twenty-six or twenty-eight scales round the middle of the body; dorsals largest and sometimes feebly striated. Præanals not or scarcely enlarged. The adpressed limbs usually fail to meet. Digits cylindrical; subdigital lamellæ smooth, nineteen to twenty-three under the fourth toe. Tail once and one-third to once and three-fourths the length of head and body. *Colour.*—Bronzy-olive above, with a black, light-edged lateral band; frequently the light lateral streaks are again edged with black, and a vertebral black streak is present; lower surfaces grayish or greenish white.

Total length	.. ...	173	mm.
Head	... ...	12	,,
Width of head	... ...	8	,,
Body	... ...	51	,,
Fore-limb	... ...	15	,,
Hind-limb	... ...	23	,,
Tail	... ...	110	,, "—Boulenger.

Habits.—Habits similar to *L. entrecasteauxii*, to which it is very closely allied.

Distribution.—Victoria: Melbourne, Ringwood, Keilor, Brandy Creek, Western Port, Western District (Melb. Mus.); Melbourne, Kew, Carrum, Myrniong, Castlemaine, Grampians (L. and F.).

Range outside Victoria.—Kent Group, Tasmania, New South Wales, West Australia.

LIOLEPISMA METALLICUM, O'Shaughn.

Mocoa ocellata, part., Gray, Cat., p. 82.

Mocoa metallica, O'Shaughn, Ann. and Mag. N.H. (4), xiii., 1874, p. 299.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths to once and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield shorter than frontoparietal and interparietal together; in contact with the first and second supraoculars; four supraoculars, second largest; six or seven supraciliaries; fronto-parietal single (in one specimen divided); interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening roundish, as large as or a little larger than the transparent palpebral disk, without distinct lobules. Twenty-four to twenty-eight scales round the middle of the body; dorsals largest and usually more or less distinctly striated or pluricarinate. Præanals not or but feebly enlarged. The adpressed limbs meet or slightly overlap. Digits cylindrical; subdigital lamellæ smooth eighteen to twenty-two under the fourth toe. Tail about once and a half the length of head and body. *Colour.*—Bronzy-olive above, with small dark-brown spots, sometimes with a dark-brown vertebral streak; sides dark-brown, light-dotted, often with a more or less distinct light streak from ear to groin; lower surfaces greenish or greyish, uniform or with darker dots.

Total length	... ...	133 mm.
Head	... ...	11 „
Width of head	... ...	8 „
Body	... .	42 „
Fore-limb	... ...	14 „
Hind-limb	... ...	19 „
Tail	... ...	80 „ "—Boulenger.

Habits.—Usually found moving about in open scrub country. Food, insects and worms.

Distribution.—Victoria: Port Albert (Melb. Mus.); Melbourne, Croajingolong (L. and F.).

Range outside Victoria.—Tasmania, Kangaroo Island, Loyalty Islands, New Hebrides.

LIOLEPISMA GUICHENOTI, Dum. and Bibr.

Mocoa guichenoti, Gray, Cat., p. 80.

Mocoa trilineata, part., Gray, l.c., p. 81.

Lygosoma guichenoti, Dum. and Bibr., v., p. 713.

——— *(Mocoa) guttulatum*, Peters, Sitzb. Ges. Naturf. Freunde, 1881, p. 83.

——— (———) *platynotum*, Peters, l.c., p. 84.

Description.—"The distance between the end of the snout and the fore-limb is contained once and one-third to once and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal, which is quite lateral; no supranasal; frontonasal forming a broad suture with the rostral, the width of which suture equals the width of the frontal, and a narrower one with the frontal; latter shield narrower and not longer than the frontoparietal, in contact with the two anterior supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietal single; a small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, about as large as the transparent palpebral disk, without projecting lobules. Twenty-six to thirty scales round the middle of the body; dorsals largest and sometimes feebly striated. Præanals not or but feebly enlarged. The adpressed limbs overlap, meet, or fail to meet. Digits cylindrical; subdigital lamellæ smooth, twenty to twenty-six under the fourth toe. Tail about once and two-thirds the length of head and body. *Colour.*—Bronzy-olive or brownish above, with or without small darker and lighter spots; vertebral region sometimes darker; a dark-brown lateral band, edged above and below by a light streak; greenish-white inferiorly sometimes with blackish dots.

Total length	97 mm.	
Head	9 „	
Width of head	6 „	
Body	31 „	
Fore-limb	11 „	
Hind-limb	15 „	
Tail	57 „	"—Boulenger.

Habits.—Usually found running about amongst the grass and herbage on dry sandy ground and stony hill sides. Soon becomes tame in captivity and will feed readily on flies, caterpillars, worms, bits of bread and potato.

Mode of reproduction.—Oviparous; eggs oval, three, laid in the ground.

Distribution.—Victoria: Melbourne, Ringwood, Upper Yarra, Mitta Mitta (Melb. Mus.); Kew, Ringwood, Carrum, Loch, Myrniong, Healesville, Beaconsfield, Ferntree Gully, Grampians (L. and F.)

Range outside Victoria.—New South Wales, South Australia, West Australia.

Liolepisma pretiosum, O'Shaughn.

Mocoa pretiosa., O'Shaughn., Ann. and Mag. N.H. (4), xiii., 1874, p. 298.

——— *microlepidota*, O'Shaughn., l.c., p. 299.

Description.—"The distance between the end of the snout and the fore-limb is contained once and two-fifths in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a suture with the rostral and with the frontal; latter shield a little shorter than frontoparietal and interparietal together, in contact with the two anterior supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietal single; a small interparietal, behind which the parietals form a suture; a pair of nuchals and a pair of temporals border the parietals; fifth upper labial largest and entering the orbit. Ear-opening oval, larger than the transparent palpebral disk. Thirty-four to thirty-eight scales round the middle of the body; dorsals largest, striated or feebly pluricarinate, præanals not enlarged. The adpressed limbs meet or overlap. Digits cylindrical; subdigital lamellæ smooth, twenty to twenty-two under the fourth toe. Tail a little longer than head and body." *Colour.*—Olive-brown above with small darker and lighter spots, a blackish light dotted lateral band extending from the eye to the groin, often edged above with pale-brown; a blackish vertebral streak may be present; lower surfaces greenish or greyish-salmon, lips and throat black dotted.

Total length	...	...	119	mm.
Head ...	...	...	11	,,
Width of head	...	...	8	,,
Body ...	...	...	43	,,
Fore-limb	...	...	16	,,
Hind-limb	...	...	22	,,
Tail ...	...	...	65	,,

Habits.—Met with under logs and stones in moist and thickly timbered country and dense gullies.

Mode of reproduction.—Young developed within the body of the parent; three brought forth in January or February.

Distribution.—Victoria: Upper Yarra, Mount Baw Baw, South Gippsland.

Range outside Victoria.—Tasmania, Kent Group.

Liolepisma tetradactylum, O'Shaughn.

Mocoa tetradactyla, O'Shaughn., Ann. and Mag. N.H. (5), iv., 1879, p. 300.

Description.—"The distance between the end of the snout and the fore-limb is contained once and one-third in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, broadly in contact with the rostral, præfrontals, inner angles touching; frontal much shorter and narrower than the frontoparietal, in contact with the first and second supraoculars; four supraoculars; seven supraciliaries; frontoparietal single, followed by a minute interparietal; parietals forming a median suture; a pair of nuchals and a pair of temporals border the parietals; four labials anterior to the subocular. Ear-opening oval, smaller than the transparent palpebral disk, with a short obtuse lobule anteriorly. Thirty-four scales round the middle of the body, all perfectly smooth; dorsals largest, laterals smallest. Præanal scales not enlarged. The hind-limb reaches the wrist. Fingers four, toes five; subdigital lamellæ smooth, twenty under the fourth toe. Tail a little longer than head and body." *Colour.*—Olive-brown above, head with a few black specks; five interrupted black lines along the middle of the back, the median extending all along the tail, each alternate scale along the line being streaked with the pale ground colour, the black lines on the back often merged into a single broad band, within the area of which, alternate scales are streaked with the pale ground colour; a dorso-lateral series of black dots, separated from the median dorsal lines by a band of pale ground colour; sides immaculate, with two bright rosy-carmine (dull yellow in spirit specimens) stripes, the lower of which extends from axilla to groin, lower surfaces greenish.

Total length	...	...	117 mm.
Head ...	...	...	14 ,,
Width of head	...	...	10 ,,
Body ...	...	...	41 ,,
Fore-limb	...	...	16 ,,
Hind-limb	...	...	22 ,,
Tail ...	...	...	62 ,,

Habits.—This elegant little lizard is found amongst the grass and herbage on the dry, open plains near the Murray. Food consists of insects, chiefly locusts and grasshoppers.

Distribution.—Victoria: Brown's Plains, Barnawartha.

Range outside Victoria.—New South Wales, Queensland.

Lygosoma.

Sub-genus Emoa, Gray.

Limbs well developed, pentadactyle, overlapping when adpressed. Lower eyelid with an undivided transparent disk. Supranasals present.

Emoa spenceri, sp. nov.

(Plate 2, fig. 1, 1a.)

Description.—Head and body slightly depressed. Limbs well developed, pentadactyle. The distance between the end of the snout and the fore limb is contained once and one-third in the distance between axilla and groin. Snout obtusely pointed. Ear-opening about midway between the end of the snout and the fore-limb; eye about midway between the ear-opening and the tip of the snout. Lower eyelid with a very large transparent disk, nearly as large as the eye. Nostril pierced in a small nasal. Supranasals narrow, widely separated by the frontonasal; a narrow postnasal often fused with the supranasal; frontonasal much broader than long, forming a suture with the rostral and with the frontal; præfrontals well developed; frontal slightly longer than the frontoparietals, in contact with the first and second supraoculars; four supraoculars, second much the largest; seven supraciliaries; frontoparietals and interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; seventh upper labial largest and entering the orbit. Ear-opening oval, oblique, smaller than the transparent palpebral disk, with three or four small lobules anteriorly. Forty-two to forty-four smooth scales round the middle of the body, dorsals largest, especially the two vertebral series, laterals smallest. A marginal row of slightly enlarged præanals. The adpressed limbs slightly overlap. Digits moderate, slightly compressed; subdigital lamellæ smooth, about twenty-two under the fourth toe. Tail slightly longer than head and body. *Colour.*—Dark-brown above with pale greenish-white markings of which the most constant is a dorso-lateral band commencing above the eye and lost on the tail; usually with regular longitudinal series of light spots; sides blackish-brown light dotted, a narrow longitudinal line of the above pale colour extending from the ear above the fore-limb to the groin. Lower surfaces bluish-green.

Total length	...	...	104 mm.
Head ...	...	...	10 ,,
Width of head	...	...	7 ,,
Body ..:	...	...	39 ,,
Fore-limb	...	...	13 ,,
Hind-limb	...	...	18 ,,
Tail ...	...	...	55 ,,

Distribution—Victoria: Brandy Creek, Dandenong Ranges (Melb. Mus.); Dimboola, Gisborne, Croajingolong (L. and F.).

We have named this elegant little lizard after Prof. W. B. Spencer, M.A., Professor of Biology at the Melbourne University, to whom we are indebted for assistance in many ways during the preparation of this work.

Lygosoma.

Sub-genus Hemiergis, Wagl.

Limbs very short, with less than five digits. Lower eyelid with an undivided transparent disk. Ear covered with scales. No supranasals, præfrontals well developed. Frontal not broader than the supraocular region.

Hemiergis peronii, Fitz.

Tetradactylus decresiensis, Gray, Cat., p. 86.

Seps peronii, Fitzing, N. Class, Rept., p. 53; Gray, Griff. A.K., ix., Syn., p. 72.

Tetradactylus decresiensis, Cuv., R.A., 2nd ed., ii., p. 64; Dum. and Bibr., v., p. 764; Gray, Zool. Ereb. and Terr. Rept., pl. vi., fig. 4 (and details of head, fig. 1).

Hemiergis decresiensis, part., Steind, Novara, Rept., p. 50.

Description.—" Body much elongate; limbs very weak, tetradactyle; the distance between the end of the snout and the fore-limb is contained twice to twice and two-thirds in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal;

no supranasal; frontonasal broader than long, forming a narrow suture with the rostral and with the frontal; latter shield scarcely longer than the interparietal; in contact with the first and second supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietals distinct, nearly as long as the interparietal; parietals forming a suture behind the interparietal; two or three pairs of nuchals; fifth upper labial below the centre of the eye, from which it is separated by a series of suboculars. Ear covered with scales, indicated by a depression. Eighteen or twenty smooth scales round the middle of the body; dorsals largest. A pair of enlarged præanals. The length of the hind-limb equals the distance between the centre of the eye and the fore-limb; third toe longest. Tail thick, once and a half to once and two-thirds the length of head and body. *Colour.*—Pale-brown or golden above, with or without minute brown dots; a black dorso-lateral line; sides grey, speckled with black; lower surfaces whitish, black spotted.

Total length	... ...	152 mm.
Head ...	... ...	9 ,,
Width of head	... ...	6·5 ,,
Body ...	... ...	48 ,,
Fore-limb	... ...	7 ,,
Hind-limb	... ...	13 ,,
Tail ...	... ...	95 ,, "—Boulenger.

Habits.—Found under logs and flat stones on the hillsides and in gullies. Movements very slow.

Distribution.—Victoria: Dandenong Ranges (Melb. Mus.).

Range outside Victoria.—Kangaroo Island, Albany.

Hemiergis decresiensis, Gray.

Hemiergis decresiensis, Gray, Cat., pp. 87 and 272.

Zygnis decresiensis, Fitzing, N. Class, Rept., p. 53.

Tridactylus decresiensis, Cuv. R.A., 2nd. ed., 64; Gray, Griff. A.K., ix., Syn., p. 72.

Hemiergis decresiensis, Dum. and Bibr., v., p. 766; Gray, Zool. Ereb. and Terr. Rept., pl. vi., fig. 5.

——— *decresiensis*, part., Steind, Novara, Rept., p. 50.

Hemiergis polylepis, Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 48.

Description.—"Body much elongate; limbs very weak, tridactyle; the distance between the end of the snout and the fore-limb is contained twice and one-fourth to twice and a half in the distance between axilla and groin. Snout short, obtuse. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal broader than long, forming a narrow suture with the rostral and with the frontal; latter shield not longer than the interparietal; in contact with the first and second supraoculars; four supraoculars, second largest; seven or eight supraciliaries; frontoparietals distinct, nearly as long as the interparietal; parietals forming a suture behind the interparietal; no enlarged nuchals; fifth upper labial below the centre of the eye, from which it is separated by a series of suboculars. Ear covered with scales, indicated by a depression. Twenty-four smooth scales round the middle of the body, subequal. A pair of enlarged præanals. The length of the hind-limb equals the distance between the centre of the eye and the fore-limb; second toe slightly longer than the third. *Colour.*—Pale-brown above, four longitudinal series of black dots, sometimes confluent into lines, on the back; a black dorso-lateral line; sides grey, black dotted; lower surfaces yellowish, throat and tail black spotted."—Boulenger.

Total length	102 mm.
Head	8 ,,
Width of head	5 ,,
Body	39 ,,
Fore-limb	6·5 ,,
Hind-limb	10 ,,
Tail	55 ,,

Habits.—Similar to former species.

Distribution.—Victoria: Ferntree Gully, Beechworth.

Range outside Victoria.—South Australia, Kangaroo Island.

LYGOSOMA.

Sub-genus SIAPHOS, Gray.

Limbs more or less developed. Lower eyelid scaly, or with a transparent disk. Ear covered with scales or very minute.

No supranasals. Præfrontals (in species with short limbs) minute or absent. Frontal not broader than the supraocular region.

SIAPHOS MACCOYI, sp. nov.

(Plate 2, fig. 2, 2a.)

Description.—Body much elongate, limbs weak, pentadactyle; the distance between the end of the snout and the fore-limb is contained about three times in the distance between axilla and groin. Snout short, obtusely pointed. Lower eyelid with an undivided transparent disk. Nostril pierced in the nasal; no supranasal; frontonasal very broad, forming a broad straight suture with the rostral, and a curved one with the frontal; præfrontals absent; frontal not longer than the frontoparietals, in contact with the first and second supraoculars; five supraoculars, second largest; seven supraciliaries; frontoparietals and interparietal distinct; parietals forming a suture behind the interparietal; a pair of nuchals and a pair of temporals border the parietals; fourth upper labial below the centre of the eye. Ear opening distinct, minute. Twenty smooth scales round the middle of the body. Præanals not enlarged. The length of the hind-limb scarcely equals the distance between the centre of the eye and the fore-limb. Fourth toe not longer than the third, with six or seven smooth lamellæ inferiorly. *Colour.*—Brown or greyish-brown above, each dorsal scale with three or four minute dark longitudinal lines; a more or less distinct black dorsolateral line extending from the eye to the base of the tail; ground colour of lateral scales brownish, or greyish, sometimes nearly white, each with irregular minute darker streaks; throat ivory-white spotted with brown; belly bright-yellow immaculate; under surface of tail bright-yellow, more or less covered with blackish-brown blotches.

Total length	...	...	139 mm.
Head	... ...	...	8 „
Width of head	...	...	4·5 „
Body	... ...	...	48 „
Fore-limb	...	...	6 „
Hind-limb	...	...	9 „
Tail	... ...	...	83 „

Habits.—Usually met with under logs and flat stones in moist places. Movements very slow.

Mode of reproduction.—Young developed within the body of the parent, eight or nine being brought forth in January or February.

Distribution.—Victoria: Brandy Creek, Trafalgar, Waterloo, Lakes Entrance, Ferntree Gully, Fernshaw, Dandenong Ranges, Goulburn Valley (Melb. Mus.); Ringwood, Dandenong Ranges, Berwick, Plenty Ranges, Upper Yarra, Croajingolong, North and South Gippsland (L. and F.).

We have named this graceful little lizard after Sir Frederick McCoy, K.C.M.G., &c., through whose kindness and courtesy we have been able to examine a large number of specimens preserved in the National Museum of Victoria.

Lygosoma.

Sub-genus Rhodona, Gray.

Limbs short or rudimentary. Lower eyelid with a transparent disk. Ear distinct, minute. No supranasals. Præfrontals very small and widely separated, or absent. Frontal not broader than the supraocular region.

Rhodona bougainvillii, Gray.

Lygosoma bougainvillii, Gray, Cat., p. 85.

Riopa bougainvillii, Gray, Ann. and Mag. N.H., ii., 1839, p. 332.

Lygosoma bougainvillii, Dum. and Bibr., v., p. 716; Günth., Zool. Ereb. and Terr. Rept., p. 13.

——— *laterale,* (non Say), Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 46.

Description.—"Body much elongate, limbs weak; the distance between the end of the snout and the fore-limb is contained twice to twice and a half in the distance between axilla and groin. Snout moderate, obtusely conical. Lower eyelid with an undivided transparent disk. Nostril pierced in a rather large nasal, which is in contact with its fellow, frontonasal large, broadly in contact with the rostral; præfrontals small, and widely separated; frontal broader than the supraocular region, longer than the frontoparietals and interparietal together; in contact with the first and second supraoculars; four supraoculars, second largest; fourth very small; six supraciliaries; frontoparietals and interparietal distinct, sub-equal; parietals forming a suture behind the interparietal; two or four pairs of nuchals; fifth upper labial entering the orbit. Ear-opening minute, not or scarcely larger than the nostril. Twenty-two or twenty-four smooth scales round the middle of the body; dorsals largest. A pair of large præanals. The length of the hind-limb equals the distance between the nostril and the fore-limb; toes slender, slightly compressed, fourth much longer than third; subdigital lamellæ feebly keeled, fifteen to eighteen under the fourth toe. Tail slightly longer than head and body. *Colour.*—Greyish above, with blackish dots or short lines along the series of scales; a black lateral band, passing through the eye; flanks white, black dotted; lower surfaces white.

Total length	135 mm.	
Head	9 „	
Width of head	6 „	
Body	54 „	
Fore-limb	8 „	
Hind-limb	14 „	
Tail	72 „	"—Boulenger.

Habits.—Met with under logs and stones in moist places, where they frequently make excavations in the ground. Movements slow.

Distribution.—Victoria: Melbourne, Keilor, Pyramid Hill, Western District (Melb. Mus.); Carrum, Bacchus Marsh, Castlemaine, Grampians, Beechworth, Mt. Stanley (L. and F.).

Range outside Victoria.—South Australia, Kangaroo Island.

Rhodona punctatovittata, Günth.

Rhodona punctatovittata, Günth., Ann. and Mag. N.H. (3), xx., 1867, p. 47.

——— *officeri*, McCoy, Prodr. Zool. Vict., dec. vi., pl. li.

Description.—"Body much elongate; limbs very weak, anterior monodactyle, posterior didactyle; the distance between the end of the snout and the fore-limb is contained more than three times in the distance between axilla and groin. Snout subcuneiform, with slightly projecting labial edge. Eye very small. Lower eyelid with an undivided transparent disk. Nostril pierced in a large swollen nasal, which forms a suture with its fellow ; fronto-nasal much broader than long, forming a broad suture with the frontal ; præfrontals small and widely separated ; frontal much broader than the supraocular region, in contact with the first and second supraoculars and with the interparietal ; supraoculars three, small, second largest ; six supraciliaries ; frontoparietals small, much smaller than the interparietal ; parietals forming a suture behind the interparietal ; four pairs of nuchals ; fourth upper labial entering the orbit. Ear-opening scarcely distinguishable. Eighteen smooth scales round the middle of the body, dorsals largest, ventrals smallest. A pair of enlarged præanals. Fore-limb nearly as long as the snout ; hind-limb as long as the distance between the ear and the fore-limb ; second toe more than twice as long as first." *Colour.*—Rich brown above, each scale with a black spot, the spots forming six or eight longitudinal rows ; head-shields black-edged ; lower surfaces pale yellow-ochre.

Total length	169 mm.
Head	10 ,,
Width of head	6·5 ,,
Body	75 ,,
Fore-limb...	3·5 ,,
Hind-limb	10 ,,
Tail	84 ,,

Habits.—Found in loose sandy soil, into which it burrows.

Distribution.—Victoria : Swan Hill.

Range outside Victoria.—Queensland.

Ablepharus, Fitzing.

Palatine and pterygoid bones in contact mesially, the palatal notch not extending forwards to between the centre of the eye ; pterygoids toothless. Maxillary teeth conical. No movable eyelids, a transparent disk covering the eye. Ear distinct or hidden. Nostril pierced in the nasal; supranasal present or absent. Limbs more or less developed.

The genus extends over south-eastern Europe, south-western Asia, Tropical and South Africa, and Australia.

Ablepharus boutonii, Desj.

Cryptoblepharus boutonii, Gray, Cat., p. 64.

Scincus boutonii, Desjard, Ann. Sc. Nat., xxii., 1831, p. 298.

Ablepharus leschenaulti, Cocteau, Mag. de Zool., 1832, Rept., pl. i.

Ablepharus pœcilopleurus, Weigm., N. Acta Ac. Leop.-Carol, xvii., 1835, i., p. 202, pl. viii., fig. 1; Günth, Proc. Zool. Soc., 1874, p. 296.

Cryptoblepharus peronii, Cocteau, Et. Scinc., p. 1.

——— *leschenaultii*, Coct., l.c.

Cryptoblepharus pœciiopleurus, Gray, Ann. N. H., ii., 1839, p. 335, and Zool. Ereb. and Terr. Rept., pl. v., fig. 2.

Tiliqua buchanani, Gray, Ann. N. H., ii., p. 291.

Ablepharus peronii, Dum. and Bibr., v., p. 813; Peters, Mon. Berl. Ac., 1854, p. 619; Bavay, Cat., Rept., N. Caléd., p. 31.

Cryptoblepharus eximius, Girard, Proc. Ac. Philad., 1857, p. 195, and U. S. Explor. Exped., Herp., p. 222, pl. xxvi., figs. 25-32.

——— *plagiocephalus*, Girard, U. S. Explor. Exped., Herp., p. 220, pl. xxvi., figs. 17-24.

(?) Ablepharus nigropunctatus, Hallow., Proc. Ac. Philad., 1860, p. 487.

Ablepharus boutonii, Strauch, Mél. Biol. Acad., St. Pétersb., vi., 1869, p. 566, and Bull, xii., p. 368; Günth, l.c.; Peters and Doria, Ann. Mus., Genova, xiii., 1878, p. 339; Peters, Reise, n. Mossamb., iii., p. 77.

——— *quinquetæniatus*, Günth, l.c.

Ablepharus rutilus, Peters, Sitzb., Ges. Nat. Freunde, 1879, p. 37.

——— *(Cryptoblepharus) boutonii*, Bocourt, Miss. Sc. Mex., Rept., p. 463, pl. xxii., H., fig. 1.

—— (———) *leschenaultii*, Bocourt, l.c.

—— (———) *peronii*, Bocourt, l.c.

Ablepharus boutonii, var. cognatus, Boettg., Zool., Anz., 1881, p. 359; and Abh. Senck., Ges., xii., 1881, p. 454, pl. ii., fig. 4.

Description.—"Snout pointed, rostral not projecting. Eye entirely surrounded by a circle of granules; upper eyelid represented by three or four larger scales. Rostral largely in contact with the frontonasal; præfrontals either forming a suture or narrowly separated; frontal small, in contact with the first and second supraoculars, in contact with or separated from the interparietal; latter very large, formed by fusion with the fronto-parietals; five supraoculars, second largest, fifth smallest; five or six supraciliaries, second largest; a pair of large nuchals. Ear-opening roundish, about as large as the pupil. Scales smooth, or feebly striated; twenty to twenty-eight round the middle of the body; dorsals largest; the two median series strongly dilated transversely in specimens with fewer (twenty or twenty-two) longitudinal series of scales. Limbs well developed, pentadactyle; the hind-limb reaches the axilla, or not so far; digits long and slender, smooth inferiorly. Tail a little longer than head and body." *Colour.*—Greenish, or bluish above, strongly metallic, covered with small blackish spots, sides sometimes with irregular lighter and some darker bands; lower surfaces greenish or bluish-white.

Total length	105	mm.
Head	10	,,
Width of head	6	,,
Body	33	,,
Fore-limb	15	,,
Hind-limb	19	,,
Tail	62	,,

Habits.—Usually met with on fences, fallen trees, and tree-stumps, into the crevices of which it quickly disappears on the approach of an enemy. It soon reappears, when, by the exercise of a little patience, it may be easily captured.

Distribution.—Victoria: Grampians, Western District (Melb. Mus.); Dimboola, Swan Hill, Baringhup, Brown's Plains (L. and F.).

Range outside Victoria.—Irregularly distributed over the hotter parts of both hemispheres.

ABLEPHARUS LINEO-OCELLATUS, Dum. and Bibr.

Cryptoblepharus lineo-ocellatus, Gray, Cat., p. 65.

Morethia anomalus, Gray, l.c.

Ablepharus lineo-ocellatus, Dum. and Bibr., v., p. 817; Strauch, Mél. Biol. Ac., St. Pétersb., vi., 1868, p. 569, and Bull, xii., p. 371.

Cryptoblepharus lineo-ocellatus, Gray, in Grey's Trav. Austr., ii., p. 427.

Morethia anomalus, Gray, Zool. Ereb. and Terr. Rept., p. 4, pl. v., fig. 1.

Ablepharus anomalus, Strauch, l.c., pp. 570, 571.

Morethia anomala, Günth, Zool. Ereb. and Terr. Rept., p. 10.

Ablepharus (Morethia) anomalus (adelaidensis), Peters, Mon. Berl. Ac., 1874, p. 376.

Description.—"Snout short, obtuse, rostral not projecting. Eye entirely surrounded by a circle of granules. Rostral largely in contact with the frontonasal, which is in contact with the frontal; latter shield nearly as long as, but narrower than the interparietal, which is formed by fusion with the frontoparietals; four supraoculars, second and third largest, first and second in contact with the frontal; six supraciliaries, third to fifth usually very large, sixth minute; a pair of nuchals; four (or five) labials anterior to the subocular; supranasals sometimes present. Ear-opening rather large, oval, with one or several projecting small lobules anteriorly. Scales subequal in size, twenty-four to thirty round the middle of the body. Limbs well developed, pentadactyle; the hind-limb does not reach the axilla; digits obtusely keeled inferiorly. Tail longer than head and body. *Colour.*—Olive or brownish above, black spotted, or with light black-edged ocelli; a more or less strongly marked blackish lateral band, edged below by a white black-edged streak which extends from the eye or ear to the groin; a white black-edged spot or streak between the thigh and the tail; lower surfaces yellowish, or greenish-white.

Total length	...	...	108	mm.
Head ...	...	...	9	,,
Width of head	...	...	6	,,
Body ...	...	...	31	,,
Fore-limb...	...	...	11	,,
Hind-limb	...	...	17	,,
Tail ...	...	...	68	,, "—Boulenger.

Habits.—Habits similar to those of *A. boutonii.*

Distribution. — Victoria : Melbourne, Goulburn Valley, Western District (Melb. Mus.) ; Dimboola (L. and F.).

Range outside Victoria.—South Australia, Kangaroo Island, West Australia.

DESCRIPTION OF PLATE II.

Fig. 1.—Emoa spenceri, L. and F.
,, 1a. ,, ,, upper view of head.
,, 2.—Siaphos maccoyi, L. and F.
,, 2a. ,, ,, upper view of head.

Rae Bros., Phototype, Melb.

FIG. 1, EMOA SPENCERI. FIG. 2, SIAPHOS MACCOYI.

Art. III.—*Further Notes on Australian Hydroids, with Descriptions of some New Species.*

(With Plates III., IV., V., VI.)

By W. M. Bale, F.R.M.S.

[Read April 13, 1893.]

The hydroids treated of in the present paper were mostly comprised in a collection made by Mr. J. Bracebridge Wilson, M.A., and forwarded to me a considerable time since for examination and report in connection with the work of the committee appointed by this Society to investigate the fauna of Port Phillip. Many of the species included in the collection had already been described and recorded from that locality, and of these for the most part no particular mention is here necessary; but in a few cases the specimens present more or less distinct varietal features, which I have duly noted, and in two or three other instances they include the gonangial capsules, which had not previously been observed. A few of the species had not been recorded from Port Phillip, and among them were nine which proved to be new to science. Two of these, however (one of them forming the type of a new family), have since been described and figured with careful and elaborate detail by Professor Spencer in the Transactions of this Society, under the names of *Plumularia procumbens* and *Clathrozoon wilsoni*.

One Calyptoblastic species probably represents an undescribed genus, but as the specimens consist merely of the polypidom, I content myself with giving a description and figure (without names), pending the discovery of specimens in a fit condition to admit of its true affinities being ascertained. The genus *Halocordyle*, not hitherto known to occur in Australia, is represented by a single incomplete specimen.

Some good examples of *Diplocheilus mirabilis*, Allman, have on examination satisfied me that the character on which the genus was founded, namely, the presence of a secondary envelope to the hydrotheca, is, as I have previously suggested, illusory, the appearance of an outer calycle being caused by a solid thickening of the perisarc, such as is common in the hydrothecæ of many *Plumulariæ* and at intervals along the hydrocladia of nearly all; while the discovery that this species possesses mesial nemataphores which are unprovided with sarcothecæ assigns to it a place under Jickeli's genus *Kirchenpaueria*, to which genus also it is now evident that the very closely related species *Azygoplon productum (Plumularia producta)*, Bale, must also be relegated.

Two or three species of *Eudendrium* are included in the collection, but although the hydranths are present, their condition is not such as to enable me to decide satisfactorily whether they are to be referred to any of the species already known, some of which differ very slightly from each other, especially in regard to the polypidom. In such cases it appears very desirable that confusion of species should be avoided by describing only such forms as are examined in a perfectly fresh condition, and in which the gonosome is present, as the smallest details, even the colour, must be taken into consideration.

My thanks are due to Mr. A. J. Campbell, F.L.S., for specimens of three or four species representative of the unexplored hydroid-fauna of Western Australia, one of them—a large species of *Aglaophenia*—being new; also to Dr. MacGillivray for a new species of *Plumularia* from the Snowy River, as well as a few other specimens.

Halocordyle australis, n. sp.

Hydrocaulus branched (monosiphonic ?), small branches biserial, alternate, polypiferous ramuli biserial, rather irregular, both series directed to the front; all branches strongly and closely ringed for a considerable distance above their point of origin and above the point at which other branches spring from them; polypiferous ramuli and some of the others ringed throughout; polypiferous ramuli not expanded towards the aperture. Hydranths large, flask-shaped, with a stout cylindrical proboscis rounded at the top, about 8 or 10 filiform tentacles springing from the lower part of the body, and four or five short capitate tentacles surrounding the proboscis.

Gonophores pedunculate, borne on the lower part of the hydranth within the circle of filiform tentacles, umbrella with a small opening and four radial canals, manubrium large.

Larger branches deep red-brown, smaller ones lighter.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

I have only seen a single mounted specimen of this species, and cannot therefore give full particulars of its size and habit. So far as it goes the specimen is monosiphonic, with the small branches alternately directed slightly to the right and the left, while the polypiferous ramules are also directed slightly to right and left, but are not strictly alternate, two often following on the same side. The polypidom could be readily distinguished from that of any other Australian hydroid known to me by the extent and distinctness of the annular wrinkling of the perisarc, which answers to Ellis' description of a "tubulous coralline wrinkled like the windpipe" far more closely than does the *Tubularia larynx* to which that description was applied.

The hydranths differ from those of *Pennaria australis* in no important particular except in having the capitate tentacles fewer in number and confined to a single circlet round the base of the proboscis, instead of being scattered irregularly over the body. It is possible that the number of the filiform tentacles is habitually double that of the capitate ones, but I had not a sufficient number of hydranths in which the tentacles could be counted to satisfy myself that such was the case.

The gonophores, which are borne one or two on a hydranth, are small and regularly ovate, and like those of *Ceratella* as figured by Professor Spencer, are quadrate in transverse view, owing to the enlargement of the umbrella at the four sides where the radial canals are situated. In side view the umbrella is seen to thin rapidly away to the small orifice at the summit (which is closed in by the ectotheca), and no traces of tentacles could be detected. In these points they agree with the immature gonophores of *Pennaria* (except that the structure of the umbrella is more distinct), and it is probable that they also agree with them when mature in being completely open and in the possession of rudimentary tentacles, which condition exists also in the species of *Halocordyle* already known (*H. tiarella*).

CLATHROZOON WILSONI, Spencer.

(Trans. Royal Soc. Vict., Vol. II, Part I.)

This hydroid was represented only by the polypidom in the collection which I received from Mr. Wilson; other specimens, which the same gentleman collected later on, and which included the soft parts, were forwarded to Professor Spencer, who has described them as the type of a new family.

——— ———, n. gen., and sp.?

(Plate III., figs. 1, 2.)

Hydrocaulus nine inches (or more) in height, consisting of a stout monosiphonic stem with a few ascending branches, nearly equal in diameter for the greater part of its length, not distinctly jointed, very irregular in shape, being much swollen about the origin of the polyp-tubes; polyp-tubes given off on all sides without any regular order, sometimes very short, scarcely projecting, but usually about as long as the diameter of the stem, straight, or more often irregularly bent or twisted, terminating in a stout annular thickening, darker in colour than the rest. Hydranths unknown.

Gonophores solitary, borne on peduncles which occupy tubes like those of the hydranths.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

The hollow stem averages about $\frac{1}{30}$ to $\frac{1}{25}$ of an inch in diameter, but varies greatly at different points, owing mainly to its inflated condition at those parts where the polyp-tubes originate. The latter also are far from uniform in shape and size, often having a distorted appearance, and being sometimes, but not invariably, a little expanded at the summit. Here and there the margin, with its thickened ring, is duplicated, as in many caliculate species. There are no hydrothecæ, and I failed to find any hydranths; but one or two of the lower tubes bore gonophores, which appeared to take the form of ovate or oblong sacs, without openings at the summit, but were not in sufficiently good condition to admit of their structure being accurately determined.

I refrain from naming this species at present, as in the absence of the hydranths it is impossible to decide whether it forms the type of a new genus, or whether it may be possible to refer it to one already established.

Campanularia.

The only species of this genus which I have to describe, though small and of simple habit, agrees in all its more important characteristics with the two or three species for which Professor Allman has proposed the genus *Thyroscyphus*. It is true that a four-sided operculum is given as a feature of that genus, while in *C. tridentata* the operculum is three-sided; but the precise number of opercular valves is obviously not of generic importance; in another direction, however, the genus is unsatisfactory, namely in separating species which are exceedingly close allies, differing in no important particular except in the presence or absence of the operculum. For example, the *Campanularia insignis* of the *Challenger* Report and the *Campanularia Torresii* of Busk (*Thyroscyphus simplex*, Allman) and *T. ramosus*, Allman, are all so closely related that no arrangement which separates them can be regarded as satisfactory. The species mentioned, with some others, though having shortly pedunculate hydrothecæ, are, in regard to the arrangement of the latter and the ramification, more like the genus *Sertularella* than the typical members of the Campanularian family; and as in *Sertularella*, the hydrothecæ may have three or four emarginations of the border, with an operculum of the same number of valves, or may be entire and destitute of any operculum. It cannot be maintained that the presence or absence of the operculum in the one group is in the slightest degree more important than in the other, and as Professor Allman is doubtless justified in remarking concerning species of *Sertularia* provided with membranous opercular valves that "few systematists would think of separating these generically from the closely allied species in which no valves are present," it seems to follow that such separation is equally unwarranted in the Campanularian group. Undoubtedly such species as *C. insignis* and *C. Torresii* form a group distinct from the typical *Campanulariæ*, and it would perhaps be advisable to unite them in a single genus, which, ranking under the Campanulariidæ, would yet exhibit strong affinities with the Sertularians. This was recognised by Lamarck, who included such species as a section of the genus *Sertularia*, thereby, however, placing them on the wrong side of the boundary line.

Campanularia tridentata, n. sp.

(Plate III., fig. 3)

Hydrocaulus simple, about half an inch in height, each internode bearing a short process from which springs a hydrotheca. Hydrothecæ alternate, tubular above, curving inwards towards the base on the upper side only, so that the lower or outer wall of the cell is straight or concave, while the upper is strongly convex; aperture with three pointed teeth (or three deep emarginations), and an operculum of three pieces.

Gonothecæ?

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

This is a member of the group which includes operculate species such as *C. Torresii* and inoperculate species like *C. insignis* and *C. rufa*. From such of the former as are already known it differs in having three valves instead of four, as well as in its small size and simple habit. In this group each hydrotheca usually springs, as in *Sertularella*, from a distinct internode; the hydrothecæ have short peduncles of one or two joints only, and they are mostly gibbous above the base on the side next the hydrocaulus, but less so or not at all on the outer side. In *C. tridentata* the margin of the hydrotheca proper is scarcely thicker than the valves into which it is continued; the line of demarcation is therefore not conspicuous.

Campanularia insignis, Allman.

This species, described in the *Challenger* Report, appears to be the same which Busk identifies with the *Laomedea antipathes* of Lamouroux. Busk says of *Laomedea Torresii* that "at first sight it is very like *L. antipathes*, Lamx., which occurs in New Zealand, but differs materially in its smaller size and in the four shallow emarginations of the mouth, which part in *L. antipathes* is entire and with the margin a little thickened." As *Campanu-*

laria (Laomedea) Torresii differs from *C. insignis* in precisely these particulars, there is every probability that Busk was speaking of the latter species under the name of *L. antipathes;* it is very doubtful, however, whether it was really the same as that described by Lamouroux ; indeed, if the figure given by the latter be at all correct, it cannot be intended for the species mentioned by Busk.

Thyroscyphus simplex, Allman.

The species described under the above name in the *Challenger* Report is identical with *Campanularia Torresii*, Busk, (*Laomedea Torresii* of the " Voyage of the *Rattlesnake*"). Both Busk's and Allman's types came from Torres Strait, and appear to have been wholly alike, except that the latter was a rather larger specimen.

Obelia geniculata, Lin.

A dwarf variety, about one-fourth of an inch in height, and with all its parts small in proportion. The thickenings of the stem-internodes, which give the species its characteristic appearance, are, especially towards the bases of the shoots, even more strongly developed than in the larger forms.

The *Monosklera pusilla* of von Lendenfeld appears to be identical with this variety, so far as can be judged from a comparison with some of the type specimens, from which, however, the hydrothecæ have fallen off.

Port Phillip Bay (Mr. J. B. Wilson).

Halecium gracile, Bale.

Port Phillip Bay (Mr. J. B. Wilson).

The female gonothecæ when mature have the summit notched like those of *H. parvulum*,* and do not differ greatly from them in other respects ; it would appear, therefore, that the differences which I have shown as existing between them may depend largely on their state of development. The male gonothecæ are considerably longer than those of my former specimens, which were evidently immature.

* Proceedings of the Linnean Society of New South Wales, 1888, p. 759.

It is not impossible that *H. gracile* and *H. parvulum* may ultimately prove identical, but so far all my specimens of the former have been monosiphonic, while the opposite condition characterises those of *H. parvulum*.

Sertularia unguiculata, Busk.

A form of this protean species differing from those which I have hitherto examined in the total absence of the short internodes, which in most varieties occupy the distal portion of the pinnæ, and which bear only one pair of hydrothecæ each. In the present form all the hydrothecæ are as a rule closely adnate, and the pinnæ have rarely more than one distinct joint in their whole length, and in the majority of cases not even one.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularia tuba, Bale.

These specimens differ from others which I have examined in the possession of a slender stem some four inches or perhaps more in height, which gives off throughout its whole extent numerous pinnate branches about $\frac{3}{4}$-inch in length. The stem, though slender in proportion to its length, is thicker and darker than the branches, but bears hydrothecæ similarly arranged ; it tends towards a fascicled condition, being strengthened by one or two supplemental tubes, which also give off hydrothecal ramuli. I at first concluded that this was a distinct variety, but it is quite possible that it may only be a more fully developed stage of the usual form, with which, in minute structure, it entirely agrees.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella.

In the *Challenger* Report Professor Allman suppresses the genus *Sertularella* on the ground that the distinctions relied upon to justify its separation from *Sertularia* break down on a critical comparison of a large number of species of the two groups. He does not allude, however, to what I have always regarded as the principal characteristic of the genus *Sertularella*, namely, the fact that each hydrotheca, at least on the smaller branches, occupies a distinct internode, while in *Sertularia* there are one or more *pairs* on an internode, and in *Thuiaria* two series which are not paired. A great many species of *Sertularella* have been described by different authors, and the essential character mentioned above seems to be common to all of them, except in the case of two which were described by Professor Allman in his paper on Australian, Cape, and other Hydroida, in the Journal of the Linnean Society for 1885. One of these—*S. diffusa*—seems to be a true *Sertularia*, with two pairs of alternate hydrothecæ on each internode; the other—*S. trochocarpa*—undoubtedly exhibits strong affinities with *S. Johnstoni* and similar species, especially in the form of the gonangia, while at the same time the arrangement of the sub-alternate hydrothecæ (a pair on each internode) would require it to be placed in the genus *Sertularia*, an affinity indicated also by the form of the hydrotheca-margin. It may therefore be regarded as a transitional form of that genus.

Sertularella longitheca, Bale.

(Plate IV., figs. 7–9.)

Gonothecæ with three longitudinal angles, one dorsal and two lateral, the latter more acute and prolonged upwards into two large erect conical hollow processes, dorsal angle sometimes having a similar conical summit, but often terminating in a slight shoulder about the level of the aperture; summit of the gonangium forming a broad truncated cone between the processes, with a depression at the top from which rises a small conical neck, with narrow aperture.

Port Phillip Bay (Mr. J. B. Wilson).

The form of the gonotheca was previously somewhat doubtful, as I had only a single distorted specimen. When the dorsal angle is not prolonged upward the gonotheca in front view is not unlike those of *Sertularia elongata*, except in the elevated and narrow aperture. There are no transverse undulations, but the gonotheca is covered with delicate wavy transverse striæ, which appear to be minute ridges.

The largest specimen is about four inches long, with five or six distant ascending branches.

Sertularella macrotheca, Bale.

(Plate IV., fig. 3.)

The gonangia are smaller than those of my former specimens, and have the transverse undulations much deeper, closely approximating to those of *S. solidula*.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella Johnstoni, Gray.

Some of the specimens have the hydrothecæ more conical than the commoner forms, therein resembling specimens from New Zealand, but agreeing with other Victorian specimens in the shape of the gonothecæ.

Port Phillip Bay (Mr. J. B. Wilson).

Sertularella angulosa, n. sp.

(Plate IV., fig. 6.)

Shoots simple, short, zig-zag, divided by slightly-twisted joints into internodes, each bearing a hydrotheca on its upper part. Hydrothecæ adnate from one-third to one-half their height, large, divergent, barrel-shaped, but smaller towards the summit, with about six distinct sharp annular ridges; aperture expanding, with four teeth; three internal compressed vertical teeth, two of which are within the two upper emarginations of the border, and the third opposite the inferior marginal tooth.

Gonothecæ ?

Hab. ?

In habit resembling *S. polyzonias*, but the lower internodes are mostly more strongly zig-zag than in that species, while the hydrothecæ are less contracted above in proportion to the diameter of the lower portion, are not adnate for so far, and are more particularly differentiated by the distinct ridges encircling them. The internal vertical teeth are arranged exactly as in *S. polyzonias* and *S. microgona*, and, as in those species, are so delicate and transparent as to be easily overlooked, especially when the hydrothecæ are not perfectly free from the soft parts.

The specimens, of which there were very few, only reached about one-fifth of an inch in height, but were doubtless immature. The perisarc of the lower portions was rather thick.

SYNTHECIUM PATULUM, Busk.

Specimens about two inches in height, with several of the pinnæ anastomosing. Some of the hydrothecæ are much stouter and less curved than usual, with the margin more deeply sinuated at the sides, while the portions of the internode outside of the hydrothecæ are correspondingly diminished; the hydrothecæ thus occupy almost the whole internode. These modified internodes are mixed on the same pinna with the normal form.

Mouth of Snowy River (Dr. MacGillivray).

THUIARIA LATA, Bale.

(Plate IV., fig. 1.)

Gonothecæ borne two or three on a pinna, springing from between the two series of hydrothecæ, very large (about $\frac{1}{8}$-inch long), gradually tapering downward, thickest part a little below the summit; presenting, as seen in side view, a dorsal and a ventral aspect, the former regularly undulated most of its length, the latter smooth; summit concave and oblique, more elevated at the back than in front.

Port Phillip Bay (Mr. J. B. Wilson).

(The gonothecæ of this species have not hitherto been described).

THUIARIA FENESTRATA, Bale.

(Plate IV., fig. 2.)

Port Phillip Bay (Dr. MacGillivray).

The gonothecæ are more nearly globular than those of any other species known to me. The sketch of one of them by Mr. Busk, which I copied in the "Catalogue of the Australian Hydroid Zoophytes," and from which I took the description, is evidently erroneous, which may possibly be due to some other species having been mixed with the material. The description in the "Voyage of the *Rattlesnake*" did not mention the gonosome.

Idia pristis, Lamx.

(Plate IV., figs. 4, 5.)

In the *Challenger* Report Professor Allman has given a more complete account of this remarkable hydroid than had previously been possible, having had the advantage of examining specimens sufficiently well preserved to exhibit much more of the detail than could be made out in ordinary dried specimens. It is through an oversight, however, that Professor Allman states in two different parts of his work that the species had previously been known only from Lamouroux' inadequate figure and description and a short notice of the gonosome by Mr. Hincks in the Journal of the Linnean Society of London for 1887, since I had in 1884 described and figured both trophosome and gonothecæ, while Mr. Busk had described the species in 1852, in the "Voyage of the *Rattlesnake*," from which notice I first identified it. The description of the gonothecæ, however, in the work just mentioned was an error, the object described being a parasitic hydroid *(Campanularia costata?)*; but Mr. Busk afterwards observed the true gonothecæ and made sketches of them, which I reproduce. The figures of the gonothecæ given in the *Challenger* Report differ considerably from the specimens I have seen (which resemble Mr. Busk's figures), especially in showing the longitudinal ribs much closer and terminating at the shoulder instead of continuing up to the margin, while they give no indication of the curved wrinklings of the surface which form series of irregular arches joining all the ribs. Possibly the latter feature is a result of the drying of the perisarc, and therefore not present in well-preserved specimens which have not been dried. The gonothecæ are apt to be very irregular in form, sometimes being deeply constricted round the middle, while others have the characteristic ribs absent in parts, and represented by a totally irregular wrinkling of the surface. According to Professor Allman, the hydrothecæ have the peculiarity of opening backwards by a small valvular operculum, but in specimens which have been dried it is scarcely possible to make out the exact form of the aperture, owing to the collapsibility of the delicate perisarc at that part. The stems of the *Challenger* specimens appear to be more slender than usual, and the axillary hydrothecæ are figured like the others on the stem, while in my specimens they are smaller than the rest, and are curved over so as to point directly to the back of the polypidom.

Aglaophenia parvula, Bale, var.

Larger than the type, reaching two to three inches in height, and branched, branches nearly in the same plane.

Port Phillip Bay (Mr. J. B. Wilson).

The largest specimen bore five or six branches, one of which was again branched. I have formerly described the hydrotheca of *A. parvula* as having five teeth on each side, two of which are often folded together so as to resemble a single tooth; judging from most of the specimens I have since observed, however, it would be more correct to describe the number of teeth as four on each side, one of them being sometimes folded and bifid, the latter being the exceptional rather than the normal condition.

Aglaophenia (?) Whiteleggei, Bale.

Port Phillip.

Of this species, hitherto known only from New South Wales, I have received specimens both from Mr. Wilson and Dr. MacGillivray. The largest specimen is about four inches in height, with a slender stem formed of two tubes in addition to the original jointed filament, and the branches given off most freely towards the summit, so that the polypidom is somewhat cymose. In all the specimens I have observed the peri sarc is very delicate, so much so that nearly all the cells are generally more or less collapsed and distorted after mounting or drying.

Aglaophenia carinata, n. sp.

(Plate VI., figs. 1–3.)

Hydrocaulus polysiphonic, reaching a height of about eighteen inches, much and irregularly branched, stem and main branches thick, branches ascending, pinnæ short, alternate, one on each internode, both series springing from the front. Hydrothecæ set at an angle of about 40°, deep, narrowed towards the base, not bent; a fold or constriction springing from the side next the pinna a little above the base, almost crossing the cell and curving towards the aperture ; margin with a median anterior tooth and three on each side, the last pair often hidden behind the lateral sarcothecæ ; back entire, adnate ; front of hydrotheca with an external longitudinal ridge, terminating in an elevated pointed tooth over the anterior tooth of the margin (sometimes absent). Hydrothecal internodes with two folds, one opposite the fold of the hydrotheca, the other at the base of the lateral sarcothecæ. Mesial sarcotheca about three-fourths the length of the hydrotheca, adnate most of its length, slightly projecting, terminal and lateral apertures distinct or united. Lateral sarcothecæ divergent, adnate up to the hydrotheca-margin, free terminal portion short, conical, directed forward, terminal and lateral apertures united. Cauline sarcothecæ stout, with open margin, two on the stem at the base of each pinna.

Gonangial pinna generally springing from the basal part of a branch, and bearing only sarcothecæ on about the first five internodes. Corbula large, closed, composed of about nine pairs of broad leaflets, the junction-lines marked by thickenings, which towards the front of the corbula generally rise into free prominent expansions, and which are beset with short, conical, canaliculate sarcothecæ, except at the base, where each gives off a stout process armed with a very broad sarcotheca and a longer and narrower pointed one below it ; each leaflet abruptly narrowed on the proximal side near the base, leaving a series of openings along each side of the corbula. A large sarcotheca projecting into the corbula from the basal part of each leaflet.

Colour.—Light-brown.

Hab.—Rottnest Island, Western Australia.

This handsome species was obtained by Mr. A. H. Courderôt, and by him given to Mr. A. J. Campbell, to whom I am indebted for the opportunity of describing it.

Halicornaria ascidioides, Bale.

(Plate V., fig. 1.)

Gonothecæ in two rows, springing from the bases of the hydrocladia, somewhat pyriform, with the top flattened, and a very distinct circle of highly refractive granules just below the aperture.

Port Phillip Bay (Mr. J. B. Wilson).

(The gonothecæ have not previously been described.)

Halicornaria superba, Bale.

Dongarra Beach, Western Australia (Mr. A. J. Campbell).

Kirchenpaueria, Jickeli, (modified).

Diplocheilus, Allman.

Azygoplon, Bale, not Allman.

Hydrocaulus pinnate; hydrocladia furnished with median sarcothecæ, but none at the sides of the hydrothecæ; median sarcostyles present which are not provided with sarcothecæ, but communicate with the interior of the hydrocladia by simple apertures in the perisarc.

Gonangia without phylactocarps of any kind, sometimes adnate by one side to a foreign substance.

The genus *Kirchenpaueria* was founded by Jickeli for some specimens collected at Trieste, which, though fragmentary, were sufficiently well preserved to exhibit clearly the peculiarity which induced him to establish a new genus for them, namely, the presence of naked sarcostyles above the hydrothecæ. Another feature which seems to me of equal importance was the absence of the lateral sarcothecæ usually found in connection with the hydrothecæ; I have accordingly included this characteristic in the generic definition.

Among the material forwarded to me by Mr. J. B. Wilson were several specimens of the *Diplocheilus mirabilis* of Professor Allman's *Challenger* Report, in which the soft parts were fairly well preserved, and examination of these readily showed them to belong to Jickeli's genus. The hydrothecæ of *D. mirabilis* bore a striking resemblance to those of the small species which I formerly described as *Plumularia producta*, and afterwards as *Azygoplon productum*. I therefore carefully re-examined the latter species, and although none of the specimens retained the soft parts, I found the circular apertures through which the naked sarcostyles had been protruded, and which would scarcely have been noticed without a special search, owing to the tenuity of the perisarc around them, and to the fact that their peculiar position rendered it difficult to get a clear view of them. The perisarc of the hydrocladium curves upward to meet the back of the hydrotheca, and the circular aperture is situated in this curved-up portion, nearly vertical to the hydrocladium, so that, whether the latter be viewed laterally or in front, the aperture is turned edgewise to the observer, and is therefore not noticeable, the perisarc being so delicate that the interruption of continuity is only to be seen by careful focussing. However, if a hydrotheca can be found tilted up perpendicularly, the orifice is readily distinguished. In *K. mirabilis* the hydrotheca is formed on the same model, but the perisarc is thicker, and the interruption in it can be easily seen in optical section, as I have shown in Figs. 4-5. The sarcostyles, which are present in most of Mr. Wilson's specimens, are not altogether unprotected, as the perisarc is extended into a slight web on each side of the hydrotheca, which it joins to the pinnule, so that the sarcotheca is to a great extent sheltered in every direction except in front. In Jickeli's specimens the cauline sarcostyles were all naked, but in our two species they are usually provided with sarcothecæ more or less developed ; I have found them entirely absent, but it is possible that in those cases they had been broken off.

The gonangia have no distinct marginal ring or operculum, but open by an irregularly circular line of fracture at the summit. Those of *K. mirabilis* are very large, and free, those of *K. producta* are smaller but of similar type, modified however by having one side flattened and adnate to the substance to which the hydrorhiza is attached.

As hereafter mentioned, the special character on which the genus *Diplocheilus* was founded is not really present ; there is therefore no reason why the only species should not be transferred to the present genus, where it rightfully belongs. (See *Kirchenpaueria mirabilis.*) The genus *Azygoplon*, Bale, must also be cancelled, as the only species, *A. productum*, is now proved to be referable to *Kirchenpaueria.*

KIRCHENPAUERIA MIRABILIS, Allman, sp.

(Plate VI., figs. 4–7.)

Diplocheilus mirabilis, Allman, *Challenger* Report on Hydroida, part i., p. 48, pl. viii., figs. 4-7.

Hydrocaulus about two to three inches in height, monosiphonic or slightly fascicled, sometimes sparingly branched ; stem-internodes long, pinnæ alternate, not close, one or two on an internode of the stem, a hydrotheca on each internode of the pinnæ, joints of stem and pinnæ very oblique. Hydrothecæ nearly parallel with the pinna in their proximal portion, distal part curved upwards, aperture circular, margin free, widely expanded ; front wall of hydrotheca deeply inflected immediately below the lip, the inflection forming an intrathecal ridge which extends rather more than half across the cavity of the cell ; external sinus caused by the inflection completely filled up with homogenous perisarc. A single sarcotheca below each hydrotheca, fixed, erect, upper portion forming a nearly circular concave shield, facing the hydrotheca. A sarcostyle in the angle between the back of each hydrotheca and the pinna, not provided with a sarcotheca, but partly protected on each side by a narrow web which connects the pinna with the back of the hydrotheca. Cauline sarcothecæ—one at the base of each pinna, and one or two others near it, one (conical) in each axil.

Gonangia large, free, with rounded summit, and irregular wide transverse undulations, no distinct marginal ring or operculum, sporosacs two.

Stems brownish yellow, pinnæ nearly colourless.

Hab.—Port Phillip (Mr. J. B. Wilson) ; Griffiths' Point (Dr. Haswell) ; Moncœur Island, Bass' Strait (Prof. Allman).

This species was described by Professor Allman in the *Challenger* Report as the type of a new genus—*Diplocheilus*—characterised by the possession of an external calycine envelope in addition to the ordinary hydrotheca. I have suggested in a former paper* that the supposed external envelope was probably a *thickening* of the hydrotheca-wall in front, similar to that which

* On Some New and Rare Hydroida in the Australian Museum Collection.—Proceedings of the Linnean Society of New South Wales, vol. iii., 2nd Series, 1888.

exists in *Plumularia delicatula* and various other species, and which, present in some forms only of *P. setaceoides*, may attain in them a thickness nearly equal to the inside diameter of the calycle itself;* and this view of the structure is completely borne out by an examination of the specimens collected by Mr. Wilson. The hydrothecæ are formed on essentially the same plan as those of *Lytocarpus phillipinus* and many other Statopleans; that is to say, they form a sac, the proximal part of which lies parallel with the hydrocladium, while the distal portion is sharply recurved, the front wall being thereby doubled upon itself so as to form a deep constriction or an intrathecal ridge in front of the cell. In some species—for instance, *Aglaophenia longicornis*—the inflected parts of the wall do not quite meet, but leave a deep open angle on the outside of the calycle-front; in others, such as *Lytocarpus phœniceus* and *Acanthocladium Huxleyi*, the hydrotheca is more strongly recurved, so that the two parts of the inflected wall come into close apposition and union, forming a completely internal partition.† In *K. mirabilis* a somewhat intermediate condition occurs; the thin wall of the recurved portion is not brought into contact with that of the proximal part, but the external angle formed by the inflection of the sac is entirely filled up by a solid homogeneous chitine, appearing, as seen in lateral view, as a stout wedge-shaped projection, extending fully half across the diameter of the hydrotheca, from a point immediately below the lip. This ridge, however, is only a thickening of the adjacent perisarc, as may be readily observed in optical section, where the substance of the ordinary hydrotheca-wall is seen to expand gradually into the thickened ridge, which is bounded by a single contour only, proving that it is not an enclosed cavity, but a homogeneous continuation of the perisarc. In precisely the same way the perisarc along the front of the

* Further analogous cases are afforded by the thickening of the stem-internodes in *Obelia geniculata*, the almost complete filling-up of the hydrotheca by perisarc in *Hypanthea* and *Eucopelia*, and the thickening of the calycle-wall in *Campanularia caliculata*, so as to give the appearance in optical section of two calycles, an inner and an outer, often differing considerably in form from each other. In most instances the extent to which the perisarc is thickened varies greatly in different examples of the same species.

† In *Halicornaria superba* and its allies the partition is considerably below the aperture, and the mesial sarcotheca continues in union with the front of the hydrotheca up to the margin; the partition or ridge therefore appears to spring from the sarcotheca, and its homology is not at first sight so obvious as in the species already mentioned.

hydrocladia is thickened at intervals to form those internal transverse ridges which are found in most species of *Plumularia* and its allies. In viewing the hydrotheca in front the inner boundary of the ridge presents a biconcave aspect, or it may be nearly straight in the central portion, except for a distinct median tooth or point. The hydrothecæ are very transparent and colourless, but (in this instance at least) they bear immersion in Canada balsam without shrinkage of the wall-thickenings or distortion of any kind, though the everted circular margins are of such tenuity that they are scarcely traceable in balsam unless exactly in focus.

The cauline sarcothecæ are somewhat variable in number and arrangement, but there appears to be always an erect conical one in the axil of every hydrocladium, with two or three on the front of each stem-internode, the latter being very much of the same character as those in front of the hydrothecæ. I have had for a long time some specimens collected by Dr. Haswell at Griffiths' Point, which consisted only of the basal parts of the stem with bunches of gonangia, and which I now identify as belonging to this species by comparison with Mr. Wilson's specimens. They have no sarcothecæ on the stem, but only apertures ; it is quite possible, however, that sarcothecæ may have been formerly present.

The stem-internodes bear sometimes one, sometimes two hydrocladia, the longer ones being mostly found in the older parts of the polypidom and the shorter ones nearer the summit ; they are, however, sometimes interspersed. The species appears normally monosiphonic, but the lower part is sometimes slightly fascicled.

The gonangia, which have not been hitherto known, reach about one-eighth of an inch in length, with a few very irregular transverse undulations and no neck or marginal ring.

Kirchenpaueria producta, Bale.

Plumularia producta, Bale, Journ. Micr. Soc. Vict., Apr., 1882, p. 39, pl. xv., fig. 3 ; Catal. Aust. Hyd. Zooph., p. 133, pl. x., fig. 4.

Azygoplon productum, Bale, Proc. Lin. Soc. N.S.W., 2nd ser., vol. iii., p. 774, pl. xix., figs. 1 to 5.

Hydrocaulus about one-third of an inch in height, monosiphonic, unbranched; stem-internodes long, pinnæ alternate, not close, one or two on an internode of the stem; a hydrotheca on each internode of the pinnæ; joints of stem and pinnæ very oblique. Hydrothecæ nearly parallel with the pinnæ in their proximal portion, distal part curved upwards, aperture somewhat oblong, margin free, not widely everted at the sides; a strong intrathecal ridge springing from the front wall of the hydrotheca, a little below the lip, and extending rather more than half across the cavity of the cell. A single sarcotheca below each hydrotheca, fixed, erect, upper portion forming a concave shield facing the hydrotheca. A sarcostyle in the angle between the back of each hydrotheca and the pinna, not provided with a sarcotheca, but partly protected on each side by a very narrow web which connects the pinna with the back of the hydrotheca. Cauline sarcothecæ one (conical in form) at the base of each pinna, and one in each axil, sometimes an additional one on the stem-internode.

Gonangia flattened on one side, by which they are adnate to the substance on which the colony is attached, a few irregular indistinct transverse undulations on the upper side, aperture subterminal, without any distinct marginal ring or operculum.

Colour.—Yellowish.

Hab.—Queenscliff, Williamstown, Portland, Port Jackson.

This species, though closely allied to *K. mirabilis* in its more mportant features, differs from it entirely in its dwarf habit, its adnate gonothecæ, and, to a certain extent, in the form of the hydrotheca, which is here somewhat more recurved, so that the distal and proximal portions become closely united in the front, forming the ordinary intrathecal ridge, instead of leaving a space to be filled up with solid perisarc, as in *K. mirabilis.* The hydrothecæ, however, are rather variable in form, and in some specimens the lip projects strongly, and the angle just below it, along with the constriction which marks the origin of the intrathecal ridge, is filled up by chitinous matter, which in my specimens was evidently not of dense consistence, as it shrivelled on immersion in balsam; indeed the whole polypidom is of fragile texture, and generally shrivels more or less on drying, or on immersion in a dense medium.* In front view the hydrotheca appears very different to that of the other species, on account of the aperture being of an oblong or elliptic form, due to the lateral margins being erect instead of widely expanded, so that the aperture, though long, is no wider than the body of the hydrotheca, while in *K. mirabilis* the sides are strongly everted, contributing to form the wide circular rim characteristic of that species. The intrathecal ridge as seen in front view is not toothed or pointed at the centre, but has the margin convex or sometimes nearly straight. The mesial sarçothecæ are variable in the extent to which the upper loculus is developed, generally approximating in form to those of the last species, but sometimes being much narrowed at the sides; those on the rachis are not constant in number. The internodes of the stem may bear either one or two hydrocladia.

The gonangia being attached by the whole of the lower side, the aperture is on the upper surface, close to the end, and is formed by the rupture of the perisarc in a circular form; at least, such was the case in all the specimens I have examined except one, which had the orifice partly terminal and partly lateral, with the margin more distinctly outlined than usual. The undulations on the upper surface are so faint as to be scarcely perceptible except in dry specimens.

Plumularia campanula, Busk.

Marktanner-Turneretscher† states that the *P. rubra* of von Lendenfeld is an unbranched but pinnate form of this species, a conclusion which was to be expected, seeing that their minute structure is identical, though they had not previously been found in conjunction. Busk, however, in his original description of *P. campanula*, mentioned that simple and branched shoots grew together in the same colony, and there can be little doubt that the hydrosoma always commences its growth as a simple shoot, bearing hydrothecæ, that it afterwards gives off pinnate hydro-

* It is worthy of note that in this and other species the terminal or newest hydrothecæ occasionally retain their shape perfectly, while all the older parts of the perisarc are more or less shrunken and distorted.

† Die Hydroiden des k.k. naturhistorischen Hofmuseums, Wien, 1890.

cladia, and finally assumes a branched form. In most *Plumulariæ* the primary form is pinnate, and they bear no hydrothecæ on the rachis; but in species like *P. campanula* there is no difference between the structure of pinnæ and stem until the latter begins to assume a polysiphonic form.

Plumularia tubulosa, n. sp.

(Plate V., figs. 2–5.)

Shoots simple, slender, about one-third of an inch in height, divided by very oblique joints into rather long internodes, each of which bears a hydrotheca at its lower end. Hydrothecæ set at an angle of 40° to 45°, tubular, cylindrical, sometimes slightly bent, twice as long as broad, and free for half their length; aperture plain, the sides slightly and evenly sinuated, lip curved a little outwards in front. Sarcothecæ bithalamic, canaliculate, fixed and stout at the base, one at each side of the hydrotheca (pedunculate), one in front, one midway between every two hydrothecæ, on the same internode as the lower.

Gonothecæ—female, large, pear-shaped, broad, somewhat flattened above, tapering below, with a distinct sub-globular segment at the base of the capsule, and a sarcotheca at each side a little above the base; a circular operculum at the summit, the border of the aperture slightly thickened; male—smaller, with one sarcotheca only.

Almost colourless.

Hab.—Port Phillip Bay (Mr. J. B. Wilson).

Closely allied to *P. campanula*, differing, however, from the stemless form of that species in the much greater proportionate length of the hydrothecæ. It is just possible that it may prove to be only a variety, but so far I have failed to find any intermediate forms, and the difference in the hydrothecæ seems to fully warrant its being regarded, at least provisionally, as a distinct species. Most of the Plumularians in which the hydrocladia spring direct from the hydrorhiza are known to be merely stemless forms of ordinary pinnate species, and probably the present species may prove no exception to the general rule; so far, however, no pinnate specimens have been observed.

The perisarc is ordinarily thin, but in some of the shoots the walls of the hydrothecæ are much thickened. The male and female gonangia were on different shoots; the former seemed rather larger in proportion than those of *P. campanula*, otherwise there was no important difference.

Plumularia filicaulis, Pœppig.

Port Phillip Bay (Mr. J. B. Wilson).

The specimens consisted of pinnate and undivided shoots growing abundantly from the same hydrorhiza.

Plumularia procumbens, Spencer.

(Plate V., figs. 11–12.)

(Trans. Royal Soc. Vic., Vol. II., Part I.)

Since I received the specimens from Mr. Wilson, Professor Spencer has very fully described and illustrated this species (also from specimens collected by Mr. Wilson); I may however add that in a few instances I have found sarcothecæ on the short internodes of the hydrocladia, which ordinarily bear no appendages of any kind. The hydrothecæ are very small, and in proportion to them the sarcothecæ are unusually large.

Plumularia compressa, Bale, var.

A form differing from the type only in the size, which does not exceed about $\frac{1}{8}$-inch in height, with all the parts small in proportion. Dongarra Beach, Western Australia (Mr. A. J. Campbell). A similar variety occurs in Port Jackson.

Plumularia flexuosa, n. sp.

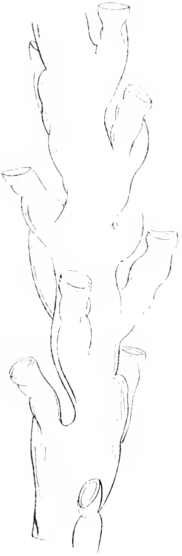
(Plate V., figs. 6–10).

Hydrocaulus monosiphonic, unbranched, about one-eighth of an inch in height, stem very slender, flexuous; pinnæ alternate, each borne towards the upper part of an internode and supporting a single hydrotheca, distal part curving abruptly from under the hydrotheca, widening upwards, generally with a constriction behind the hydrotheca. Hydrothecæ campanulate, margin entire, slightly everted, rising a little above the summit of the pinna, at right angles to it and the cell. Sarcothecæ bithalamic, canaliculate, with slender bases, one below each hydrotheca, one on each side above it, two in each axil, and one on the lower part of each stem-internode. Gonothecæ 7-8 times the length of the hydrothecæ, ovate, aperture terminal, rather small, somewhat oblique, without internal teeth, sometimes with an elevated rim.

Hab.—Mouth of Snowy River and Cape Lefebvre (Dr. MacGillivray).

This species is very close to *P. pulchella*, of which I at first considered it a variety. So far as the trophosome is concerned, it is distinguished by its very small size and extremely slender stems, which are strongly flexuous, and bear the pinnæ near the summit of the internodes. In *P. pulchella*, on the other hand, the whole structure is much more robust, the stem a good deal wrinkled or annulated, with the internodes straight, very short in proportion to their length, and bearing the pinnæ for the most part about the middle. The form and arrangement of the hydrothecæ and sarcothecæ is the same in both species, except that *P. flexuosa* has a sarcotheca on the lower part of each stem-internode in addition to having two in each axil. The gonothecæ furnish the most important distinction—those of *P. pulchella* are stout with a large aperture directed laterally, and surrounded inside with large smooth teeth projecting into the interior, those of *P. flexuosa* are much narrower in proportion to the length, with a smaller aperture, only slightly oblique, and without teeth. The aperture in some cases only is surrounded by an elevated margin, and the general outline of the gonotheca is somewhat apt to be irregular, showing at times a decided tendency towards a transversely undulated form.

Some fragments from Bondi, which I have hitherto considered a dwarf variety of *P. pulchella*, agree with the present species except in the absence of the inferior sarcothecæ of the stem-internodes, a distinction not sufficiently important to forbid their reference to *P. flexuosa* if the gonothecæ should prove similar to those of that species.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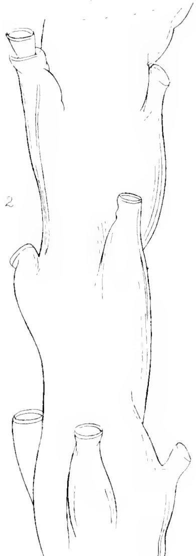
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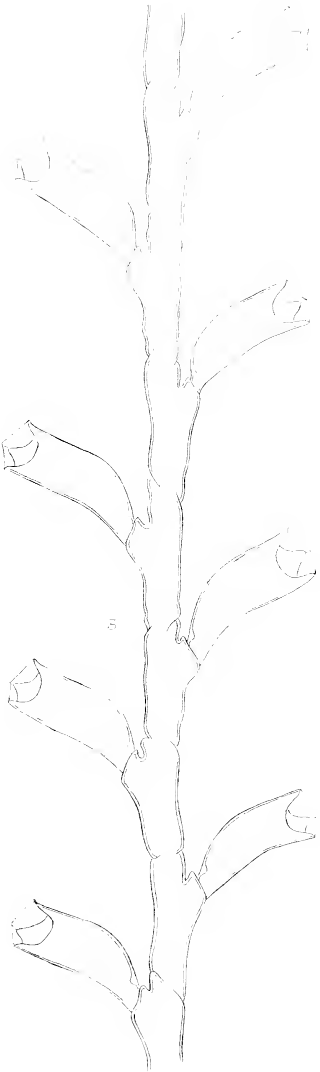
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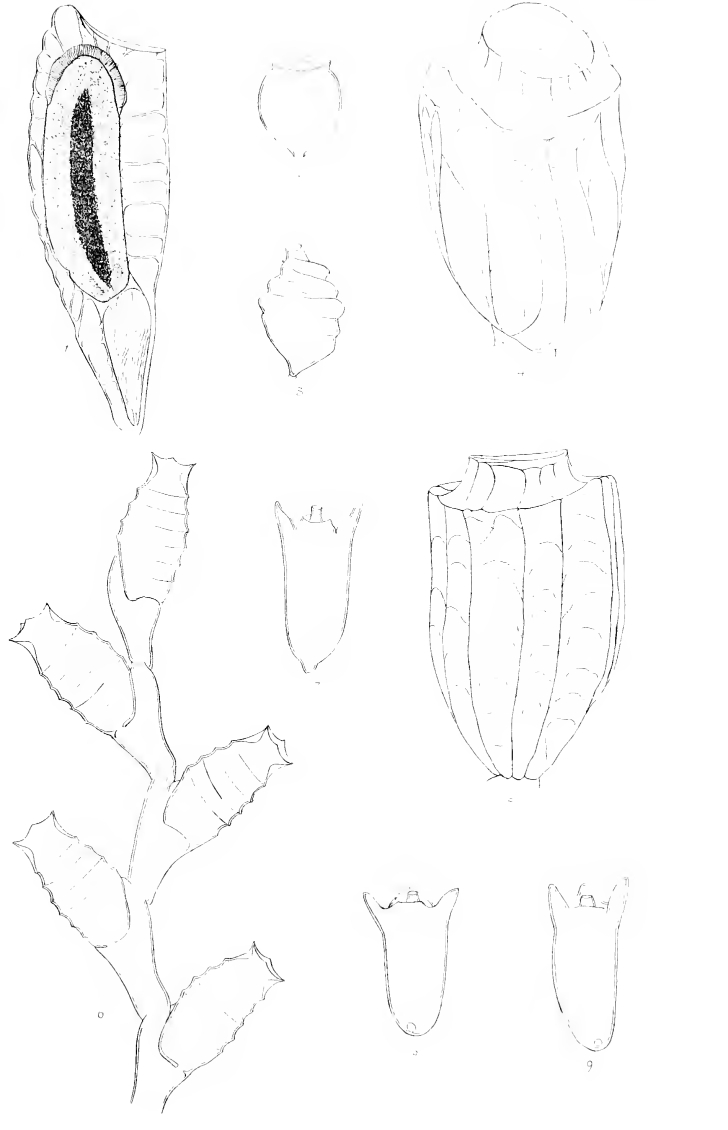


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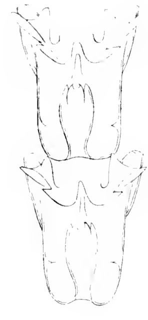

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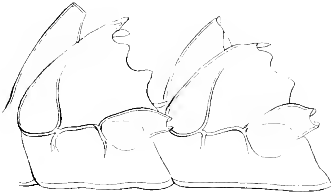

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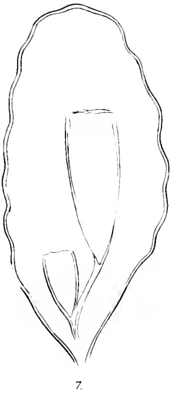

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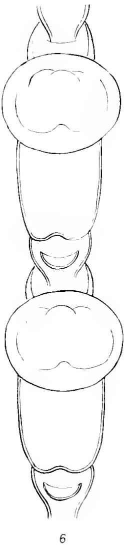

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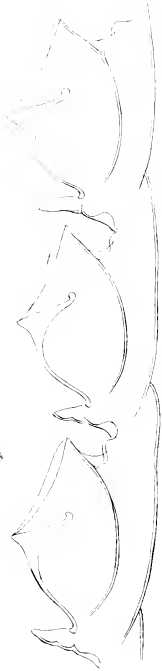


4.

EXPLANATION OF PLATES.

PLATE III.

Fig. 1.—n. gen. and sp. ?, distal portion. × 20.
„ 2. „ „ proximal portion. × 20.
„ 3.—*Campanularia tridentata*, n. sp. × 40.

PLATE IV.

Fig. 1.—Gonangium of *Thuiaria lata*, Bale. × 20.
„ 2. „ „ *Thuiaria fenestrata*, Bale. × 20.
„ 3. „ „ *Sertularella macrotheca*, Bale. × 20.
„ 4-5. „ „ *Idia pristis*, Lamx. (From drawings by Mr. Busk).
„ 6.—*Sertularella angulosa*, n. sp. × 40.
„ 7-9.—Gonangia of *Sertularella longitheca*, Bale. × 20.

PLATE V.

Fig. 1.—Gonangium of *Halicornaria ascidioides*, Bale. × 40.
„ 2.—*Plumularia tubulosa*, n. sp., thick-celled specimen. × 80.
„ 3. „ „ thin-celled specimen. × 80.
„ 4. „ „ male gonangium. × 25.
„ 5. „ „ female „ × 25.
„ 6.—*Plumularia flexuosa*, n. sp. × 80.
„ 7. „ „ more enlarged.
„ 8-10. „ „ gonangia. × 40.
„ 11.—*Plumularia procumbens*, Spencer. × 80.
„ 12. „ „ more enlarged.

PLATE VI.

Fig. 1-3.—*Aglaophenia carinata*, n. sp. × 80.
„ 4-6.—*Kirchenpaueria mirabilis*, Allman, sp. × 80.
„ 7. „ „ gonangium. × 20.

Art. IV.—*The Hatching of a Peripatus Egg.*

By Arthur Dendy, D.Sc.

[Read 13th April, 1893.]

In *Nature* for 17th September, 1891, I briefly described some eggs of the larger Victorian *Peripatus*, which were laid by specimens kept alive by me in the winter (Australian) of 1891. At that time, following previous authority, I identified the species which laid the eggs as *P. leuckartii*. It appears now, however, that the real *P. leuckartii*, at any rate in New South Wales, is undoubtedly viviparous, and our oviparous Victorian species is therefore probably distinct. It may be remembered that in *Nature* for 14th February, 1889, I suggested this probable distinction on account of the remarkable pattern of the skin usually exhibited by the fifteen-legged Victorian form. Further particulars on this subject are given in my "Further Notes on the Oviparity of the larger Victorian *Peripatus*, generally known as *P. leuckartii*," * and in the literature cited therein. In that paper I also described two embryos removed from eggs which had been laid for about three and eight months respectively. In the latter case I showed that the embryo was possessed of the full number of appendages and was in all respects a perfect young *Peripatus*, differing externally from the adult only in the smaller size and less deeply pigmented skin. On the strength of those observations I claimed to have definitely proved that the larger Victorian *Peripatus* at any rate sometimes lays eggs, and that these eggs are capable of undergoing development outside the body until perfect young animals are produced. I am now able to add some further information.

For some time only one egg (belonging to the original lot, for none have since been obtained) remained in the hatching-box. The shell of this egg had changed to a dark brownish colour, and latterly an embryo had been visible through the shell, coiled up

* Proceedings of the Royal Society of Victoria, vol. v., p. 27. (Also published in the Annals and Magazine of Natural History, 1892).

inside. The egg was lying on a small piece of rotten wood which rested on the glass floor of the hatching-box.

On 3rd January, 1893, not having opened the box for some days, I made an examination. The egg was in its former position, so far as I could tell, but the shell was split on one side and the young *Peripatus* had escaped. This young *Peripatus* was found lying dead on the glass bottom of the hatching-box, 25 mm. distant from the shell. It must have crawled off the rotten wood and along the glass to the position in which it was found. It was only about 5 mm. in length, so that, even assuming that it moved in a perfectly straight line, it must have crawled for a distance five times its own length.

To the naked eye the young animal appeared of a pale greenish colour. It cannot have been dead for very many days, but decomposition had already set in and the animal was stuck on to the glass on which it lay. It was impossible to remove it without considerable injury, but I ultimately succeeded in mounting it in Canada balsam, and it is impossible, even in its present condition, to doubt that it really is a young *Peripatus*, for the characteristic jaws and claws are well shown. I also mounted the ruptured egg-shell, and found that the characteristic sculpturing on the outside was still clearly visible.

This egg, then, hatched out after being laid for about seventeen months (from about July, 1891, to about the end of December, 1893). I cannot believe that under natural conditions the embryos take so long to develop. They were possibly retarded by being kept in a very cool room. At any rate it now appears certain that the larger Victorian *Peripatus* lays eggs which may hatch after a lapse of a year and five months.

Art. V.—*A New Thermoelectric Phenomenon.*

(With Plate VII.)

By W. Huey Steele, M.A.

[Read 13th April, 1893.]

In text books on thermoelectricity it is usually stated that while an electromotive force may be caused by heating part of some metal, which either in its molecular condition, or in its shape, is not homogeneous or symmetrical, no electromotive force can be caused by heating a homogeneous piece. The experiments of Magnus in his paper on Thermoelectric Currents in *Pogg. Ann.*, 1851, are generally quoted as authority, but the experiments described below (performed in the Physical Laboratory of the University of Melbourne) seem to show that these statements require to be greatly modified. Magnus, using a very sensitive galvanometer, obtained a number of relative measurements of the electromotive force produced when similar wires at different temperatures were brought into contact, and when wires of the same material but different temper were heated in contact. But he got no effect from heating a single wire up to 100° C. But it appears that he had to take great precautions to prevent unequal heating or temper, or an e.m.f. was sure to appear. An important and interesting example of an electromotive force from one metal is described by Mr. F. T. Trouton *(Proc. Roy. Soc.*, 1886), where it is generated by moving a flame along a steel or iron wire slowly enough to make it red hot. The e.m.f., he says, is generated between the part which has cooled through the critical point and the part which is coming to it. This is of varying magnitude. In a recent report of a committee of the British Association to inquire into the phenomena connected with iron at a dull red heat it is stated that on bringing together a bright red iron wire and a cold one, an electromotive force of ·05 volt is generated. Both of these phenomena, but especially Trouton's, probably depend on the great change in the magnetic susceptibility of iron at a dull red heat.

It was in repeating Trouton's experiment that I found that great effects were produced by heating the iron wire steadily. This effect however was soon found to be very arbitrary and irregular, and steps were taken to obtain regular and systematic observations. A couple of yards of very hard iron wire were put in series with a sensitive galvanometer, the junctions of iron and copper being immersed in the same vessel of oil to insure their being at the same temperature and that no thermoelectric effects were generated in them. The iron was stretched into a loop and heated in various ways, such as warmed with the fingers, parts immersed in boiling water, in hot oil, in melted tin both bare and protected with asbestos, heated in a bunsen and in a blow-pipe flame, long portions heated in a tube furnace, and a small part was cooled by evaporating ether. In each case some effect was observed, though below 300° C. it was small, about the same order of magnitude as an ordinary thermal junction of silver and copper. Consistent results however were never obtained: if a certain effect were observed by heating part of the wire in a certain way, then on repeating the conditions a different effect would be observed, perhaps greater, perhaps less, and as likely as not of opposite sign. When kept heated steadily the effect was not constant. It increased, decreased, kept steady, changed sign, vanished and reappeared in the most arbitrary way imaginable, and showed no sign of becoming steadier even after being left alone for half-an-hour. Below a dull red heat these changes were slow, but fast enough to keep the galvanometer needle moving perceptibly, but above a red heat the changes were too fast for the needle to follow dead beat, and it was kept continually oscillating. These oscillations were sometimes small, perhaps ten per cent. of the total deflection, while at others the needle was jerked about so widely that one could not even form a mental estimate of the changes of electromotive force, much less make a note of them. I tried various samples of iron wire of different hardness and thickness, from ·2 mm. to a bar 1 cm. diameter. The effect was observed in each case, it being as a general rule more marked in the finer wires than the coarser. The highest effect I observed in iron was about ·002 volt. On passing the wires through tubes, glass or clay, and heating them, very little effect could be obtained.

After working at the iron for some days I treated a copper wire similarly to see if the effect existed in it too, but could not find a trace of it. The copper wire was a thick one, and this was before I noticed the effect greater in fine wire than coarse. I came to the conclusion that the effect was in some way connected with the magnetic property of iron, and for some time confined my attention to it. After a while, however, I tried a fine brass wire, and instantly found the effect marked, about ·0001 volt. As the wire was heated in the naked flame it soon fused. On twisting the ends together and heating the junction ·001 volt was indicated. Platinum wires of ·8 and ·4 mm. diameter gave very small effects, but a very fine wire of ·06 mm. diameter gave ·0001 volt. Copper wire 1·7 mm. gave no effect, as already stated. ·3 mm. gave ·00002 volt, and one of ·14 mm. ·0001 volt. These values were all obtained by heating the wires in a flame, but as all except the platinum fused almost instantly even in a candle flame I had to take steps to protect them. The most obvious plan was to pass them through glass tubes, but at a red heat there seemed to be chemical action between some of the metals and the glass, so the glass tubes were abandoned for clay tobacco pipe stems. Even the finest wires could be heated for some time in these without burning through or fusing.

Gold wire, when heated, presented some interesting peculiarities. The first tried was an alloy of gold and silver, 62 per cent. gold (fifteen carats). It was somewhat fine wire, ·26 mm. diameter. I found the effect well marked, though at first not so great as in iron, but more steady. The effect was not constant, but the changes took place very slowly, so that the galvanometer needle moved dead beat. Repeated heating and cooling the same part greatly increased the effect, this was not noticed in iron. Frequently on cooling the tube I noticed an extraordinary effect. On turning off the gas there were almost immediate, and apparently instantaneous, rises, sometimes of fifty per cent., sometimes as much as one hundred per cent., though only temporary; one of these sudden rises reached ·01 volt. While repeating the experiment the wire fused, and I had to take a fresh piece. On several occasions I found that by shifting the flame back and forward over an inch or two of the wire that there were points which gave a maximum effect, intermediate points giving little or none. By thus shifting the flame about I occasionally got very large effects, once reaching ·02 volt, at which it was steady for some time. This was by far the largest effect I had yet observed in any metal. I afterwards obtained two wires drawn from standard gold, 92 per cent. gold, 8 per cent. copper, these were about 1 mm. and ·5 mm. diameter. Neither gave any effect when heated up to melting point in a naked flame, and I could get no effect at all by heating the coarser one in a clay tube. On heating the finer in a clay tube moderate effects, *e.g.*, ·0001 volt, were observed. On attempting to draw the hot wire through the tube it parted. On pushing the broken end into the tube again there was an enormously high effect, but before the resistances could be altered it had fallen somewhat, and when the needle had become steady enough to indicate the amount, it was ·3 volt, though I think it must have been quite ·5, but ·3 was the highest I read, and that I can vouch for. On allowing the tube to cool it was found that the wire was stuck. The tube was cracked open, and it was seen that the gold had fused into a lump the thickness of the tube, and about 1 cm. in length. Another wire was heated, and after the flame had been shifted, about ·025 volt was reached, another shift giving ·13 volt. The effect was always much greater after the wire was fused and the ends pushed together. For the most part with gold the effect was temporary, none of those over ·1 volt lasting more than fifteen seconds, though on one occasion a steady ·18 volt was obtained. The effect was nearly always increased by disturbing the system in any way, such as shifting the flame or pulling the wire along the tube. When the junction of the thick and thin wires was heated the effect was much the same as with the thin wire by itself, but as a rule it was greater and more permanent, and with one exception, which was only for a few seconds, it was always in the same direction—the currents flowing from thin to thick. I alternately heated and cooled such a junction, and at last obtained a temporary effect of ·33 volt, which dropped quickly to ·3 and remained steady. After some time I shifted the flame in hopes of raising it, but it fell. On another occasion it increased steadily to ·29 volt and remained steady till disturbed.

In the early part of my work I used the most sensitive galvanometer obtainable—a low resistance, astatic instrument, with telescope and a scale at some distance. I soon found that there was no necessity for such a sensitive arrangement, as the needle was constantly going off the scale. It was also necessary for me to measure the resistance of the circuit each time it was altered, *i.e.*, each time a wire was fused or broken and had to be renewed. This was troublesome and took up a lot of time, and I soon found it more convenient to use a high resistance though less sensitive galvanometer, which I arranged to give direct readings as a volt meter and save the trouble of reducing the readings. The lamp and scale was at a distance of forty inches from the concave mirror on the needle which formed on the scale an image of a lens with a dark vertical hair-line immediately in front of the lamp, the lens serving to concentrate on the mirror a larger amount of light from the lamp than it would otherwise have received. The scale had 350 divisions on each side of zero. The galvanometer resistance was 7,400 ohms; in series with this I added 2,600 and another 90,000, which could be short circuited, so that neglecting the resistance of the wires under observation I could have a resistance of either 10,000 or 100,000 ohms. The galvanometer was also provided with three shunts $\frac{1}{9}$, $\frac{1}{99}$, and $\frac{1}{999}$ of its own resistance. Now, putting a Leclanche cell of 1·45 volts into circuit with the 100,000 ohms and the $\frac{1}{99}$ shunt I adjusted the height of the control magnet till the deflection was 145 scale divisions. With this arrangement the readings were always very approximately in decimals of a volt whatever shunt was used. Thus with 10,000 ohms and no shunt, 100 scale divisions indicated ·001 volt; with 100,000 ohms, ·01 volt; with same resistance and $\frac{1}{9}$ shunt, ·1 volt; $\frac{1}{99}$ shunt, 1 volt; and with $\frac{1}{999}$ shunt, 10 volts, so that by adjusting two plugs the one instrument would indicate ·00001 volt and measure 35 volts. I found this arrangement very satisfactory. For perfect accuracy the external resistance should have been slightly different for each shunt, but neglect of this caused an error of only two or three per cent., and I aimed at quickly getting the magnitudes of the effects involved rather than a very accurate measure of them. It may perhaps be convenient to those who are not familiar with the magnitude of the ordinary thermoelectric phenomenon to quote a few figures, so that the relative amounts of ordinary thermoelectric forces and those which I am describing may be readily compared.

The table shows the temperatures at which three different thermoelectric junctions will generate various electromotive forces, the cold junctions being at 0° C.

E.M.F.	·0001 volt.	·001 volt.	.01 volt.	·1 volt.	·3 volt.
Lead Copper	60°C	336	1310	4420	7760
Lead Bismuth ...	2	16	150	921	1870
Antimony Bismuth ...	1	9	85	522	1064

The above are based on Professor Tait's results.

Returning now to the phenomenon under consideration, I may say that, in this paper, I am not following altogether the order of my experiments, but am giving all experiments on one metal together, though I frequently left a metal and returned to it again.

In platinum there was apparently an anomalous result. Two unequally thick wires and a very fine one were stretched in series, the fine being between the other two. Heating the junction of the fine and coarsest gave ·0027 volt; while the fine and medium gave ·0007, *both in the same direction;* one would expect that in each case it would be from fine to coarse or *vice versâ.* It may however have been due to different amounts of impurity in the specimens. When the medium wire was heated by itself there was no perceptible result, the coarsest gave ·0001 volt and the fine gave various amounts up to ·0023 volt.

Fine brass wire heated in a tube behaves similarly to iron when heated in a flame, the effect being very unsteady. It is much less sensitive than gold to being disturbed; the highest effect I observed with brass was ·015 volt.

The behaviour of German silver was, in many respects, similar to gold. The effect was greatly increased by repeated heating and cooling, and the changes were generally slow and steady, though occasionally without any apparent cause the changes became great and abrupt, as much as with iron. Like gold too it showed distinct positions of maximum and minimum effects, they being even more marked than in the case of gold. Plate VII. shows the best example of this I ever obtained, but I could never again get one nearly so good. The time occupied in taking the observations from which it is drawn was about two hours. When the flame was shifted forward a centimetre, the needle crept slowly to the next position, there not being a single oscillation the whole time. For a long time I had been unable to obtain more than ·001 volt from German silver, but on one occasion I found two different parts of a wire, one of which gave ·0014, the other ·0016, giving the same values after several heatings. I then heated them simultaneously and got ·0031, which afterwards increased to ·0042, and after being heated and cooled several times increased to ·0047, the wire then fused. On another occasion, after heating a wire for some time, with little effect, I left the flame alone for a considerable time, and the electromotive force rose steadily to ·0045, and unsteadily to ·0052, and then fell as suddenly as if the wire had parted, but it had not, for on the oscillations of the needle dying out there was still a small deflection.

To examine lead I first of all dipped part of a lead wire into hot oil, but could get no effect. I afterwards melted some lead in the bowl of a pipe and heated the stem so as to make it run along and fill it up. The lead could thus be heated far above its melting point without running away and breaking circuit. On heating this tube the effect was apparent at once, and on irregular heating soon became considerable, ·001 volt. The tube was then heated systematically from end to end, and it was found that there was about an inch towards one end which always gave great results when heated, while at all other parts the effect was very small. After several heatings ·013 volt was observed at this critical point. Though the movements of the galvanometer needle were very slow and generally dead beat, yet, about this part, there were some peculiar effects. On one occasion, on applying the flame to this point, the galvanometer reading rose steadily to 110, decreased unsteadily to 10, and then swung unsteadily between 90 and 10 in such way as to indicate sudden and systematic rises and falls of electromotive force, though the flame was not disturbed and the temperature of the lead was constant, and there was nothing apparent which could have caused these changes. At another time the reading being 30, not very steady, I removed the flame, the reading fell steadily to 10 and then jerked to 60, after which it gradually decreased to zero. These jerks on the removal of the flame occurred so frequently as to make one of the characteristics of the phenomenon in the case of lead. Sometimes on heating the lead the readings rose gradually from zero, and at others there was no effect for some minutes when a sudden great deflection occurred. Another pipe stem was taken and a lead wire drawn down till it could be pushed along it, and on heating it I at last got ·2 volt. At the time this was by far the greatest effect yet observed. On one occasion after heating the tube in the usual way I removed the flame at a time when the reading was steady at zero. The e.m.f. rose quickly, but not suddenly, to ·07 volt, and then decreased. As a type of the general behaviour of lead I will describe the chief movements which took place in forty-five minutes, during which the flame was not disturbed. After a little preliminary heating the needle began to move and indicated ·02 volt, then reversed and rose gradually to ·17, but decreased to ·16, at which it remained steady for some time. It decreased further to ·1, but rose to ·185 and kept steady at ·18 ; decreased to ·05, rose to ·1, at which it kept for five minutes, then went on to ·15, and ·18, after which it fell and reversed to ·07, but soon came back to ·1, and on to ·205, fell to ·1, rose to ·15, fell to ·05, but came back to ·2, and again fell and reversed to –·05 for a few seconds only, after which it rose again to ·15; reversed again to –·08, and –·1, and back to ·205, remained steady at ·203 for half-a-minute. It fell again and reversed to –·02, rose to ·1, and again reversed to –·13. The gas was then turned off for the night. There were many smaller motions superposed on the larger ones, but were quite irregular. In spite of the occasional excursions to the negative side, the deflections were on the one side for the great bulk of the time, –*ve* and +*ve* are, of course, quite arbitrary. The motions were all dead beat except some of the negative deflections, which were so quick and so short that they set up oscillations in the needle. When the gas was lighted again next morning, the system not having been disturbed, there was no effect after five minutes. The flame was then shifted about, but no effect more than ·0005 volt could be got. I tried several other tubes with lead wires passed through them and found the behaviour much the same in each case, ·15 volt being observed frequently, and ·2 occasionally. It had nearly always been necessary to shift the flame and thus set up irregular heating before the effect could be observed in any considerable degree. To see if the effect could not be obtained from a perfectly symmetrically heated system, I took a fresh tube, and passing a wire along it applied a flame to the middle, prepared to watch it, if necessary, half-an-hour. There was no effect for a minute, the e.m.f. then became manifest and rose quickly to ·035 volt, and fell again to ·03. Then after rising and falling irregularly for a time it soon reached ·13 volt. Forty-five minutes after lighting the readings changed sign but did not get higher than ·05 on the other side. After an hour I began to heat it irregularly, but did not get more than ·15 volt. With lead a very slight cooling of the tube caused the effect to disappear. Merely cutting off the supply of air from the bunsen flame was always followed by a very great decrease, if not a complete disappearance, of the effect, although the luminous flame kept the tube at a moderate red heat. An estimation of the temperature reached inside the tube, made by means of a copper platinum junction with specimens in which I had not been able to observe this other effect, showed that with the bunsen flame 900° C. was reached, and with a blowpipe 1050°. I only used the blowpipe occasionally, generally using an ordinary bunsen flame.

Filling a tube with tin as the first had been filled with lead no effect higher than ·0001 volt was observed for half-an-hour either by steady or irregular heating. At last there was a large and sudden swing of the needle and on its coming to rest it indicated ·15 volt, remaining between ·12 and ·15 for several minutes. Various parts of the tube were heated, and as in the case of the first lead tube there was one point in particular which gave great effects. After leaving it for a couple of days and again applying the flame to this point ·3 volt was indicated almost at once, and for half-an-hour from ·28 to ·31 volt was maintained, only once did it fall to ·21 but instantly rose again. While at its height the gas was turned off. There was a steady and very slow fall, ·01 volt still remaining after ten minutes. The gas was lighted again and ·28 was soon indicated again.

Several other tubes were filled with tin and heated, and with one exception all gave from ·1 to ·2 volts, from the remaining one only infinitesimal results could be obtained. The changes of e.m.f. were much slower in tin than in lead, but it was very sensitive to the flame being shifted along the tube, a few millimetres of shift sometimes causing a great variation in the galvanometer reading. There were no abrupt changes as in the case of lead on removing or lowering the flame. A tin wire (alloyed with lead) when put through a tube and heated behaved similarly to tin and lead, ·16 volt was obtained from it.

I could not get a tube filled with zinc in the same way as I had filled others with lead and tin, but I managed to get one filled by exhausting it while the end was dipped into a crucible of melted zinc. The highest e.m.f. I observed with this was only ·00035, but that was partly, if not wholly, due to the hot junction of the zinc and copper, as the tube of zinc was very short. I afterwards got some zinc wire and passed it along a tube and heated it. There was no result at first, and the wire fused and broke circuit as the diameter of the wire was much less than the bore of the tube. When the ends were pushed in and contact renewed ·05 volt was indicated, but it quickly fell to ·004. On shifting the flame there were various smaller effects, but after cooling and heating several times ·2 volt was at length reached, the behaviour not being in any way characteristic. At a time when the e.m.f. was ·01 and falling slowly I turned off the gas. It fell somewhat faster, though still slowly, and after some minutes, when the tube was cool enough to be held in the fingers, ·006 volt was still indicated. The temperature of the zinc could not have been over 200°.

As already mentioned I had examined copper to see what effect could be obtained from it and had only reached ·0001 volt. After obtaining such high effects in other metals I returned again to copper, using the finest wire I could get, this was ·16 mm. diameter, and silvered, but the silver disappeared almost instantly on heating. After a little irregular heating, ·001 volt was reached, the changes being very slow, and oscillations of the needle being scarcely perceptible. After some time, however, there was a sudden swing indicating a change from ·0002 to –·001, then suddenly back to ·016, and steadily on to ·034, then a sudden great swing much higher still, but it fell before a reading could be taken. On cooling it fell steadily to zero. When heated again the effect rose steadily to ·25 volt, and for some time rested steadily between ·23 and ·25. Shifting the flame back and forward increased the effect to ·28, and it remained steady at ·27 for some time, and on shifting the flame along the whole tube I found two places about 2 mm. apart which gave maximum effects of + ·27 and – ·25 volt. The wire then parted. In repeating the experiment with other samples of the same wire I could never again get the great effects of the second part of the experiment, though ·001 was reached frequently enough. Several times on turning out the gas I noticed that the readings decreased very slowly, and once when the tube could be held comfortably in the fingers ·0002 volt was still indicated. I dipped part of the wire into hot oil at about 250° when ·0006 volt was given, while at 900° only ·001 had been given.

A tube was filled with antimony by exhaustion, and on heating it ·27 volt was given almost at once, but not for long. ·1 volt was reached again, but after a time I could get none. Another tube gave ·01 volt with the bunsen flame, and ·015 with the blowpipe. I made several other efforts to fill tubes with antimony, but failed, as the metal was not continuous through the tube.

With bismuth the highest effect observed was ·06 volt, but I did not keep at it very long.

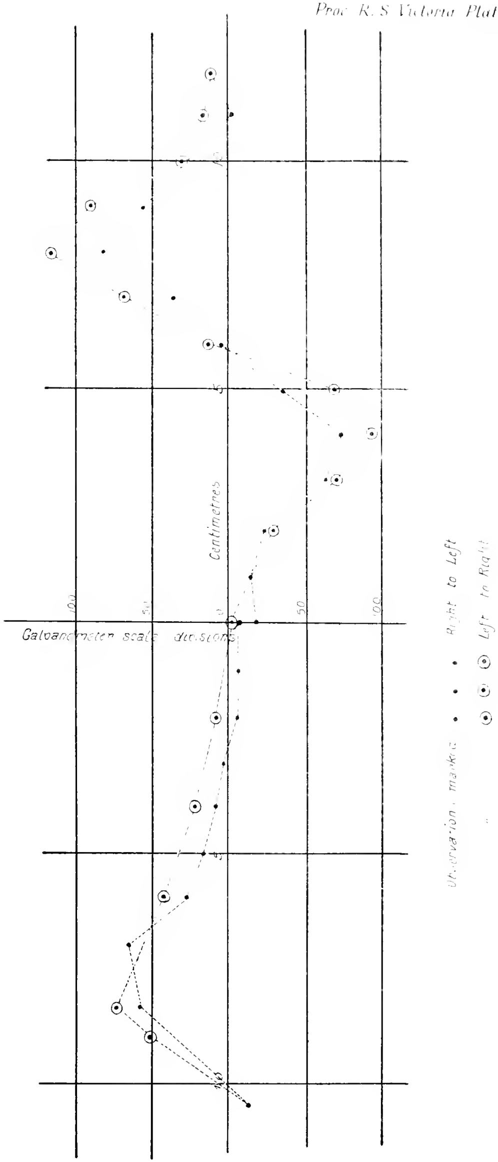
Silver wire heated in a glass tube gave ·00007, which, when the flame was removed, rose to ·0007. When heated in a clay tube ·0008 was reached after several heatings and coolings. In another piece ·001 was reached after a time, but only temporarily. The effect was never steady, though more so than with iron. Another sample of very pure silver gave various effects up to ·0001.

Thallium gave various effects up to ·0005 volt, but I did not keep at it long as it attacked the clay, and I did not wish to lose it.

Magnesium was a difficult metal to examine. Heated in air it oxidises instantly, and heated in clay or glass it combines with the silicon and the resistance becomes infinite almost at once. In the clay tubes, however, I once got a reading of ·03, and a single swing indicating ·1 volt. I tried it by wrapping it in asbestos. The general effect was small at first, but there was generally a big swing when the magnesium parted, ·3 volt being once indicated. On another occasion, after igniting in the asbestos ·03 volt was indicated, but as the resistance was very great it was really much more.

With aluminium I could not get any great effect. When heated in a clay tube there was at once a deflection indicating ·0002 volt, but it soon decreased to about two-thirds of this, and after a few seconds to zero, and there was no further effect till the flame was shifted, when the same effect was repeated. Heating in a flame without the tube gave larger and more irregular effects, once up to ·0009, and another sudden heating gave a temporary ·003. With another specimen the highest effect was ·0001 volt.

In conclusion then, in contradiction to the commonly received statement, thermoelectric forces, in many cases of a high order of magnitude, have been observed by heating a homogeneous conductor. This been detected in twelve different metals and four alloys and may fairly be taken as a common property of all metals. The effect cannot be due to chemical change, because it is manifest in some cases at very low temperatures. It is not due to differences of thickness of the metal as mentioned by Clerk Maxwell. It is not due altogether to irregular or unsymmetrical heating, because it was observed several times when symmetrically heated. It is not altogether due to the action of the clay on the metals because it has been observed without the clay, though it must be remembered that the very high effects were all observed in clay tubes. The abruptness with which the effect occurs or increases at times when the temperature is rising steadily, or, strangest of all, falling, is one of the most extraordinary characteristics of the phenomenon ; this frequently occurs with certain metals, particularly lead, never with others. The phenomenon is independent of the Thomson effect, for it is much more marked in lead in which the Thomson effect is zero, than in iron in which it is very high. The metals in which I observed the highest effects are not necessarily those in which the effect is really highest, for I examined some for weeks and others only for a few minutes. Most of the time was spent over iron, lead, and gold (ninety-two per cent.) The purest metal I used was silver, one of the specimens being absolutely pure, and with this the effect was very small. The effect however cannot be altogether due to impurity, for with alloys the effect was not more marked than with moderately pure metals.


Centimetres
Galvanometer scale divisions
100
50
0
50
100
Right to Left
Left to Right

Art. VI.—*Glaciation of the Western Highlands, Tasmania.*

(With Plate VIII.)

By E. J. Dunn.

[Read 8th June, 1893.]

During the month of October, 1892, professional work took me to the high rugged region surrounding Lake Dora, and there I had the satisfaction of discovering glaciation in its various developments and on an extensive scale. The salient features were made known at the time through the press, but as further particulars may be acceptable, a sketch plan has been drawn of the locality, and further data are appended.

Position, etc.

Lake Dora lies in a direct line about due east from the township of Zeehan and twelve miles distant, but the track between the two points is quite twenty-five miles long, and very difficult to traverse. Lake Dora is about 2,500 feet above sea level. The high tract of country over which glaciation occurs is shown on the plan on the smaller scale, the area more carefully examined is shown on the larger scale plan.

Geology.

This region is occupied by two principal rock formations, the older or schistose series is usually highly inclined, consisting of arenaceous, argillaceous and conglomerate schists; the schists are covered unconformably by massive sandstones, quartzites, cherty and quartzose conglomerates, belonging, apparently, to the Devonian age and corresponding to the Devonian conglomerates of Victoria. Most of the hills and ridges on the highlands are of the Devonian series, the schists occupying the hollows and valleys. The schist appears to be more readily worn down than the Devonian beds, hence most of the tarns appear to be on the former rock, or rather scooped out of it.

Physical Aspect.

The whole region consists of rugged rock-strewn mountains bare, except where sheltered sites have encouraged a forest growth; tarns are dotted about at many different altitudes, from the tiniest pools up to lakelets some miles in length. There is an absence of level land except where a small valley or tarn has been filled with peaty soil, on which the "button-grass" flourishes. Altitudes range from 1,800 to 3,800 feet above sea level over this tract.

Moraines.

The first evidence met with of glacial action was at the outlet of the gorge, where Lake Rolleston stands; this is an excellent example of a terminal moraine. From the level of the lake the morainal matter rises to an elevation of 150 feet on the east side, and for 250 feet on the west side, the whole consisting of a confused mass of angular, sub-angular and partly rounded boulders and blocks from a few pounds to masses of more than 100 tons in weight; this extends over several hundreds of acres. Enormous blocks project above the mass at intervals, while the east edge of the moraine is fringed with a very remarkable curved line of giant stones; they commence at the large one named "The Scout" on the plan, and they fringe the moraine for considerably more than half a mile, running in a northerly direction. Feeders to the glacier of which this moraine is the relic came in further northward from the country to the west and north-west of Lake Rolleston, and morainal matter occurs as marked on the plan. It would appear as though the glacier did not extend much further down the valley, but as though the end of the glacier became melted where the morainal matter now stands, and this continuing for ages caused the enormous accumulation of rocky material to take place. The whole of the moraine apparently consists of *débris* from the hills west of the lake (Rolleston), and is very largely made up of cherty conglomerate (Devonian). An examination of the individual blocks shows that one or more sides have been subjected to a planing action by which this intensely hard pebble-studded rock has been worn down and sometimes even polished. Portions of the moraine consist of stones and blocks thrown loosely together, the interstices open; in other portions, the interstices are filled with fine material.

Another well marked moraine extends in a southerly direction from Lake Ruby (a small tarn in a gorge under a precipice 280 to 300 feet in height) down the course of Limestone Creek. The material, arrangement, etc., are very similar to that of the Lake Rolleston moraine. In both cases the surface of the moraine is of the most rugged nature.

Erratic Blocks.

Scattered over the surface all round Lake Dora on the hill sides, and even on the tops of hills 300 feet above the level of that lake, are blocks of stone, from small boulders up to heavy masses many tons in weight, that have been transported, in some cases, for miles by ice from their former sites to their present positions; all the morainal matter was thus transported. Some of the more conspicuous examples have been especially named on the plan. Scarcely any of them, but if carefully examined, show unmistakable evidence of having been ground, planed, striated, or polished on some portion of their surfaces. There is a great sameness of material, all of which is local and derived within a very few miles' distance. Some of the large blocks have been split since they reached their present position. Odd blocks of hornblendic rock occur of small size, they probably are derived from masses intruded through the Devonian rocks. Many of the erratic blocks are of great size, and some probably weigh hundreds of tons.

Planing, Scoring, and Polishing.

Planed and scored surfaces are features inseparable from glacial action, and these are most abundantly present over this region. On the western side of Lake Dora the rocky hillocks are planed down, scored, and striated in a beautiful manner, and right up the valley westward from Lake Dora this same action is exemplified on the rounded dome-like rocky projections of schist. To the east of Lake Dora, at the site marked on the plan, there are splendid examples of grooving, etc., both on the sides and floor of the rocky knoll. All the sides of the hills to the east from Lake Dora leading down to the valley of King River, are abundantly planed, scored, striated, and polished, the latter especially where the beds consist of quartzite rock; even to the top of the hills, some 300 feet above the level of the lake and on the east side, these features extend, striations and polished surfaces occurring to the very crest of the hills. By means of the striæ it is easy to see the direction in which the ice mass moved, for the great glaciers, which at Lake Dora must have been at least 400 or 500 feet thick, moved continually outwards from where the accumulation of ice was greatest. Studded as this ice was with small and great angular blocks of conglomerate, etc., it resembled a huge rasp, which, with irresistible force, filed down, rounded off, planed and scored the surfaces they came in contact with, and also registered in a most durable manner the course in which they were travelling. About Lake Dora the striæ point in many different directions, and it appears as though over this tract there must have been a very thick covering, the pressure of the great mass above compelling the ice to travel in different directions, even up the sides of hills, for the hills on the east side of Lake Dora are striated and scored up steep faces in the direction of their crests and over their summits.

About the best example of what such a great ice-rasp can accomplish is shown at Moore's Shoulder, named after my friend, Mr. T. Moore, who was my comrade and guide in this wild region. At this site a great glacier throughout a vast period must have been deflected around this projecting angle of rock; the result is marvellous, for the intensely hard Devonian conglomerate has been planed, rounded, scored, and polished in a manner that baffles description; the ice marks are noticeable high up the hill sides. Probably at this point the ice was of great thickness, in fact it appears from the scorings, etc., that a great volume of ice hundreds of feet thick covered the whole of this elevated region.

The bed-rock over this region showing such abrasions, etc., it is natural to expect that the moving blocks and boulders which, set in ice, formed the teeth of the rasp, should also equally bear evidence of the work they did, and such is abundantly present, for a large proportion of both great and small rocks and boulders in the moraines are ground down, striated, or otherwise bear testimony to the forces they have been subjected to. Many of the small pebbles detached from the blocks of Devonian or schistose conglomerates are remarkably ground down, polished, or striated. Some of the pebbles from the Devonian conglomerate are sheared in a remarkable manner; this was done while in their parent mass, the glacial markings have been added since. Curiously enough, at Prince Albert, in Cape Colony, sheared pebbles of precisely similar character occur in the older glacial conglomerate (Dwyka conglomerate) of that region that also show glacial markings, and they, too, are derived from a conglomerate of supposed Devonian age.

Tarns.

Lakelets from several miles in length down to mere ponds are met with throughout these highlands; they occupy rock-basins that the ice mass ground out where the bed-rock happened to be softer than usual. It is noticable that many of these basins have the longer axis in the direction of the strike of the rock, and they appear to occur most frequently on schist country. Nowhere do these tarns appear to be more than a few feet deep, they occur at many different altitudes. The outlets are sometimes over bare bed-rock, in other cases morainal matter dams the water back. Small rocky islets dot some of the tarns, and on them and around the edges of some of the tarns ti-tree and other small trees grow, greatly enhancing their beauty. Now that the flexibility of ice masses is well understood it is easy to understand how such rocky basins could be eroded.

Extent of Glacial Action.

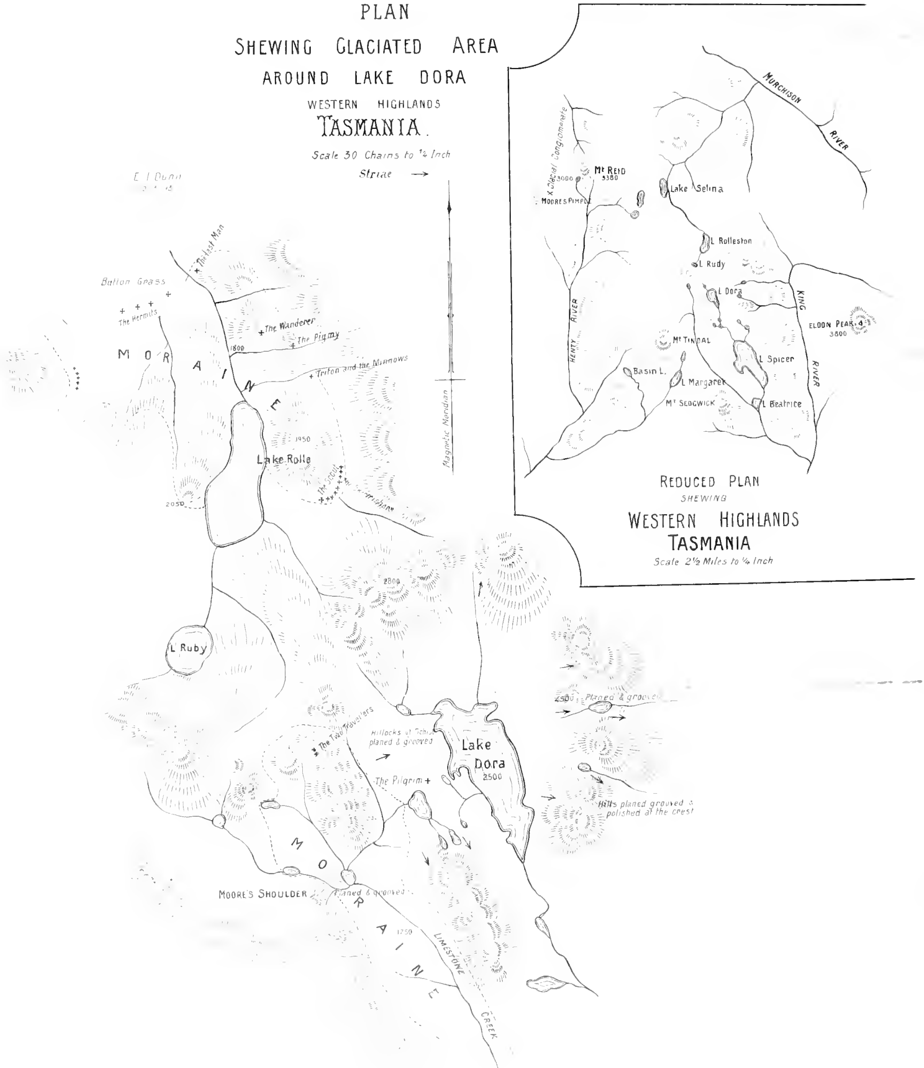
It appears highly probable that the central highlands around Lake St. Clair, and in fact the greater portion of the island above the 2,000 feet level should also contain evidences of glacial action if searched for, and remains in abundance may be expected in the higher country east of Lake Dora.

Age.

There are no direct evidences by which the age of this glaciation can be determined; so far as the appearance of the moraine, erratic blocks and scored and planed surfaces go, it might have taken place only a few years ago; in some places where the peaty material can be stripped off the abraded surfaces, the face of the rock is as fresh-looking as though the work had been done but yesterday. I do not consider this glaciation could have been older than of tertiary date, and it may very well be recent in age.

Glacial Conglomerate.

Quite distinct in character from the above, and differing entirely in age, origin, and method of deposit, is a remarkable conglomerate that occurs on the south side of the track between Mt. Reid and Moore's Pimple, and about equidistant from each; the site is marked by a shallow hole, and it is 3,000 feet above sea level, high above the observed morainal deposits, etc. The conglomerate consists of a great variety of sandstones, igneous rocks, shales, etc., nearly all well rounded and also beautifully striated; the pebbles and boulders are of non-local origin, unlike the morainal matter above described, and it rests upon Devonian sandstones. There is a marked similarity in the nature of the cementing material, and in the character of the embedded pebbles and boulders, to the glacial conglomerate found at Wild Duck Creek, Victoria, and to the Dwyka congolmerate of South Africa, and they probably all belong to a very ancient epoch, either near the close of the Palæozoic period, or else the commencement of the secondary era. This particular outcrop is, apparently, of no great thickness, and not very extensive, but further search should discover more such outcrops, and their relations might eventually be determined as regards the older Devonian series, and also the more recently accumulated rocks.


PLAN
SHEWING GLACIATED AREA
AROUND LAKE DORA
WESTERN HIGHLANDS
TASMANIA.
Scale 30 Chains to ¼ Inch
Striae →
Magnetic Meridian
Button Grass
The Hermits
The Last Man
The Wanderer
The Pigmy
Triton and the Minnows
MORAINE
1800
Lake Rolle
1950
2050
The Scout
L Ruby
2800
Lake Dora
2500
Hillocks of Schist planed & grooved
The Two Travelers
The Pilgrim
Planed & grooved
Hills planed grooved & polished at the crest
MOORE'S SHOULDER
Planed & grooved
1750
LIMESTONE CREEK
REDUCED PLAN
SHEWING
WESTERN HIGHLANDS
TASMANIA
Scale 2½ Miles to ¼ Inch
MURCHISON RIVER
KING RIVER
HENTY RIVER
Mt REID
3380
3000
MOORES PIMPLE
Glacial Conglomerate
Lake Selina
L Rolleston
L Rudy
L Dora
ELDON PEAK
3800
Mt TINDAL
Basin L.
L Margaret
L Spicer
Mt SEDGWICK
L Beatrice

Art. VII.—*Further Note on the Glacial Deposits of Bacchus Marsh.*

By Graham Officer, B.Sc., and Lewis Balfour, B.A.

[Read 8th June, 1893.]

The immediate object of the present note is to correct a mistake in our investigations of the Bacchus Marsh glacial deposits, the results of which were embodied in a paper read before this Society last year. In that paper we claimed to have shown that there were two distinct tills at Bacchus Marsh, separated by the so-called Bacchus Marsh sandstones, and that the upper of these rested on the denuded surface of the sandstone. It is to the latter point that we desire to draw attention.

Our conclusions in this respect were principally drawn from the consideration of sections at a small quarry on the Korkuperrimul Creek. We here described till overlying the sandstone, and a granite boulder over a yard in diameter together with an accumulation of smaller erratics as being jammed into the broken surface of the sandstone.

Having since traversed a good deal more ground without seeing any further evidence of such a state of things, we investigated the matter further, with the result that we now find that the supposed till overlying the denuded sandstone is really a "wash," containing striated stones, and derived in part, at least, from an outcrop of a deposit a little above the quarry. The broken sandstone is due to weathering and a certain amount of rock movement. The granite boulders lie embedded in a matrix of clay which is really intercalated with the sandstones, but looking very much at first sight as if subsequently injected. There are several thin clay bands besides this running through the sandstone, and in these bands small stones of the kinds met with in the till occur. Several we found bore glacial striæ. One of these stones was six inches in diameter. About the line of junction of the largest of these bands, both the sandstone and the clay are remarkably contorted, and the whole are inclined besides at about thirty-five degrees E.S.E.

There can be no doubt that the clay bands containing the stones and boulders are of glacial origin, in part at least, and that the larger boulders at any rate have been transported by ice, but by floating ice or land ice? It must be said that the stratified nature of the clay bands points to floating ice as being the transporting agent. In the "pocket" containing the large granite boulder we have noted at least three varieties of granite, a boulder of gneiss, and others of quartz-rock, clay-slate, etc.

The sandstone, which is of a massive type, contains *Gangamopteris* in abundance in certain zones. It passes upwards into a bed of more or less clayey nature, indistinctly, if at all, stratified, and bearing boulders and smaller stones. One well rounded boulder of granite measured eighteen inches in diameter. This deposit is overlaid by shales, and fine-grained, argillaceous, well stratified sandstones.

Consistently with our former idea we described a mass of till occurring on the Korkuperrimul Creek, opposite Bald Hill, as being banked up against sandstone. It is really overlaid by sandstone. At the large quarry on Bald Hill the sandstones are seen to be overlaid by a bed which is very rudely, if at all, stratified, and containing small stones scattered irregularly through it. The bedding planes of the sandstones appear contorted along the line of junction, but it is possible this appearance may be due to weathering.

At another small section we described before on the creek, the till is seen underlying tumultuous looking sandstones. The latter bear a few odd stones, several of which we found to be glaciated. A good deal of faulting has taken place here.

Considering the sections exposed on the Korkuperrimul Creek in this locality, we get a succession as follows :—

(1). Till containing a great deal of rock material.

(2). Stratified clays or shales.

(3). Sandstones containing intercalated bands of clay bearing boulders.

(4). A somewhat clayey unstratified deposit, which does not seem to contain so many stones as the bottom deposit.

(5). Shales and fine-grained well stratified sandstones.

A section exposed on the Lerderderg River, about two miles above Darley, shows unstratified clay containing irregular and lenticular bands of hard coarse sandstone, associated with well stratified fine glacial cla ys. Striated stones and boulders are very abundant through this, and are, as a rule, exceptionally well scored. One of these boulders, a hard blue slate, is five feet six inches long, three feet six inches broad, and a depth of two feet is exposed ; the surface is well scored in a longitudinal direction, though cross striæ occur also. Several other boulders at this section are over two feet in diameter. Though stones occur in the stratifled parts yet they are not nearly so abundant as in the unstratified. It is worth mentioning, as illustrating the tough and tenacious nature of the unstratified till, that a farmer resident in the locality, in course of conversation with us, remarked that he had never come across such an unsatisfactory material to work. In constructing a race he had occasion to pass through some of it, which proved very obstinate to the ordinary methods of excavation. Blasting had hardly any effect, and he said the only way to deal with it was to knock it away bit by bit with a hammer and a gad.

We traced the till on to the crest of a spur of the Lerderderg Ranges at a height of about 1000 feet above sea-level (aneroid reading). At one place on the flanks of these ranges, where we could actually see the junction of the till and the Silurian, we found the latter well scored and grooved. In the striated rock surfaces described in our last paper, the striæ and grooves were N. and S., being parallel to the strike of the rocks. In this case the direction of the striæ and grooves is W. 10° N. and E. 10° S., almost at right angles to the strike. In the former case the grooving and moulding was more marked and may be compared to grooves made by a gouge working with the grain of a piece of wood, while in the latter instance the appearance is somewhat similar to that made by a blunt gouge working across the grain of a piece of wood of uneven texture, now working fairly smoothly, now catching in a harder band, wrenching a piece out, and again proceeding evenly. An indication of the direction of the ice can be thus obtained. In this case the ice appears to have come from ten degrees south of east, but it would be unwise to infer much from this one instance, especially as there is abundant evidence to show that the Silurian rocks have undergone considerable movement since this ancient ice-age.

Wherever we have seen the junction of the till with the Silurian, the former has always been intensely hard and unstratified, and the latter invariably grooved, smoothed, and striated. These are facts, which, in our opinion, point to one conclusion, viz., that the lowest member, at least, of the glacial series is morainic, due to the action of land ice, of the former presence of which we have unquestionable evidence in the *roches moutonnées.* It will have been seen that the Bacchus Marsh sandstones must be considered as part of the glacial series—a conclusion to which our friend, Mr. Brittlebank, has also come independently of us. As the only fossils obtained so far are plant remains, a fresh-water origin for them is indicated, and it is reasonable to suppose that these sandstones were deposited in a glacial lake in which floating ice drifted. The clay bands in the sandstone may perhaps have been formed by subglacial material carried into this lake by streams. Any floating ice would be drifted with the currents and drop their burdens occasionally in the accumulating silt. Such a lake may have been almost an inland sea. The vast size attained by glacial lakes in America during the last ice-age is well known. The alternation of boulder beds with plant-bearing sandstones is only what would be expected on the astronomical theory of ice-ages.

POSTSCRIPT.

Since reading the above paper we have discovered several beautiful examples of *roches moutonnées*, near Coimadai. The smoothed and grooved surfaces can be traced right beneath hard unstratified till. There is also good evidence to show the direction the ice took at this locality, viz., from S.S.W. to N.N.E. These are by far the best example of *roches moutonnées* we have seen in this district. A detailed description we must leave for a future paper.

Among the fossil plant remains we have discovered in the Bacchus Marsh sandstones, what Sir F. McCoy thinks are probably *Schizoneura* are by far the most abundant. Sir Frederick has also determined the genus *Ptilophyllum*, being the first occurrence of this genus in Victoria. He has described it under the name of *P. officeri*. Several other forms are awaiting identification. They all come from the Schizoneura bed—a thin clayey band about four inches in width. The horizon is apparently above that of the *Gangamopteris* beds.

Sir F. McCoy's description of *Ptilophyllum officeri* is as follows: "Pinnæ about one inch wide; pinnules about eleven in one inch, nearly at right angles to rachis, with coarse, unequal, longitudinal striæ; width of pinnules about half a line, one line apart; rachis about one line wide."

Art. VIII.—*Notes on the Trawling Expedition off Lakes Entrance.*

By T. S. Hart, M.A.

[Communicated by Dr. Dendy, 13th July, 1893.]

Trawling operations were commenced at the end of last April off Lakes Entrance, with a view to obtaining the Government bonus and establishing the industry. The boat obtained was the s.s. *Swansea,* of forty-one tons, twenty-two horse-power. The trawling apparatus consisted of two trawl-heads of iron, connected by a beam above and a ground-rope below, a net being attached to the beam and ground-rope, and ending in a bag with a flap to prevent fish escaping. The trawl-heads consisted of an iron bar, bent so as to form two straight pieces diverging at about thirty degrees, and connected by a curve at the front. At the sharp angle the ground-rope was attached. One of the straight pieces formed a sliding surface, and at the highest point the beam was attached, the tow-line was fixed a little above the middle of the curved part. The trawl-heads in use at first weighed about 180 pounds each, and the beam was about forty-nine feet long, and eight inches in diameter; the ground-rope being about double that length. The net had a mesh of about two inches for the greater part. When I reached Lakes Entrance on the evening of 1st May, they had been out once or twice and not caught much, and were putting in a lighter beam, about six inches in diameter. After this was done and the sea had become a little calmer, a start was made. The trawling apparatus was carried, when not in use, along the port side, and lowered and raised there, the tow-rope being brought round to the stern after it was lowered. The raising and lowering took about two hours, owing to there being only one winch on board, and the side of the boat being obstructed by railings and other things. It was stated on board by the men who were engaged as experts in trawling, that it should only have taken about twenty minutes with proper appliances and arrangements. The time the net was left down varied from four to eleven hours.

The steamer was not sufficiently powerful to tow the net at a proper speed, the speed attained at one time being only one mile an hour; while on one occasion it was found that the steamer could scarcely manage to turn with the net, an hour being spent in turning round.

The plan of operations was to fish near the entrance, running in early in the morning to send up the fish to Melbourne. The ground trawled over extended from about fourteen miles west of the Entrance to opposite Lake Tyers. The depth of water was about twelve to fifteen fathoms, once reaching twenty-five fathoms.

The fish caught were chiefly Flounders, Flathead, Gurnet, Sandcod, Skate, a few Sole, and a fish said to be well known in Sydney though not in the Melbourne market, for which they had no name. At first sight the latter were thought to be young Schnapper. Owing to the coarseness of the net many small things could escape, and as the net in the raising was for a long time almost at water level they had good opportunities of doing so. Starfishes, Crabs, and other animals could frequently be seen walking off as the net was brought up to the surface. After some days it was decided that the trawling apparatus was too heavy for the boat and must be considerably lightened. They therefore decided to cut ten feet off the beam, put on lighter heads of about forty pounds each, and alter the net accordingly. These alterations would take time, and as the weather had set in rough I decided to return on Monday, 8th May. When on shore I spent the time in searching for anything that might be thrown up, but the beach was very barren. Inland there also appeared to be very little to be found.

I have to express my thanks to the Royal Society for defraying my expenses on the expedition; and to Dr. Wollaston (the Secretary for Trades and Customs), Captain Anderson, Messrs. Hill and Son (the Melbourne agents for the owners, Messrs. Murray and Co. of Sydney), and Captain MacArthur of the *Swansea*, for their assistance in making the arrangements, and for granting me every facility in obtaining specimens.

Dr. Dendy says of the *Sponges* collected :—"There are about twenty species, including *Cavochalina bilamellata*, *Halisarca australiensis* (growing on *Boltenia*), and one calcareous sponge, *Leucilla saccharata*. The remainder appear to be nearly all common forms, closely resembling if not identical with those of Port Phillip Heads."

Of the *Polyzoa* Dr. MacGillivray gives the following list:—*Cellaria gracilis*, *Beania magellanica*, *Membranipora pyrula*, *Steganoporella magnilabris*, *Adeona grisea*, var., *Adeonellopsis mucronata*, *Hipporhoa divaricata*, *Schizoporella triangula*, *Porella marsupium*, *Cellepora foliata*, *C. mammillata*, *C. albirostris*, *Smittia oculata*, *Retepora monilifera*, *Crisia acropora*, *Hornera foliacea.* He says "There is nothing new among them, but the specimens of *Cellepora foliata* and *Steganoporella magnilabris* are unusually good, as also is that of *Adeonellopsis mucronata.* There may be an additional species among the smaller *Celleporæ* but the genus, which is an exceedingly difficult one, is not yet completely worked out."

Other specimens were:

Hydrozoa.—One species.

Alcyonaria.—Two species.

Echinodermata.—Two species of Ophiuroids; one species of Crinoid (*Antedon*); two species of Echinoids (*Strongylocentrotus erythrogrammus* and another). All appear to be common forms.

Worms.—Several tubicolous Annelids, chiefly *Filograna*, and a number of worms living in the sponges.

Crustacea.—About eight species of Crabs, including large Hermit crabs, living in shells of *Voluta fusiformis* and *V. undulata*, and another species in a shell of *Cassis*, and also very large specimens of *Ibacus peronii.*

Mollusca.—On shore, thrown up, *Pectunculus flabellatus* and a few other species all much worn by the surf, including *Triton* sp. and *Potamides* sp. Inside the entrance on the mud banks a species of *Modiola.* Dredged from the bottom, *Pecten laticostatus* and another species of *Pecten*, *Modiola* sp., *Siphonalia* sp., *Voluta fusiformis*, *Crepidula* sp., and empty shells of *Voluta undulata*, *Crassatella kingicola*, *Pinna tasmanica*, *Ostræa* sp., and *Cassis* sp.

On the shore of Lake Bunga, I found a few empty shells of *Bulimus atomatus.*

Tunicata.—One compound Ascidian.

Art. IX.—*Some Statistics showing the extent of the damage done to members of the Medical Profession by the abuse of Alcohol.*

By James W. Barrett.

[Read 13th July, 1893.]

A very valued friend of mine stated some time since his conviction that in this colony, and up to date, alcohol was the causal agent in effecting the physical and moral ruin of about twelve per cent. of the male population with whom he was acquainted. As he is a highly cultivated man this proportion would be under that obtaining for the community in general. I thought his judgment was biased and told him so, but set to work to find what data were available for the purpose of ascertaining the accuracy of his opinion.

The only feasible plan appeared to be the tracing of the career of a number of people I had known for periods as lengthy as possible, and the estimation of the number whose health or whose prospects in life had been distinctly injured by the abuse of alcohol. If, however, the conclusions were to be of any value the careers of everyone I had been acquainted with must also be followed, and not simply of those whose morbid habits brought them into notoriety. In order to do this it ultimately became necessary to limit consideration entirely to members of the medical profession graduating at the Melbourne University, because it then became possible to make calculation on the whole body of graduations in the medical school, and the fallacy just referred to was eliminated. The objection to the method is that it takes account of the habits of men in one occupation only —an occupation, which, by reason of its exhausting and irregular character, gives a strong filip to moral decrepitude.

In the *University Calendar* for 1881-82 there are fifty-six Bachelors of Medicine on the list, of whom forty-three may be classed with Cæsar's wife as regards the abuse of alcohol. Of the remainder, twelve, or about twenty-one per cent., were decidedly injured by the excessive use of alcohol. Some of them practised allied vices (opium and chloroform). If the thirteen be included, the percentage rises to about twenty-three. The great majority of the thirteen are now deceased, and their deaths were certainly hastened by the same causes.

In the *University Calendar* for 1883-84 there are eighty-six Bachelors of Medicine on the list, of whom ten, or about twelve per cent., certainly used alcohol in excess, and were much injured thereby in every respect. Some of these ten are included in the thirteen above mentioned, but several of the thirteen had died in the interval.

In the *University Calendar* for 1885-86 there are 106 Bachelors of Medicine on the list, of whom twelve, or about eleven per cent. became distinct alcoholics.

In all these cases the habits of intemperance began, I believe, subsequent to their entry into student life, in most cases they were not pronounced until leaving it. Whatever may be the value of these figures the real truth is, if anything, understated. The diminution in the percentage in the more recent years may, or may not be fallacious; it may be due possibly to increasing civilisation in the colony, or it may be due on the other hand to the shortness of the interval which has elapsed, and consequent anticipation of results. Further, I find it much more difficult to trace the movements of the more numerous graduates in recent years.

Again emphasising the fact that the conclusion may be understated, but is certainly not overstated, it can only be described as appalling. That such a number of men who have been reared, as Carlyle puts it, "at infinite trouble and expense," and who have qualified themselves by a course of long and severe study to practice a most interesting profession, should then pass into the world to obstruct, and not assist, social progress, to become not objects of respect, as cultivated and useful citizens, but a by-word and reproach, can only excite the most profound dismay.

Be it observed that the figures in themselves warrant no conclusion whatever on the vexed question, whether alcohol is the cause or the consequence of destruction, or both. Whether, in other words, alcoholism is a symptom of moral deterioration, or whether moral deterioration is a symptom of alcoholism, or whether they mutually interact. They further in no way indicate any specific remedy. The broad fact remains, that of the graduates in medicine of the Melbourne University, at or about the years named, about one in seven became social wrecks, the proximate cause of the disaster being, what the total abstainers designate, in the words of Robert Hall, "liquid fire and distilled damnation."

Art. X.—*An Operculum from the Lilydale Limestone.*

(With Plate IX).

By R. Etheridge, Junr., Corr. Member.

[Read 14th September, 1893].

The opercula of Univalves are amongst the less common fossils met with in rocks of Upper Silurian age, but although known to occur in those of Europe, have not been described, so far as I am aware, from deposits of a similar nature in Australia. My acquaintance with opercula from the Lilydale Limestone was first made through the collection of Mr. G. Sweet, of Brunswick, and subsequently by means of collections made at Lilydale by Mr. A. J. North, on behalf of the Australian Museum, Sydney. These bodies were also casually referred to by Messrs. G. B. Pritchard and T. S. Hall* during the discussion on the Rev. A. Cresswell's paper† "Notes on the Lilydale Limestone." The observations in question will be referred to later.

The Opercula are disc-shaped, amphicœlous, strongly reminding one of the vertebral centrums of some fish. Those I have seen vary in size from half to once inch in diameter, and are bevelled from the exterior inwards along the sides. Further, they are thick solid bodies, almost equally concave, but the concavity less acute on the exterior, and more gradually inclined inwards than on the interior. The periphery of the latter side is flattened, the central area small, depressed, and circular, and often presenting a minute central nucleus. The thickness on the sides of the largest example I have seen is two-eights of an inch, or a trifle over; the thinnest, three-sixteenths of an inch. Mr. Pritchard informs me that he possesses examples of these opercula varying in size from one-sixteenth to one and a quarter inches in diameter, and from one-fiftieth to one-quarter of an inch in thickness. The structure is very apparent, even to the naked eye, the exterior exhibiting close concentric thread-

* Proc. R. Soc. Vict., 1893, v. (n.s.), p. 260. † *Ibid*, p. 38.

like lines, the edges of the component laminæ. Every here and there one is larger than the others. In sections prepared for the microscope, the concentric laminæ become very apparent, both in horizontal and vertical sections. The latter also display the outline exceedingly well. The opercula are practically round, a fact which can be easily ascertained by following the concentric laminæ in a transverse section. This point is an important one, as it may bear on the question of the identity of the operculum to its shell.

Mr. T. S. Hall mentioned in the discussion before referred to, that an operculum had been found "wedged into the mouth of an Euomphalus." Not having seen this genus amongst the Lilydale fossils, I am unable to follow the suggestion further, but must fall back upon the question—Do these opercula appertain to either of the described shells, *Oriostoma Northi*, or one of the *Cyclonemæ?* The mouth in the former is not, strictly speaking, round, but angulated towards the inner lip. On the other hand, *Cyclonema australis*, and probably also *C. lilydalensis* possess a round mouth, but this difficulty presents itself—the smallest operculum before me is too large for the largest *C. australis*. It is hardly necessary to consider such a form as *Phanerotrema australis*, that being a member of the Pleurotomariidæ, in which the operculum is corneous; but, at the same time, so far as mere size goes, the mouth of this species would far better accommodate a body of the size of these opercula than the shells mentioned above. If one may be permitted to surmise that the *Euomphalus* mentioned by Mr. Hall be *Oriostoma Northi*, then the matter narrows itself down to the question, is the operculum in such a position that it can be regarded as *in situ?* If on the other hand the shell be *Euomphalus* the matter becomes still more interesting. Let us now consider what previous investigations on Silurian opercula teach us.

Many years ago Dr. F. Smithe, M.A., figured* the well-known Wenlock shell, *Oriostoma sculptum*, Sby. sp., with its operculum *in situ*. The latter is plano-concave, plane without, concave within, formed of twelve concentric laminæ, and with a well-marked nucleus and bevelled edges; therefore, except in its

* Observations on the Opercula of some Silurian Gastropoda.—Proc. Cotswold Nat. Field Club.

section, remarkably like the opercula from Lilydale. In 1881 I figured* some of these bodies from the Carboniferous and Wenlock rocks of Great Britain, and the Wenlock of Gotland. Those from the English Wenlock occupy the mouths of *Oriostoma sculptum*, Sby., and are depressed-conical, circular bodies, bearing seventeen or more concentric rings. The other side is flattened near the margin and then rises at the centre into a low spiral eminence. Allowing for the state of preservation, and slight variability, these agree perfectly well with those figured by Mr. Smithe and also those now about to be referred to.

By far the most complete set of Silurian opercula figured, however, are those from the Wenlock rocks of Gotland, by Dr. G. Lindström.† He gives illustrations of those of *Oriostoma coronatum*, Linds., and *O. globosum*, Schl., besides a number of others not relegated at the time he wrote to their proper species. The whole of these are conical, in a greater or lesser degree, and are thus described:—"The operculum, *i.e.*, of the genus, is calcareous and solid, on the inner side smooth with a thick, elevated rim round the margins, outside conical, sometimes higher than broad, covered with a number of spiral coils, ornamented with exceedingly thin lines."‡ It will be at once apparent that the opercula from Lilydale differ from those of the Gotland molluscs in the entire absence of any conical outline; on the contrary, they are flattened disk-shaped. Lindström figures one of the less conical filling the aperture. The variation in form is very remarkable, from a depressed conical, through a depressed roundly-conical, to an elongately-conical, or absolutely plug-shaped outline, much resembling some rifle bullets. At the same time all possess the flat or very slightly concave inner face, accompanied by the external concentric coils, the latter having a more or less subimbricating appearance.

The operculum of *Cyclonema* is thus described: — "The operculum is broadly conical, with some ten large coils outside, impressed by a shallow groove along their superior border, and streaked by oblique, transversal lines."§ Illustrations‖ are given

* Ann. Mag. Nat. Hist., 1881, vii. (5), p. 29.

† The Silurian Gastropoda and Pteropoda of Gotland, 1884. t. 17.

‡ *Ibid.*, p. 156. § *Loc. cit.*, p. 174. ‖ *Ibid.*, t. 17.

of the operculum of *C. striatum*, His., and of those of two other undetermined species. The general type is quite similar to that of this portion of the shell economy in *Oriostoma* as figured by Lindström. The Lilydale opercula more closely resemble those described by Smithe and myself from the Wenlock beds, than they do those from Gotland; at the same time, trivial differences which strike the eye on close examination, may ultimately prove of wider significance. The cross section of an operculum given by Smithe is most undoubtedly more akin to that of the Lilydale specimens than are any sections which could be derived from the Gotland examples. The latter are wholly plano-conical in section, Smithe's Wenlock operculum is certainly plano-concave, whilst the Lilydale forms, on the other hand, are either bi-concave, or slightly plano-concave.

It is possible that the shell spoken of by Mr. T. S. Hall as *Euomphalus* may throw some light upon this subject, and I should much like to be permitted to examine this specimen.

A strange similitude to some of these opercula is seen in a fossil from the Corniferous Limestone of Indiana, described by Mr. S. A. Miller as a sponge, under the name of *Cyclospongia discus*.* It is "circular, button-shaped or discoid, and consisting of numerous thin, calcareous laminæ, having a concentric structure and filled with minute canals or interstices." The upper surface is slightly convex, bearing numerous concentric lines, the under side slightly concave, with a "broad, undefined, shallow furrow near the circumference, and round depression in the centre." Were it not for the minute canals I should be much tempted to regard this object as an operculum.

I am indebted to Mr. C. Hedley, F.L.S., for the accompanying drawings.

POSTSCRIPT.

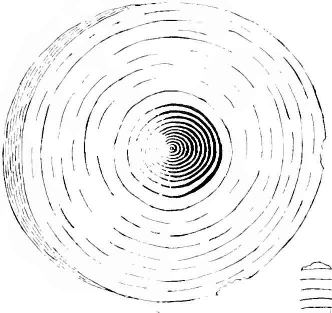
Through the courtesy of the Honorary Secretary of the Royal Society I have been permitted to add some additional information obtained since this paper was written, and kindly contributed by Mr. G. B. Pritchard. The latter informs me that he has in his

* Seventeenth Report Geol. Survey Indiana, 1892, t.l., f. 8 and 9.

possession examples of these opercula, varying from one-sixteenth to one and a quarter inch in diameter, and from one-fiftieth to a quarter of an inch in thickness, thus establishing the fact that they are both larger and smaller than the measurements previously given by me. He also informs me that in the collection of the Rev. Mr. Cresswell is a specimen of *Oriostoma Northi* with a similar operculum *in situ*, the shell about two and a half inches in diameter, and the operculum three quarters of an inch. Mr. Pritchard obtained a broken mouth of an *Oriostoma* at Lilydale, about five or six years ago, also with the operculum in its natural position. This was submitted to Professor Sir F. McCoy, and its nature determined by my eminent friend, who referred the fragment to *Euomphalus*. We have here the explanation of Mr. Hall's reference to the latter.

Mr. Pritchard's smallest *O. Northi*, a perfect young example, is half an inch in diameter, and yet is too large for the smallest of the operculums in his collection, whilst the largest specimen of this species is three and a quarter inches in diameter, with the operculum one inch in the same direction, so that the largest of the "lids" mentioned above (one and a quarter inches), seemingly indicates a very large example of the species.

These observations of Mr. Pritchard's will, I think, fairly answer my previous question as to which of the Lilydale shells our button-shaped bodies belong to. Furthermore, this additional evidence opens up the question—How far can the depressed Euomphaloid shells referred to *Oriostoma*, such as my *O. Northi*, and other similar forms, be properly placed in *Oriostoma?* Can they, with their amphicœlean opercula, be relegated to the same genus as those species so beautifully figured by Dr. Lindström, and touched on by Mr. Smithe and myself, with more or less conical opercula? It is a rather significant fact that all Lindström's figures showing opercula *in situ*, represent species with the more elevated spire, after the type of *O. discors*, Sby., *O. globosum*, Schl., and its var. *sculptum*, Sby., and not those with a depressed spire such as *O. rugosum*, Sby., nor those with a concealed spire (in a side view), like *O. angulatum*, Wahl. However, the subject is too long and complex to be considered now, and I hope at no distant date to communicate a paper to the Royal Society on the subject, and on the general family



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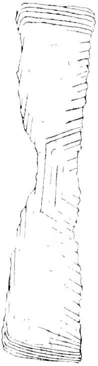

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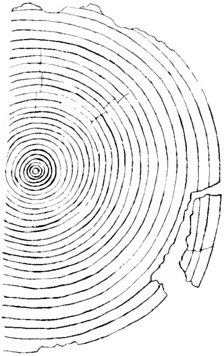

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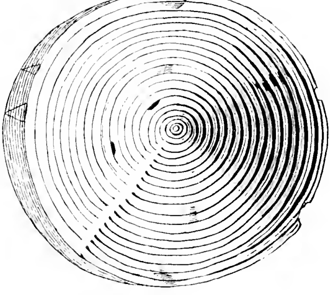

1

[illegible] del.   W.ndel lith

relations of these shells. One thing appears pretty clear, shells similar to *O. Northi* are not referable to *Euomphalus*, or any of its allies, as recently defined by the late Prof. L. G. DeKoninck, nor, so far as I am aware is the operculum of this group known with any certainty, although DeKoninck surmised that the peculiar bodies described by him, under the name of *Hypodema*, might occupy this relation to *Euomphalus*. If so, the divergence of shells like our *O. Northi* from the latter is all the greater.

DESCRIPTION OF PLATE IX.

Fig. 1.—Exterior of operculum.
,, 2.—Interior ,, ,,
,, 3.—Thin transverse section prepared for the microscope.
,, 4.—Longitudinal ,, ,, ,, ,,

The figures are twice the natural size.

Art. XI.—*Additional Notes on the Lilydale Limestone.*

By Rev. A. W. Cresswell, M.A.

[Read 14th September, 1893.]

The only additional information in regard to the Stratigraphical Geology of Lilydale that I have to record is that about half a mile to the west of the strike of the Limestone of Cave Hill, and running conformably with it, *i.e.* a few degrees to the east of north, and to the west of south, and dipping from 30° to 45° east, is a series of mudstones, shales, and shaly sandstones yielding a profusion of fossils, mostly casts, but very well preserved, specimens of which are to be seen on the table.

Among the *Brachiopoda* are "Leptagonia deltoidea," "Leptœna sp.?," "Orthis subquadrata" and "elegantula," "Spirifer plicatellus," "Pentamerus Australis" and "Rhynchonella Stricklandi?" Among the *Lamellibranchiata* the most common form is "Pterinœa sub-falcata" or an allied species. Of the *Gasteropoda* "Bellerophon Cresswelli" (Etheridge) is a common form. And of *Cephalopoda*, "Orthoceras ibex," and "capillosus" are species that are both well represented. The *Trilobitidæ* are represented by "Homalonotus Harrisoni," tails of which are very common, and *Crinoid* stems of the Actinocrinus type are also very abundant.

The fossils are easily obtained by splitting the shales along the planes of stratification, and the places which I have visited and from which I have procured specimens are :—

(1) A point on the Mooroolbark Road close to the gate of entrance to Mr. Kinsella's farm, where the shale or mudstone is exposed under the overlying basalt in a cutting.

(2) On the old Melbourne Road, near the top of the hill, about half a mile above Lilydale, in the stuff thrown out of a sinking for a tank at Mr. Wilson's.

(3) About three miles to the north of the last mentioned point, and about fifteen chains to the west of the road that leads past the cemetery (N. and S. road) at an old quarry, known as Hughes' quarry.

In regard to the Cave Hill Limestone itself or rather it contained fossils, before giving any additional notes on this head, I have first to retract a statement I made in the paper read here in July of last year as to the occurrence of a gasteropod shell belonging to the genus "Stomatia," and which I called *S. antiqua*, supposing it to be the oldest Stomatia on record. This determination was an erroneous one, as it was founded upon what has since turned out to be a very imperfect specimen of a different shell, but which in its fragmentary form was so strikingly like a Stomatia that I was quite "taken in" by the appearance of it. However, I remarked at the time that the whorls were steeper in the sides and more flattened than Stomatias usually are. A somewhat better specimen has convinced me that the shell is not a Stomatia at all, but what it exactly is, it is difficult to say at present, for even this specimen is by no means perfect. It is possibly a very eccentric Trochus, eccentric of course in the literal sense of the word in having the axis or columella very remote from the centre, and besides this the whole shell is much depressed for a Trochus. However, I have learnt caution, and will endeavour to get a better specimen before committing myself to anything beyond the assertion that it is not a Stomatia.

Euomphalus (Oriostoma) Northi.

I have much pleasure in being able to exhibit on the table this evening a tolerably perfect specimen of Euomphalus Northi (or according to Mr. Etheridge, Oriostoma Northi) with the operculum that has been the subject of so much controversy *in situ*. The controversy as to the operculum has been first as to the nature of it, some taking it for a nummulite, and some for the lid of a coral, others for the vertebra of a fish; but I think there was a general consensus of opinion amongst our Victorian geologists from the first that it was the operculum of a gasteropod shell, the only difference amongst us being as to what species of shell it belonged to; some thinking it was the operculum of Cyclonema others that it belonged to Euomphalus (or Oriostoma) Northi.

The discovery of the specimen exhibited to-night must for ever set at rest any further dispute both as to the nature of it and as to the species to which it belongs. It is a veritable operculum, and as certainly belongs to Euomphalus (or Oriostoma) Northi, for there it is *in situ*, and a grain of fact is worth a pound of theory.

And now a word or two as to the bearing of this discovery on the question as to the true genus to which the shell itself belongs. Although, in deference to Mr. Etheridge, I have quoted it by the generic name he has given it, viz., Oriostoma as an alternative to our name Euomphalus, Victorian geologists had always recognised it as a Euomphalus, and it appears to me that the form of the operculum it is now found to have possessed confirms our view, for, as Mr. Etheridge himself admits, Oriostomas have conical opercula, whereas this operculum is plano-concave and multispiral, or rather many times concentric, more like that of Euomphalus. As a further point of resemblance to Euomphalus, it is well-known that in Euomphalus the apex of the whorls is often filled up by a secondary deposit of shell and the interior is often divided off by transverse shelly partitions. Well, the same feature is also to be seen in our genus when ground down, as exhibited in the large specimen on the table; as however this is a feature not confined to Euomphalus alone, but often found in other shells of lengthened spire as well, it can only be regarded as a slight confirmation. It would be presumption on my part to differ from so high an authority as that of Mr. Etheridge in a matter of Palæontology, were I not fortified by the result of an appeal to another high authority, for I have shown this specimen to Professor Sir F. McCoy, and he tells me it is not the first he has seen from Lilydale with the operculum *in situ*, for Mr. Pritchard showed him an imperfect specimen of the same kind some years ago, and he authorizes me to state that he regards the shell as certainly an "Euomphalus," and not an "Oriostoma" at all, the latter being a name he restricts to a Tertiary genus.

Niso (Vetotuba) Brazieri.

There is a species of Gasteropod shell which Mr. R. Etheridge has described in the records of the Australian Museum, Sydney, vol. i., No. 3, as occurring in the Cave Hill Limestone at Lilydale, and to which he has given the name of Niso (Vetotuba) Brazieri. He says the material for giving a description of the shell is very imperfect, but he has provisionally called it a Niso, on account of its resemblance to that genus in several particulars, and especially in its having an umbilical cavity extending the whole length of the shell, but as Niso is not elsewhere known to occur as far back as the Upper Silurian, he suspects that further examination may show it to differ from Niso, and in that case he proposes to call it Vetotuba. I may mention that I have found several more perfect specimens than the one he figures, demonstrating that which he surmises as possible, a very marked difference to Niso in that the umbilical cavity appears to project below the base of the shell in the form of a short tube, somewhat like the anterior canal of a Cerithium, only straight instead of abruptly turned to one side, and being an extension of the hollow columella, and not a mere prolongation of the mouth. Under these circumstances I prefer to adopt Mr. Etheridge's alternative name Vetotuba. There are at least two species if not more of these turreted shells belonging to the Pyramidellidæ. The above remarks apply more especially to the one he figures under name Niso (Vetotuba) Brazieri, and which, as he says, has no more than twelve whorls. I have however in my possession and on view to-night, another species much more slowly tapering and consisting of nearly twenty whorls, but the anterior part is not sufficiently perfect to define it, and so we must wait for a better specimen. Besides this I may mention that there is a small species that has more resemblance to a true Niso.

ART. XII.—*Note from the Biological Laboratory of the Melbourne University:—On a Crayfish with abnormally developed Appendages.*

By ARTHUR DENDY, D.Sc.

[Read 14th July, 1893.]

In the five posterior thoracic limbs, or ambulatory appendages, of the common fresh-water Crayfish, the exopodite has, as a rule, completely disappeared, and the limb is formed of protopodite together with very strongly developed endopodite.

Professor Huxley, in his well-known works on the Crayfish,* referring more particularly to the European *Astacus*, observes, "I have not been able to discover, at any period of development, an outer division or exopodite in any of the five posterior thoracic limbs. And this is a very remarkable circumstance, inasmuch as such an exopodite exists in the closely allied lobster in the larval state; and, in many of the shrimp and prawn-like allies of the Crayfish, a complete or rudimentary exopodite is found in those limbs, even in the adult condition."

The common Australian Craytish (*Astacopsis bicarinatus*) agrees very closely with the European form as regards the thoracic appendages. A few weeks ago, however, when we were dissecting this Crayfish, obtained in quantities from the University pond, one of the students called my attention to a peculiarity in the specimen with which he had been provided.

On examining this specimen I found that small exopodites were present on three of the ambulatory appendages, *viz.*, on the great chela and the succeeding appendage on the right side, and on the great chela alone on the left side. In size, shape, and position these abnormally developed exopodites closely resemble the normal exopodites of the third maxillipede. The specimen is a female, of moderate size.

The presence of these abnormal exopodites, which, so far as I am aware, have not hitherto been observed in any true Crayfish,

* International Scientific Series.

affords additional proof of the generally accepted view as to the derivation of the ambulatory appendages from the primitive biramose type. Their occurrence in an isolated specimen out of the many hundreds which have been examined by various workers is, doubtless, to be explained as an instance of reversion to an ancestral condition. An analogous case is afforded by the "antenniform ophthalmite" of *Palinurus penicillatus* described by Professor Milne-Edwards, and subsequently figured by Professor Howes in the Proceedings of the Zoological Society of London (17th May, 1887).

My thanks are due to Mr. A. W. Morton for calling my attention to the specimen described above, which is preserved in the Museum of the Biological School.

Art. XIII.—*Results of Observations with the Kater's Invariable Pendulums, made at the Melbourne Observatory.—June to September, 1893.*

By Pietro Baracchi, F.R.A.S.

[Read 13th October, 1893.]

The observations which form the subject of this paper were made with the three Invariable Pendulums of Kater's pattern marked 4, (1821) or 6, and 11, belonging to the Royal Society of London, and fully described in vol. v. of the account of *Operations of the Great Trigonometrical Survey of India*, and more recently by General Walker in the *Philosophical Transactions of the Royal Society*, vol. A., 1890, page 539. They were lent to Mr. Ellery for the purpose of being employed in the Gravity Survey of Australia proposed by the Royal Society of Victoria, and to be carried out by a committee specially appointed. These pendulums have been in existence over seventy years, and were swung in many parts of the world, at elevations ranging from sea-level to over 15,000 feet. As stated by General Walker, they were variously employed by Sabine, Bayley, Airy, and McClear, between the years 1822 and 1854. Captain Basevi took two of them, viz., No. 4 and No. 6 to India in 1864, where they were employed for eight years in gravity determinations, chiefly at stations along the Central Meridian Arc of the Great Trig. Survey.

In 1881 and 1882 Colonel Herschel swung them at Greenwich and Kew, together with Pendulum 11, and afterwards took the three to America, swinging them at Washington and Hoboken. After completing his operations they were given over to Mr. Edwin Smith of the U.S. Coast Survey, by whom they were taken round the world, and swung at Auckland, Sydney, Singapore, Tokio, San Francisco, and again at the starting point, Washington. Lastly, in 1888 and 1889, the Revisionary Operations with the three pendulums at Kew and Greenwich were undertaken, in consequence of discordance in the results of 1882.

They arrived in Melbourne in November, 1892, and Mr. Ellery made the necessary preparations for swinging them at the Observatory, and had all the various parts mounted and adjusted and ready for work by the middle of June last, when Mr. Love started the observations. At about the same time Lieut. Elblein of the Austrian warship *Saida*, swung three ½-second Pendulums of Colonel von Sterneck's type, at the Melbourne Observatory, thus connecting it with an independent basis, viz.: Vienna, where the absolute value of the Force of Gravity was determined by Professor Oppolzer. This increased the importance of the Melbourne swings with the Kater's Pendulums, for their results could be tested by two different series. It was decided in consequence, to extend the operations further than it was originally intended, taking for standard the revisionary work at Greenwich and Kew, and thus establish a satisfactory basis to which other Gravity determinations in Australia, made with Kater's or any different form of pendulums, might be referred. The Melbourne Observatory possessed all the necessary conditions for carrying out the observations under the best advantages.

The value of Gravity determinations by the differential method depends on the invariability of the pendulums used. There is evidence to show that when carefully handled, these pendulums remain unchanged and may be swung without re-grinding the knife edges for many years, and as the three Pendulums now employed have not been intentionally altered, or known to have met with any accident since Colonel Herschel swung them at Kew and Greenwich in 1882, it may be expected that they are now in the same condition as they were eleven years ago. Fortunately we have the means of testing this condition by swinging them again at Sydney, which it is to be hoped will be done, at the earliest opportunity.

The pendulums were swung in the eastern underground room in the main building of the Melbourne Observatory, which, having a stone pavement, offered all the required stability, and had also the advantage of keeping a fairly constant temperature. The clock by Shelton, the same as that used in England and India, was fixed to the south wall of the room, and the Pendulum Stand

and Observing Telescope were in a line with it, in the direction of the meridian. An image of the white disc attached to the pendulum of the clock was formed at the tail piece of the Invariable Pendulum, by the proper collimating lens, and was brought into the field of view of the Observing Telescope by a plain mirror, fixed at the object end, which could rotate in a plane at right angles to the meridian, thus enabling the observer to bring the eye end at any convenient altitude. The distances of the several parts from the tail piece were as follows:—Observing Telescope, o.g. 70·3 inches; disc on Shelton pendulum, 48 inches; collimating lens, 12·2 inches; arc scale, about 1 inch for No. 11, and 0·5 inches for No. 4 and No. 6. The arc scale was about 18 inches, and the plane of suspension about 68 inches above the floor of the room, which is 84 feet above sea-level.

The operations consisted in observations of coincidences, temperature, pressure and arc of vibration, and comparison of the Shelton clock, with the sidereal standard clock of the Observatory, the rates of which are always known from transit observations, and finally, the reduction of observations.

Observation of Coincidences.

The diaphragm in front of the disc carried by the pendulum of the Shelton clock was so adjusted as to have its inner edges tangential to the disc, when at rest. (The disc is of white card two inches in diameter and turned to a true circle in the lathe). The image of the disc formed at the tail piece by the collimating lens was made of the same width as the tail piece, and the arc of vibration at the commencement was made a little less than the arc of the clock. The Disappearance *D*, and the Reappearance *R*, of the apparent right edge of the disc (actually the eastern edge) was invariably observed. The times of the first four swings were observed by the Seth Thomas, a sidereal clock kept in the room for the purposes of the Observatory, which, being near and almost in front of the observer, could be seen better than the Shelton, and had the advantage of being directly compared with the transit clock on the tape chronograph; but this method introduced confusion, and was abandoned. For all the remaining swings, the times of *D* and *R* were observed by the Shelton; the *D* taking place between an even and odd second, and *R* between an odd and even second. If the size of the segment of the disc, when last seen before *D*, was larger than the segment when first seen after *R*, one second was added to the even second of time immediately preceding *D*, and if the opposite occurred, one second was subtracted from the odd second of time immediately following *R*. This refinement was not necessary; but as the method required only a very little more attention it was followed throughout.

Temperature.

The temperature of the pendulum was frequently observed during each swing, and was shown by the two thermometers Fahr. Nos. 667 and 668, placed on the dummy pendulum inside the cylinder. The adopted correction to the mean reading of the two, was $-0{\cdot}^\circ 13$.

During the first few swings the gas was allowed to burn in the room; but this brought about irregular changes of temperature, and caused the upper thermometer to read higher than the lower, often by as much as 0·4 degrees. The gaslight was accordingly discarded. For the rest of the time, till the conclusion of the observations, the temperature in the room did not vary by as much as one degree Fahr., and the two thermometers read always nearly alike.

Two Richard's thermographs, No. 1577 and No. 3131, were placed close to the cylinder, giving a continuous record of the temperature. During the first twelve swings the changes were so irregular and large, amounting sometimes to 3° or 4° Fahr., that curves had to be formed and intergrated in order to obtain a satisfactory mean; but for the remaining swings, the mean of the observed temperatures at commencement and at the end of the swing, as shown by the two thermometers on the dummy with the correction $-0{\cdot}13$ applied, was adopted as representing with sufficient accuracy the mean temperature of the pendulum.

Pressure of Air.

The pendulums were swung at the ordinary atmospheric pressure, which was shown by the barometer Neuman, No. 122, having a correction of—0·022. The extreme range from June to the middle of September was from 29·4 to 30·4 inches. Pressure and temperature readings were always taken, at intervals of about one hour generally; sometimes more frequently.

Arc of Vibration.

This was read on the arc scale in inches. In the earlier part of the operations, the arc was read frequently, and several intermediate coincidences were observed during a swing; but later, the arc was read only twice at commencement, being generally about 0·65 inches, and twice at the end of the swing, being then reduced to about 0·08 inches.

Levelling.

The planes of suspension were carefully levelled before the pendulum was suspended, and again when the pendulum was taken out of the cylinder. No other intermediate observations of level were made; but the scale at right angles to the arc scale was read for each swing. It was found that for pendulum No. 4 and No. 6 the reading of this scale was about 0·5, and remained fairly constant in both positions of the marked face; but the readings for pendulum No. 11, were about 0·9, for face "P" and 1·2 inches for face "M". According to the level, the planes of the three pendulums generally remained in good adjustment, during each respective series of swings. Mr. Ellery invariably placed the pendulums in and out, and changed the position of the marked face when required.

The Swings.

Each pendulum was swung an equal number of times with its marked face towards the observer, and towards the clock, the first position being designated by face "M," and the second by face "P." Twelve sets were observed for each pendulum; six in each position. The results for Pendulum No. 11 came out more discordantly than those of the other two pendulums. It was feared that the ends of the knife edge sometimes touched one or other of the guiding faces close to the grooves which receive the knife edge when the pendulum is lifted off the planes. These pieces were taken off by Mr. Ellery on 6th September, and another series of twelve swings, six in each position, were observed under the new condition. This makes in all sixty swings of an average duration of five hours each. The general practice was to commence a swing at about 9.30 a.m., conclude it at about 3 p.m., commence another at 4 p.m., concluding at 9.30 p.m. Generally five coincidences were observed at the beginning and end of each swing. The pendulum was always started about half-an-hour before the first coincidence was observed.

Clock Rates.

Until the 12th August the Shelton Clock was compared with the Seth Thomas by eye and ear, the fraction of the second being determined by coincidences of beat, with a Mean Time Chronometer. The rates of the Seth Thomas were derived by chronographic comparison with the Standard Transit Clock, the error of which was determined by transit observations. After the 12th August, Mr. Ellery mounted an electric contact spring on the Shelton Clock, by which a signal was made at every sixtieth second, on the Tape Chronograph, on which the beats of the Transit Clock were simultaneously recorded, thus enabling a comparison of the two clocks to be made with all the accuracy obtainable. The uncertainty introduced by one of the weakest points in pendulum observations was, by this method of comparison, greatly reduced. A comparison was made at the commencement and end of each swing; but when two sets of swings were observed on the same day in succession, extending from 9 a.m. to 10 p.m., the rate of the Shelton Clock was derived from the two extreme comparisons in the morning and evening only, neglecting the two intermediate ones. In this way it was thought, although the rates for the two swings might be different, the resulting mean of the two vibration numbers would be improved. The Shelton Clock gave a good account of itself.

From 23rd June to 18th July it had a losing rate, gradually increasing from $1^s \cdot 9$ to $3^s \cdot 0$. It was then stopped to form the connection above mentioned, when the pendulum was slightly shortened. From 14th August to 14th September its meam gaining rate was $2^s \cdot 5$ per day, the greatest variation from mean being about $0^s \cdot 5$.

Reduction of the Observations.

The instructions contained in General Walker's *Memoranda on Pendulum Observations for the Melbourne Observatory* were followed throughout, excepting some slight variation in form, and in the co-efficient in the formulæ for the arc correction. The notation and formulæ used are as follows, viz:—If n is the number of observable coincidences during an interval I, and N the interval between two consecutive coincidences, then $I = (n-1) \cdot N$

I is obtained by subtracting the first three, four, or five from the last corresponding three, four, or five observed coincidences and taking the mean of the differences. N being approximately known from observations of two consecutive coincidences n is at once derived, with which the mean value of N is computed.

R = number of sidereal seconds in a mean solar day plus the daily rate of the clock Shelton.

V_1 = uncorrected number of vibrations made by the free pendulum in a mean solar day, then $V_1 = R - \frac{2R}{N}$

The vibration numbers V_1 resulting from each swing, were all firstly reduced to the mean temperature 62° Fahr., to 26 inches pressure at 32° Fahr., and to infinitely small arc, by the following formulæ, viz.:—

$$\text{Pressure correction} = 0{\cdot}34 . \frac{B-26}{1+0{\cdot}0023\,(T-32)} = \beta$$

$$\text{Arc correction} = V . \left(\frac{D-d}{16rD}\right)^2 . \left\{ (a+b)^2 - \tfrac{1}{3}(a-b)^2 \right\} = a$$

$$\text{Temperature correction} = 0{\cdot}45(T-62^\circ) = \tau$$

In which,

$B =$ Observed reading of Barometer $- 0{\cdot}022$ and reduced to 32° Fahr.

$T =$ Mean Temperature of the Pendulum during the swing.

a and b.—The observed Arc of Vibration in inches at the commencement, and at the end.

D, d, and r.—The distances of the Arc Scale from the observing telescope, tail piece and knife edge respectively. It was adopted for the three pendulums. $V. \left(\frac{D-d}{16r.D}\right)^2 = 0{\cdot}13$

Hence,

$$\text{Arc correction} = 0{\cdot}13\left((a+b)^2 - \tfrac{1}{3}(a-b)^2\right)$$

And if $V =$ number of vibrations in a mean solar day reduced to 62° Fahr., 26 inches pressure and infinitely small arc, we have $V = R - \frac{2R}{N} + \alpha + \beta + \tau$. This is the formula used in the reductions.

The general results are given in the following tables: Note—A full account of these operations will appear in the publications of the Melbourne Observatory.

MELBOURNE OBSERVATORY.—Collected results of Pendulum Swings (June—September, 1893). Being the number of Vibrations made by each Pendulum in a Mean Solar Day. Reduced to Mean Temperature 62° Fahr., 26 inches Pressure at 32° Fahr., and infinitely small arc. Height above sea-level, 86·5 feet.

TABLE I.

PENDULUM No. 4.

Face M: No. of Swing.	Face M: Date.	Face M: No. of Vibrations.	Face P: No. of Swing.	Face P: Date.	Face P: No. of Vibrations.			
9	July - - 15	86099·39	11	July - - 17	86099·24	Face M	...	86099·45
10	,, - - 17	86099·41	12	,, - - 18	86099·22	Face P	...	86099·09
15	August - 16	86099·55	13	August - 14	86099·07	Mean	...	86099·27
16	,, - 17	86099·44	14	,, - 15	86099·26			
17	,, - 17	86099·47	20	,, - 19	86098·96			
18	,, - 18	86099·31	21	,, - 20	86099·01			
19	,, - 18	86099·48	22	,, - 21	86098·92			
24	,, - 22	86099·54	23	,, - 21	86099·05			

PENDULUM No. 6.

Face M: No. of Swing.	Face M: Date.	Face M: No. of Vibrations.	Face P: No. of Swing.	Face P: Date.	Face P: No. of Vibrations.			
5	July - - 7	85999·25	7	July - - 9	85999·35	Face M	...	85999·43
6	,, - - 8	85999·63	8	,, - - 10	85999·27	Face P	...	85999·43
25	August - 25	85999·45	31	August - 28	85999·38	Mean	...	85999·43
26	,, - 26	85999·31	32	,, - 29	85999·25			
27	,, - 26	85999·45	33	,, - 29	85999·30			
28	,, - 27	85999·59	34	,, - 30	85999·68			
29	,, - 27	85999·48	35	,, - 30	85999·70			
30	,, - 28	85999·29	36	,, - 31	85999·46			

PENDULUM No. 11.

FACE M.			FACE P.		
No. of Swing.	Date.	No. of Vibrations.	No. of Swing.	Date.	No. of Vibrations.
3	June - - 25	86050·98	1	June - - 23	86050·10
4	,, - - 26	86050·36	2	,, - - 24	86050·56
37	August - 31	86051·40	43	September 3	86050·07
38	September 1	86051·30	44	,, 4	86050·30
39	,, 1	86051·49	45	,, 4	86050·73
40	,, 2	86050·93	46	,, 5	86050·99
41	,, 2	86051·08	47	,, 5	86051·10
42	,, 3	86051·10	48	,, 6	86051·07
55	September 10	86051·13	49	September 6	86051·55
56	,, 11	86051·08	50	,, 7	86051·74
57	,, 11	86051·22	51	,, 7	86051·62
58	,, 12	86050·97	52	,, 8	86051·48
59	,, 12	86050·97	53	,, 9	86051·55
60	,, 13	86051·08	54	,, 10	86051·74

Face M	..	86051·08
Face P	...	86051·04
Mean	...	86051·06

In order to make the vibration numbers just given comparable with the Greenwich and Kew results, they must be reduced to vacuum and sea-level. For the reduction to vacuum, using the same formula as before, we have :

$$\text{Correction} = 0{\cdot}34 . \frac{26}{1 + 0{\cdot}0023 \times 30} = 8{\cdot}269$$

and treating the correction for height of station, in the same way, as General Walker did for Kew and Greenwich (see *Phil. Trans.*, v. 1890, A., page 557), viz.—Correction $= \frac{h}{243}$ in which the height h may be put as 86·5 feet, we have

$$\text{Correction to sea-level} = \frac{86{\cdot}5}{243} = 0{\cdot}355$$

$$\text{Total correction} = +8{\cdot}62$$

The following table shows the concluded vibration number for each pendulum at the Melbourne Observatory.

TABLE II.

No. of Pendulum.	Number of Vibrations in a Mean Solar Day, reduced to the Mean Temperature 62° Fahr., infinitely small Arc, and		
	To Pressure of Air 26 inches at 32° Fahr.	To a Vacuum.	To a Vacuum and Sea-level.
4	86099·27	86107·54	86107·89
6	85999·43	86007·70	86008·05
11	86051·06	86059·33	86059·68

COMPARISON OF THE VIBRATION NUMBERS OF THE THREE INVARIABLE PENDULUMS AT GREENWICH, KEW, SYDNEY AND MELBOURNE.

As no swings under low pressure have been observed at Melbourne, only the results of swings under high pressure observed at Greenwich and Kew are taken into account in this comparison.

The following numbers are taken from General Walker's paper in the *Phil. Trans.*, vol. 1890 A., page 551, 553 and 558.

TABLE III.

Number of Pendulum.	Number of Vibrations in a Mean Solar Day reduced to Mean Temperature 62° Fahr., infinitely small Arc and to a Vacuum.		Number of Vibrations in a Mean Solar Day reduced to Mean Temperature 62° Fahr., infinitely small Arc and to the Density of Air under the Pressure of 26 inches at 32° Fahr.
	Greenwich Results, 1889, by Mr. Hollis.	Kew Results, 1888, by Mr. Constable.	Sydney Results, 1883, by Mr. Edwin Smith.
4	86164·04	86165·27	86090·93
6	86063·94	86065·80	85990·32
11	86115·68	86116·04	86042·08

General Walker states in his paper above cited that the Greenwich and Kew swings were reduced to a vacuum by using the Kew formula,

$$\text{Correction} = 0{\cdot}32\frac{\beta}{1 + {\cdot}0023(\tau - 32)}$$

Hence in order to make them comparable with the Melbourne swings, they must be increased by the quantity

$$\left(0{\cdot}34 - 0{\cdot}32\right).\ \frac{27}{1 + {\cdot}0023 \times 30} = +0{\cdot}505.$$

They must also be reduced to sea-level by applying the corrections $\frac{157}{243} = +0{\cdot}646$ for Greenwich and $\frac{15}{243} = +0{\cdot}061$ for Kew.

For Sydney the reduction to sea-level is $\frac{140}{243} = +0{\cdot}576$

$$\text{Reduction to a vacuum } 0.34.\frac{26}{1 + 0{\cdot}0023 \times 30} = +8{\cdot}269$$

The whole correction to be applied to the numbers in Table III. is therefore :

To Greenwich numbers		+ 1·15
,, Kew	,,	+ 0·57
,, Sydney	,,	+ 8.85

TABLE IV.

Number of Pendulum.	Number of Vibrations made in a Mean Solar Day, reduced to a Vacuum, to Temperature 62° Fahr., to infinitely small Arc and to Sea-level.				Differences.				
	Greenwich.	Kew.	Sydney.	Melbourne.	G-M.	K-M.	M-S.	K-G.	K-S.
4	86165·19	86165·84	86099·78	86107·89	+ 57·30	+ 57·95	+ 8·11	+ 0·65	+ 66·06
6	86065·09	86066·37	85999·17	86008·05	+ 57·04	+ 58·32	+ 8·88	+ 1·28	+ 67·20
11	86116·83	86116·61	86050·93	86059·68	+ 57·15	+ 56·93	+ 8·75	− 0·22	+ 65·68
Mean Differences - - - -					+ 57·16	+ 57·73	+ 8·58	+ 0·57	+ 66·31

This table (No. IV.) embodies the conclusion of the differential results. It will be seen that by diminishing the vibration number of Pendulum No. 6, and by increasing the vibration number of Pendulum No. 11 by (say) 0·5 vibrations in the column for Kew, the columns containing the differences would be brought into much closer adjustment. If comparisons of several clocks are involved in the operations, errors of 0·5 vibrations could be very easily introduced.

For the conversion of the differential results into absolute measure of the force of Gravity for Melbourne, we have now the Greenwich, Kew, and Vienna bases, and Professor Neumayer's independent value of g.

The absolute length of the seconds pendulum at Greenwich, was determined by General Sabine in 1830, by the convertible pendulum originally designed and employed by Captain Kater in 1817, and found to be 39·13734 inches. (See *Phil. Trans.*, 1831, Art. xxv).

In 1873 Major Heaviside determined the length of the pendulum vibrating seconds at Kew, using the same pendulum as that used by General Sabine at Greenwich; its length was remeasured by Colonel Clarke. As the result of these observations, the length of the seconds pendulum at Kew was determined to be 39·14008 inches, and this result was corroborated by the operations with the two reversible Russian pendulums at Kew, but these pendulums do not seem to have given satisfactory results elsewhere (as shown in the volume v. of *The Great Trigonometrical Survey of India).*

Professor Neumayer determined the value of g at Melbourne in 1863, by a reversible pendulum constructed by Mr. Lohmeir of Hamburg, under the supervision of Professor Peters of the Altona Observatory. Of these operations no detailed account seems to be available, and it would be desirable to know something more about them, so as to form a judgment as to the weight to be given to the result, before comparing it with the others.

Lieutenant Elblein gave to Mr. Ellery the following provisional results of his $\frac{1}{2}$ seconds invariable pendulum observations at Melbourne and Sydney:

Period of one vibration, reduced to 0° centigrade, to infinitely small arc, and to a vacuum, being the mean of three $\frac{1}{2}$ seconds pendulums

At Melbourne (86·5 feet above sea-level) $0^{s}\cdot5066120$
At Sydney (140 feet above sea-level) $0^{s}\cdot5063920$

and taking for the value of g at Vienna $g=9·80866$ meters as found by Professor Oppolzer by a reversible pendulum in the year 1886, he derived the following values, not reduced to sea-level.

Melbourne $g=9·80014$ meters
Sydney $g=9·79702$ meters

And reduced to sea-level,

Melbourne $g=9·80020$ meters
Sydney $g=9·79713$ meters

According to these values, the Indian pendulums should make 13·48 vibrations less at Sydney than the number of vibrations they make at Melbourne in a mean solar day. Therefore the difference 8·58 given in Table IV. is too small by nearly 5 vibrations, according to Lieutenant Elblein's provisional results.

This fact casts a doubt either on some of the observations or on the invariability of the pendulums, as the discordance is quite independent of the absolute values chosen as bases, and small differences in the formulæ used for computing the various corrections could not account for such a large error. It is therefore all the more urgent to swing the Pendulums at Sydney at the very first opportunity.

The several values of g for Melbourne derived from the above sources are as follows, viz.:—

By the Greenwich and Melbourne swings, and the length of the seconds pendulum as 39·13734 inches at the former place	$g=32·14645$ feet $g=9·79815$ meters
By the Kew and Melbourne swings, and the length of the seconds pendulum as 39·14008 at the former place	$g=32·14827$ feet $g=9·79870$ meters
Provisional value of Lieutenant Elblein	$g=32·15317$ feet $=9·80020$ meters

Professor Neumayer's absolute determination $\left.\begin{matrix} \\ \end{matrix}\right\}$ $g = 32{\cdot}15127$ feet
$= 9{\cdot}799607$ meters

There is no urgent need for adopting at once a final value for g—at least not until the pendulums are swung again in England on their return.

The mean of the 4 values is 32·14979 feet or 9·79916 meters, which may be provisionally adopted.

Art. XIV.—*Notes on some new or little-known Land Planarians from Tasmania and South Australia.*

(With Plate X.)

By Arthur Dendy, D.Sc.

[Read 16th November, 1893.]

I.—Tasmanian Land Planarians.

Geoplana tasmaniana, Darwin, sp.

Planaria tasmaniana, Darwin, Annals and Magazine of Natural History, vol. xiv. (1844), p. 246.

I have recived a large number of specimens from various parts of Tasmania which I believe to be referable to Darwin's species. The following description is taken from a living specimen collected by Mr. L. J. Balfour on Mount Wellington, in March, 1892 :—Body in life a good deal flattened, especially on the ventral surface, but with no well-marked lateral surfaces, the sides being rounded ; tapering very gradually in front, somewhat less so behind. When crawling, about 43 mm. long and 2·5 mm. broad. Ground colour of dorsal surface pale brownish-yellow, with five stripes of umber-brown. The median stripe narrow, dark and well-defined. The inner paired stripe broad and dark, but rather ill-defined, separated by an interval of ground colour about as broad as itself from the median stripe. The outer paired stripe at the extreme margin of the dorsal surface, narrow, rather faint and ill-defined, separated from the inner paired stripe by a band of ground colour about equal to the latter in width. Ventral surface white, with no markings. Anterior tip dark-brown. Eyes arranged as usual and continued all round the horse-shoe-shaped anterior extremity ; also continued down the sides of the body, sparsely, to the posterior end. After preservation in spirit the dorsal surface became more flattened, and its margins turned in to form more or less distinct but narrow lateral surfaces, carrying the ill-defined outer paired stripes. The peripharyngeal aperture (in spirit) is somewhat behind the middle and the genital aperture nearer to it than to the posterior end.

The copulatory organ may (in spirit) be protruded from the genital aperture in the form of a bladder-like vesicle, covered with numerous very minute, granule-like papillæ.

A good deal of variation occurs in the intensity of the colouration, and the consequent distinctness or otherwise of the stripes. The median stripe appears always to be the darkest and best defined.

There is a dwarf variety from the north coast of Tasmania, of which I received about twenty specimens collected by Mr. G. W. Officer, in February, 1892, and which differs from the types only in its very much smaller size.

At first sight this species looks a little like the common Australian *G. quinquelineata*, but it differs markedly in the shape of the body in spirit, the ill-defined character of the paired stripes, and the great breadth of the inner ones.

Localities. — Parattah (Professor Spencer; very common); Mount Wellington (L. J. Balfour, Esq.); near Newtown Falls (A. Morton, Esq.); North Coast (G. W. Officer, Esq.; dwarf variety only).

Geoplana diemenensis, n. sp.

This is a large and remarkably handsome species. The following description is taken from two specimens received alive from Mr. L. J. Balfour, who collected them on Mount Wellington in March, 1892:—

Body at rest quite flat on the dorsal surface; broad; with narrow, inwardly sloping lateral surfaces. When crawling almost the same shape in section but not quite so much flattened; tapering very gradually in front and behind; unusually sharp-pointed behind. Length when crawling about 70 mm.; breath about 6 mm. Eyes as usual in *Geoplana*, continued all round the horse-shoe-shaped anterior margin. Ground colour of the dorsal surface sepia-brown, with indications of three darker longitudinal stripes, all ill-defined. (In specimens subsequently received in spirit from Mr. Morton these stripes are better marked; there is one narrow median stripe and a pair of much broader ones close to the margins of the dorsal surface). The dorsal surface is sprinkled all over, stripes and all, with small whitish specks; while under a low power of the microscope much smaller greenish specks, probably groups of rod-cells, are also seen to be present. Anterior extremity dark sepia. Lateral surfaces mottled in about equal proportions of white and sepia. Ventral surface entirely white.

In spirit the peripharyngeal aperture is situated a little in front of the middle of the body and the genital aperture a little nearer to it than to the posterior end. The copulatory organs are extraordinarily large and complicated, and may (in spirit) be protruded from the genital aperture in the form of a pair of fleshy, somewhat comb-like processes, each bearing numerous conspicuous conical papillæ.

A slight variety of the species, obtained in quantity by Professor Spencer at Parattah, differs somewhat in markings from the typical form. An additional dark, ill-defined, paired stripe is present on each side of the median dorsal stripe, half way between it and the marginal stripe; and the speckled character of the dorsal surface is much less pronounced. Specimens of this variety (which I have seen only in spirit) approach *G. tasmaniana* in general appearance, but differ in the greater breadth of the body and, apparently, in the structure of the copulatory organs, which resembles that described in the type.

Professor Spencer also informs me that he found the species abundantly near Emu Bay, in January, 1892; that it sometimes attained a larger size than those described above, and that it varied considerably in colour. Unfortunately, the specimens collected by him in this locality all died.

It appears not unlikely that this species, in spite of its very much larger size, may be nearly related to our Victorian *G. quadrangulata*. So I judge from the characteristic shape of the body and the fundamental pattern. The point cannot, however, be determined without anatomical investigation, especially of the copulatory organs.

Localities.—Mount Wellington (L. J. Balfour, Esq.); near Newtown Falls (A. Morton, Esq.); North Coast (G. W. Officer, Esq.); Emu Bay (recorded by Professor Spencer); Parattah (Professor Spencer).

Geoplana lucasi, Dendy.

Geoplana lucasi, Dendy, Trans. Royal Soc. Vic., 1890, p. 74; 1891, p. 40, pl. iv., fig. 4.

With this rare Victorian species I identify, provisionally at any rate, three specimens received in spirit from Mr. Alexander Morton and Professor Spencer. They agree with the Victorian form in the characteristic broad, flattened body, much broader behind than in front; in the arrangement of the dark streaky markings on the dorsal surface; in the absence of markings on the ventral surface, and in the position of the external apertures (the peripharyngeal somewhat behind the middle of the body and the genital about half-way between it and the posterior end). The ground colour is yellow and the streaks or splotches dark-brown or purplish in spirit. In only one specimen, the smallest of the three, is the dark median dorsal line present, and even here not very strongly developed. The largest of the three specimens (in spirit) measures 27 mm. in length by 6·5 mm. in greatest breadth.

Localities.—Tasmania (A. Morton, Esq.); Lake St. Clair (Professor Spencer).

Geoplana mortoni, n. sp.

The following description is taken from five spirit specimens, which are so well preserved and well characterised that I have no hesitation in naming them, although I have not myself seen the animal alive. Four at any rate of the specimens reached me very soon after capture and have evidently undergone but little change in colour.*

Length (in spirit) about 40 mm., greatest breadth 5 mm. Broader, and much less gradually tapering, behind than in front. Dorsal surface strongly convex; ventral surface concave, with prominent, narrow margins. Dorsal surface yellow, closely mottled all over with small, irregular specks of brown. (The mottling, or marbling, is a good deal coarser in some specimens than in others). Ventral surface similar but paler, with the brown colour less developed and in smaller specks. A very narrow band of yellow, without any brown specks, occupies the prominent margins. The peripharyngeal aperture is situated in about the middle of the body, and the genital aperture usually

* Professor Spencer tells me that in life the colour is warmish yellow with warm umber splotches.

somewhat nearer to it than to the posterior end. The eyes, though not very numerous, are arranged as usual in *Geoplana.*

In the characteristic shape of the body this species closely resembles the Australian *G. fletcheri*, some of the varieties of which are also strongly speckled on the dorsal surface. It differs from *G. fletcheri* in the speckling of the ventral surface, the absence of continuous dark stripes, and the more anterior position of the apertures.

I have much pleasure in dedicating the species to Mr. Alexander Morton, of the Hobart Museum, from whom I first received it.

Localities.—Tasmania (Alexander Morton, Esq.); Parattah (Professor Spencer).

Geoplana munda, Fletcher and Hamilton.

Geoplana munda, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 369, pl. v., fig. 8.

Geoplana munda, Dendy, Trans. Royal Soc. Vic., 1890, p. 73; 1891, p. 36.

Geoplana munda, Spencer, Proc. Royal Soc. Vic., 1890, p. 89, pl. xii., fig. 10.

In February, 1893, Professor Spencer collected a large number of this common Australian species at Parattah, thus extending its known range to Tasmania for the first time. The specimens, which he kindly handed to me in spirit, agree exactly with those commonly met with in Victoria.

Locality.—Parattah (Professor Spencer).

Geoplana adæ, Dendy, var. *fusca*, nov.

The following description is taken from a coloured sketch of the living animal (with measurements) drawn by Professor Spencer, and from three spirit specimens collected by him at the south end of Lake St. Clair, in January, 1893:—Body (when crawling) tapering gradually in front and behind; length 69 mm., greatest breadth 3 mm. The dorsal surface has a ground colour of purplish-grey, darkening in the middle line and at the margins, so as to form a narrow median, and a pair of much broader marginal stripes; none of the stripes well defined, however. The ventral surface is cream-coloured, with no markings, and is continued up round the sides of the body to form a border on either side of the dorsal surface, very sharply marked off from the dark-coloured portion. Hence, when the animal is viewed from the upper surface we see a broad median band of a dark colour bordered on either side by a narrow margin of pale cream colour, while in the dark band itself we can recognise three longitudinal stripes of darker colour than the rest.

In spirit the animal measures about 18 mm. in length, by 5 mm. in greatest breadth. The body is ovoid in section, somewhat flattened, especially on the ventral surface, but thick and with broadly rounded margins. Exactly the same colouration is visible as in the living specimen, except that the dorsal surface appears to be darker. The light margins are still conspicuous from the dorsal surface. The peripharyngeal aperture is slightly behind the middle and the genital aperture slightly nearer to it than to the posterior end. The eyes are very abundant, arranged as usual and continued down the light-coloured sides of the body to the posterior end.

This variety differs from the ordinary Victorian form chiefly in the absence of the narrow and sharply defined band of pale-yellow colour on each side of the dark median dorsal line. It appears to be a fairly well marked variety.

Locality.—Lake St. Clair (Professor Spencer).

Geoplana variegata, Fletcher and Hamilton.

Geoplana variegata, Fletcher and Hamilton, Proc. Linn. Soc., N.S.W., ser. ii., vol. 2, p. 364, pl. v., figs. 3, 3[1].

Geoplana variegata, Dendy, Proc. Royal Soc. Vic., 1891, p. 124, pl. ii., fig. 2.

A single specimen of this common New South Wales and Queensland species was obtained by Professor Spencer at Bedlam Heights, in January 1893, and, together with coloured drawings of the living animal, placed by him in my hands. I have no hesitation in making the identification, although, curiously enough, the species has not yet been found in the intervening colony of Victoria. The general shape of the body (in spirit), the position of the external apertures, and, above all, the very characteristic arrangement of the coloured stripes, are identical. The general ground tint of the body in life was brown or bluish-brown, and the three narrow stripes, usually of "pale-yellow or greenish-yellow," lying in and near the mid-dorsal line, were decidedly green. When crawling, the specimen measured 44mm. long by 3 mm. broad.

Locality.—Bedlam Heights (Professor Spencer).

Geoplana typhlops, n. sp.

Geoplana alba, Dendy, Proc. A.A.A.S., Hobart, 1892, p. 370. (Not *G. alba* of previous papers).

In my previous notes on Tasmanian Land Planarians *(loc. cit.)* I identified two specimens of this species with the common Victorian *G. alba*, which it closely resembles in size, shape and colour. I noted, however, that I could find no eyes, and suggested that I might have overlooked them in the spirit-preserved specimens. I have, however, since then received several additional specimens, none of which show any eyes. One of these specimens I carefully examined in the living condition and could detect no eyes either under a hand-lens or when the head was compressed and examined under the microscope. The other specimens were examined in spirit. The Victorian specimens of *G. alba*, on the other hand, and also specimens of the same species which I have obtained from New Zealand, show the eyes distinctly under the dissecting microscope, even after being kept in spirits for many months. It therefore appears desirable to give a fresh specific name to the Tasmanian specimens, although I still believe them to be closely related to the common and widely distributed *G. alba*.

The following description of the species is based upon a very fine specimen which reached me alive and was collected by Mr. L. J. Balfour at Mount Wellington (Tasmania), in March, 1892:—When alive of a pale brownish-yellow colour on the dorsal surface; still paler on the ventral; anterior tip white. No stripes at all. When crawling, about 115 mm. in length and 4 mm. broad. In shape and size exactly like a large specimen of *G. alba*, with the same characteristic crenate edges when at rest and slightly ridged dorsal surface. In spirit a distinct, translucent, median ventral band appears, as already noted in the original specimen (this is much more obvious in some specimens than in others). The peripharyngeal aperture (in spirit) is decidedly behind the middle of the body, and the genital aperture much nearer to it than to the posterior end. The pharynx is funnel-shaped. The eyes appear to be be entirely absent.

Diesing's *Geobia subterranea*, from Brazil, is described by Moseley* as "Long and narrow, with rounded extremities, eye-less, and colourless. Lives underground in the holes of *Lumbricus corethrurus*, and preys upon that annelid." I have Mr. Alexander Morton's authority for stating that *Geoplana typhlops* is also sometimes found underground, but I believe that this is true of many Land Planarians. Whether the genus *Geobia* can be maintained appears to me very doubtful.

Localities.—Mount Wellington (Mrs. Dendy and L. J. Balfour, Esq.); Hobart (A. Morton, Esq.); Parattah (Professor Spencer, six specimens).

II.—South Australian Land Planarians.

Geoplana quinquelineata, Fletcher and Hamilton.

Geoplana quinquelineata, Fletcher and Hamilton, Proc. Linn. Soc. N.S.W., ser. ii., vol. 2, p. 366, pl. v., figs. 4, 5, 15, 16.

The known range of this common New South Wales and Victorian species is now for the first time extended to South Australia by the researches of Mr. Thos. Steel, from whom I received two small specimens in spirit in May, 1892.

Locality.—Extreme summit of Mount Lofty (Thos. Steel, Esq., 3rd May, 1892).

Geoplana fletcheri, and var. *adelaidensis*, Dendy.

(Plate X.).

Geoplana fletcheri, Dendy, Trans. Royal Soc., Vic., 1890, p. 78, pl. vii., figs. 8, 9; 1891, p. 38, pl. iv., fig. 6. Proc. A.A.A.S., Hobart, 1892, p. 372.

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* Quarterly Journal of Microscopical Science, vol. xvii. (N.S.), p. 289.

Geoplana fletcheri, var. *adelaidensis*, Dendy, Proc. A.A.A.S., Hobart, 1892, p. 373.

I am again indebted to Mr. Thos. Steel for no less than thirty-nine living specimens of this species, collected by him behind Mount Lofty on 3rd May, 1892. These specimens are extremely interesting, as exhibiting an unusual degree of variation in markings, as shown in the figures A to E (plate X.), and thereby connecting the typical *G. fletcheri* by almost insensible degrees with the, at first sight, very distinct variety which I have previously termed *adelaidensis*, and which I at first took to be a distinct species.

To judge from the large number of specimens met with in a very restricted area the species would appear to have its home in the Mount Lofty district, while in Victoria it is decidedly rare. It is interesting to note that no other species were found in association with it. The large number of specimens obtained by Mr. Steel is partly to be accounted for by the fact that the locality is a depôt for firewood brought from the immediately surrounding forest.

The general form of the specimens, including the strongly concave ventral surface, the markedly posterior position of the external apertures and the toughness of the skin, agree with the corresponding characters in the typical forms of *G. fletcheri* already described.

In all the specimens the ventral surface is of a pale yellow colour, without markings. The eyes are arranged in a not very densely crowded patch at each side of the head, in close-set single series round the horseshoe-shaped anterior extremity, and more or less sparingly all down the sides of the body to the hinder end.

Sometimes when at rest the body is supported on the edges of the ventral surface, leaving a hollow tunnel beneath the middle; this may be very conspicuous when the animal is resting on a sheet of glass and is viewed from beneath.

The variations in pattern, although very conspicuous, are all clearly due to the intensification or suppression of parts of what may be regarded as the typical pattern of the species; and, so far as I know, this statement holds good of all Land Planarians.

The ground colour of the dorsal surface varies from rich canary-yellow to very pale yellow. The markings (of various shades of brown) on this ground colour vary from those of the variety *adelaidensis* (fig. A), through insensible gradations, to a form (D), which is almost entirely devoid of markings, but has just a faint rudiment of a median stripe, discontinuous, in the anterior half of the body, with still fainter rudiments of paired stripes at the extreme anterior end only, and faint traces of pale brownish specks at the posterior end visible under a pocket lens. This form (D) scarcely differs from the types of *G. fletcheri* first described from Victoria *(loc. cit.)*

The two other most conspicuous varieties are the ones labelled C and E in the drawings. In C there is a distinct but narrow, dark median stripe all down the body; the paired stripes, however, are present only at the extreme anterior tip, and there are only a few brown specks, very inconspicuous, in the ground colour at the posterior end.

In E, on the other hand, the median stripe is very thin and discontinuous, almost obsolete, while the paired stripes are strong and continuous all down the body, though evidently made up each of a number of specks run together, and stronger in front than behind. There are no distinct specks in the ground colour outside the stripes.

The variety represented in the drawing marked B is intermediate between A and C, all the markings of A (= var. *adelaidensis*) being present but, with the exception of the median stripe, fainter. In this variety *adelaidensis* (A and B) the dark-brown specks are sometimes very abundant at the outer margins of the body, indicating a tendency towards the formation of a second, outer paired stripe (compare *G. howitti**) especially marked at the anterior end.

Perhaps in all cases there are more or less distinct traces of five dark stripes, one median and four paired, running back from the dark pinkish-brown anterior tip. (Possibly *G. howitti* may ultimately have to be regarded merely as another variety of *G. fletcheri*, with its sub-variety *obsoleta*.)†

During the period for which I kept the above-described specimens of *G. fletcheri* and its varieties alive (3rd to 11th May),

* Trans. Royal Soc. Victoria, 1891, p. 39, pl. iv., fig. 5.

† Proc. Royal Soc. Victoria, 1891, p. 37.

seven cocoons were laid by them. These varied somewhat in form, being nearly round, oval, or distinctly egg-shaped. The largest measured 4 by 3 mm., but two were much smaller. After being laid for a few days the cocoons had a dull, almost black colour. When freshly laid and while still within the body they had a rich chestnut-brown colour. Only one was observed inside the body, causing a swelling just behind the genital aperture.

About a month after the cocoons were laid the young began to hatch out. On 6th June I found two recently hatched young in the vivarium. They were only about 8 mm. long when crawling. Shape and movements of the body as in the adult. Eyes abundant in single series on the sides of the head, round the horseshoe-shaped anterior margin, and continued more sparingly to the posterior end. The ground colour of both surfaces was bright yellow, with distinct brownish-pink anterior tip. In both specimens specks of brown pigment were scattered over the dorsal surface. In one they were clearly arranged as in fig. E of the adult, with the addition of scattered specks outside the outer band of specks. The other specimen only showed traces of a similar arrangement.

On 9th June three more young were observed, one of which showed three distinct longitudinal lines of specks as before, while the other two showed only a very few, faint, scattered specks.

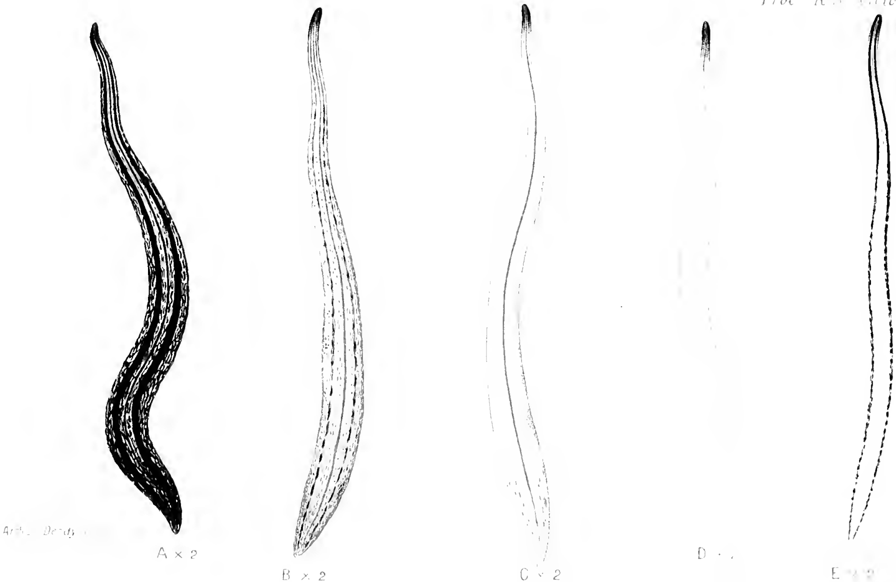
I have no observations as to the number of young developed in each cocoon, probably two or three, as in other species (*e.g.*, I have found three young in a cocoon of *G. alba).* After the escape of the young the split shell still contains a quantity of milky fluid and curls up.

Locality.—A deep gully just behind Mount Lofty (T. Steel, Esq.)

In conclusion, I desire to express my thanks to Professor Spencer and Messrs. Alexander Morton, G. W. Officer, L. J. Balfour and Thos. Steel for the specimens described in this paper.

DESCRIPTION OF PLATE X.

Five specimens of *Geoplana fletcheri*, selected from a collection of thirty-nine specimens and drawn from life to illustrate the variation in colour-markings. All the specimens are viewed from the dorsal surface, and represented of twice the natural size. (Fig. A represents the variety *adelaidensis*, which has the most strongly developed markings).



VARIATION IN GEOPLANA FLETCHERI.

Art. XV.—*The largest Australian Trilobite hitherto discovered.*

(With Plate XI.)

By R. Etheridge, Junr., Corr. Member.

[Read 14th December, 1893.]

Amongst a large suite of interesting fossil organic remains discovered by Mr. George Sweet, F.G.S., at Delatite, is what I take to be a large ill-preserved Trilobite pygidium, at any rate I can see no other feasible explanation of the specimen. It consists of a Crustacean plate on the surface of a piece of flaggy calcareous shale, compressed flat, and somewhat obliquely distorted. In its original condition, it must have been sub-semicircular, and rather acuminate posteriorly, six inches across the anterior, or pygidio-thoracic edge, and with the lateral angles rounded. The longitudinal (oblique) measurement is four and a half inches, but in the undistorted state this would probably represent about five inches. On the left hand side, when facing the observer, are five coalesced pleural segments, probably portion of a sixth, and possibly a seventh, the two last very faintly preserved. On the right hand side four only are visible, as the remainder are hidden by an intractable coating of matrix, which also obscures any trace of axial segmentation. If, therefore, my conception of this fossil be correct, it exhibits, as it should do, and allowing for the oblique distortion it has undergone, bilateral symmetry. It is unfortunate that the central portion is so completely hidden by matrix that cannot be removed, for on the axial features, the question of generic identity depends. The entire surface is minutely pitted; and the point that appears to represent the apical centre, or centre of the posterior margin, is apparently emarginate.*

The principal points which militate against the Trilobite nature of our fossil are: (1) the absence of any trace of axial

* Too much stress, however, cannot be laid upon this point, owing to the condition of the specimen.

segmentation, notwithstanding the adherent matrix; (2) the absence of any trace of a limb, or striated margin posteriorly or laterally; and (3) the presence of the apical emargination. There is, on the other hand, a definite thread-like margin round the sides and hinder portion, which at once dispels the idea that the plate might be a portion of some other organism; and I think that the lateral segmentation radiating outwards on both sides places its identity, so far as the generalised systematic position is concerned, beyond doubt, but a reference to some one of the known genera is a more difficult task. Perhaps the easiest method of arriving at a decision on this point will be by a process of elimination. The characters, so far as they can be deciphered, at once forbid the entrance of the fossil within the families of the Harpedidæ, Remopleuridæ, Olenidæ, Conocephalidæ, Calymenidæ, Æglinidæ, Cheiruridæ, Encrinuridæ, Didymenidæ, Acidaspidæ, Lichadidæ, Phacopidæ, Proetidæ, Trinuclidæ, and Agnostidæ, thus leaving the Asaphidæ, Bronteidæ, and Illænidæ to choose from.

In the Asaphidæ, *Asaphus* and *Ogygia* being the typical genera, the caudal shield is often of large size, and in some species of the former obscurely segmented, but in other *Asaphi* both the axis and pleural segments are well defined. In *Ogygia* the tail is wide transversely, with a wide striated limb. The axis extends to the margin of the latter, whilst the pleural segments are broad and flat. In *Barrandia* both axis and the divisions of the pleuræ are quite apparent, but in *Stygina* the axis is, in fact, of the two, the more prominent; the pleural segmentation is hardly to be noticed.

In the Illænidæ, having for the type genus *Illænus* itself, the caudal shield is large in proportion to the thorax, seldom, if ever, segmented—if the rudimentary axis be left out of consideration—certainly very rarely on the pleuræ, and always convex and prominent. One of the few examples of segmentation on the pygidium in *Illænus*, known to me, is that of *I. atavus*, Eichwald* and even in this instance it is very slight.

In the Bronteidæ the tail is usually of large size in comparison with the thorax, strongly sub-semicircular, or deeply fan-shaped;

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* Holm, Mém. Acad. Imp. Sci. St. Pétersbourg, 1886, xxiii., t. 7, f. 4a

the axis short and rudimentary; the coalesced pleural segments flat, broad, and typically seven to eight on either side, with a peculiar downward curve very characteristic of the genus. In many species the limb is also wide and well-marked.

Of the three families thus selected by elimination, the Illænidæ may, I think, be discarded, leaving only the Asaphidæ and Bronteidæ to choose from.

Now, however obliquely distorted Trilobite pygidia may be, take for instance the Asaphidæ of the Tremadoc Group, amongst Lower Silurian forms, the axis is invariably perceptible to a greater or less extent; and, had there been such an axis on Mr. Sweet's specimen, some trace of it would be visible, notwithstanding the adherent matrix, more particularly towards the apex. This, it seems to me, debars the entry of this fossil amongst the Asaphidæ; although, it must be admitted, excepting this character, and the absence of anterior lateral fulcral-facets, the present fossil has a general resemblance to some of the *Asaphi* proper, particularly such species as *Asaphus centralis*, Conrad.*

With regard to the Bronteidæ, and a comparison with this fossil, we are met at the outset with the same axial difficulty. The small lobiform axis is usually a prominent feature, and should have left some evidence of its presence, especially along the anterior margin, although the specimen has certainly been damaged here by blows from the hammer. There should likewise have been traces of the long terminal appendage as a continuation towards the apex of the pygidium, and the anterior fulcral-facets, but both are conspicuous by their absence. The only remaining feature on which to effect a comparison is that of the coalesced pleural segments, and these are certainly more Bronteiform than *Asaphus*-like. In *Asaphus* and *Ogygia*, the coalesced segments are sometimes grooved and at other times not, but the angle that each segment forms with the median axial line is an obtuse one, at any rate in the anterior portion, and the whole radiate, as it were, from the axis throughout its entire length. In *Bronteus*, on the other hand, the similar angle is acute, the segments, in consequence of their trend from the small axial lobe at the anterior end of the pygidium, have a much greater backward

* Whitfield, Bull. American Mus. Nat. Hist., 1889, ii., No. 2, t.12.

curvature than in the two genera named. Furthermore, the segments are entire, and without grooves, separated by intercostal spaces of greater or less width, and there are no well-marked anterior facets. On these grounds, therefore, I am led to regard the present fossil as more properly appertaining to the Bronteidæ, and possibly referable to *Bronteus* itself.

Indefinite and broad pleural segments are common to many species of *Bronteus*, becoming obsolete near the margin of the pygidium. The median appendage, however, connecting the apex of the abbreviated axis with the similar point on the posterior margin of the caudal shield is nearly always present, and generally bifurcate. No better example of such ill-defined pleuræ can be adduced than that of *B. senescens*, Clarke,* although very broad segments are also present in the typical *B. flabellifer*, Goldf.† Segments of similar width, and equally lacking in definition, may also be seen in *B. campanifer*, Barr;‡ indeed in some cases they become more like broad flat folds than segments, such as those of *B. Laphami*, Whitf.§ Another point which must be taken into consideration in attempting to decipher this fossil is the alteration in appearance caused by the successive peeling-off of layers of test, the segments becoming fainter and fainter as the process goes on. This may be seen in Barrande's figures of *B. palifer*, Beyr,‖ and *B. angusticeps*, Barr.¶

In regarding this pygidium as that of a *Bronteus*, there are two negative points that have to be considered. In the first place there is not the slightest trace of the projecting anterior end, or perhaps segment, of the axis, which is usually seen in this genus to protrude beyond the general fore-margin of the shield, although I have previously suggested an explanation of this. In the second place the hinder-margin seems to be emarginate, excentrically in the specimen's present state it is true, but in a position that would, in all probability, represent the middle line of the caudal shield, were it not for the distortion it has undergone. I know of no *Bronteus* with such

* Forty-second Report Trustees State Cab. Nat. Hist. New York for 1888 [1889], p. 403.

† De Koninck, Mém. Acad. R. Bruxelles, xiv., 1st pl., f. 1.

‡ Syst. Sil. Bohême, 1., Atlas t.44, f. 6 and 8.

§ Geol. Wisconsin, Survey 1873-79, iv., 1882, p. 310, t. 22, f. 3.

‖ Barrande, *loc. cit.*, t. 45, f. 11. ¶ *Loc. cit.*, t. 45, f. 27.

an apical break in the outline of its tail, although it is not unknown in the genus *Lichas*. These points certainly weigh against the reference of Mr. Sweet's fossil to *Bronteus*, but it is a matter for consideration, whether or no they are outweighed by those points that may be considered in favour of such a reference. The largest *Bronteus* of which I have any record is *B. Laphami*, Whitf,* with a tail measuring four inches broad, by four and a half long; and the next is *B. viator*, Barr., a tail of which, figured by Novák†, measures three and a quarter inches in length by three and a half in width. The largest described Australian *Bronteus* in *B. Jenkinsi*, E. and M.,‡ but even this, compared to the present form, is a mere pigmy.

From the point of size merely, this pygidium must represent a Trilobite well-fitted to hold its own amongst some of the largest known. For instance, taking for comparison our hitherto largest Australian *Bronteus*, *B. Jenkinsi*, we find that a pygidium possessing a length of one and a half inches represents an entire body of nearly three and a half inches. The length of our present specimen, allowing for distortion, is five inches, therefore, in the same degree of proportion, the full body would be as near as possible a foot long.

Turning to the existing record of large Trilobites we find that the *Paradoxides Tessini*, Linn.§, is twelve inches in length, the almost equally large *P. Forchammeri*, Angelin‖, is ten inches in length, whilst the immense *Asaphus (Megalaspis) heros*, Dalman¶, is fourteen inches long. Mr. F. Bayan estimates that the total length of *Lichas Heberti*, judging by the size of the cephalic shield, must have been, in round numbers, between two feet and two feet six inches long**. Many other instances might be cited, including the British *Paradoxides Davidis*, Salter††, which is thirteen inches in length; and the American *Dalmanites (Coronura) mymecophorus*, Green, figured by Hall and Clarke‡‡,

* Geol. Wisconsin Survey, 1873-79, 1882, iv., p. 310, t. 22, f. 3.

† Beiträge Pal. Ost.-Ungarns, Heft. 1 and 2, 1883, t.11, f.16.

‡ Proc. Linn. Soc. N.S. Wales, 1890, v. (2), p. 502, t. 18.

§ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 1

‖ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 2.

¶ Angelin and Lindström, Pal. Scandinavica, Pt. 1, 1878, t. 3.

** Bull. Soc. Géol. France.

†† Brit. Organic Remains, Dec. xi., 18 , t. 10.

‡‡ Pal. New York, 1888, vii., t. 15.

fourteen and a quarter inches in length. Those interested in the proportions of these gigantic Trilobites will find full data in an interesting paper recently published by Mr. J. M. Clarke,* enumerating many others than those here given, not the least interesting being the gigantic *Tretaspis grandis*, Hall†, which is believed to have attained two feet in length. Mr. Clarke remarks on this—"A size unsurpassed and unequalled by any other known Trilobite," but if Mr. Bayan's estimate of *Lichas Heberti*, Rouault, be correct, we have there a larger one.

In conclusion, believing as I do, that the fossil represents the pygidial remains of a large Trilobite related to, if not identical with the genus *Bronteus*, I suggest for it, with the view of future reference, the name of *Bronteus? enormis*, in relation to its size. With regard to its age it is certainly Lower Palæozoic, but I have not yet seen sufficient of the accompanying fossils to be in a position to express a more definite opinion.

DESCRIPTION OF PLATE XI.

Fig. 1. *Bronteus? enormis*, Eth. fil. Pygidium of the natural size, slightly obliquely distorted.

Fig. 2. Portion of the surface enlarged.

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* 44th Ann. Report New York State Mus. for 1890 [1892], p. 111.

† *Loc. cit.*, pl. opp. p. 114.

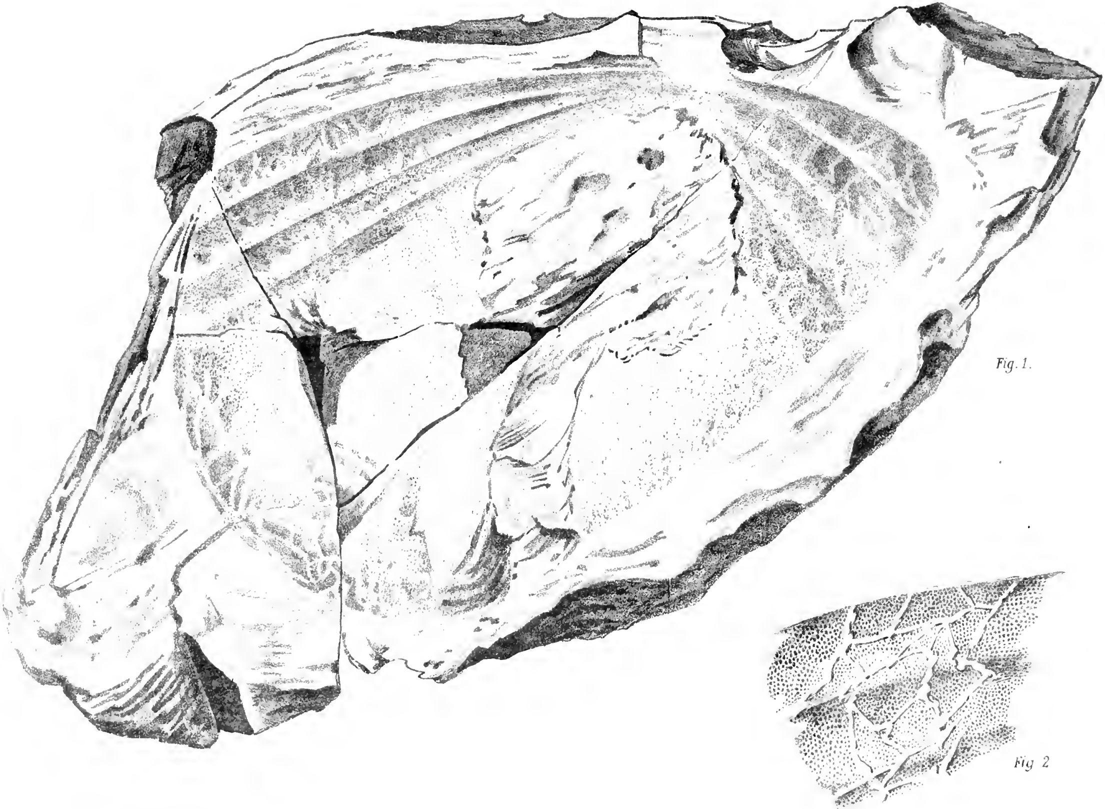

Fig. 1.

Fig 2

Art. XVI.—*Preliminary Survey of Eucalyptus-Oils of Victoria.*

By W. Percy Wilkinson.

[Communicated by C. R. Blackett, Esq., F.C.S., &c.,
14th December, 1893].

Only of recent years have the Eucalyptus-Oils, both in their purely chemical and commercial aspects, been receiving the attention they deserve, considering that large tracts of the continent of Australia are covered with forests of the Eucalypts, including more than 134 species (Baron F. von Mueller, 2nd *Systematic Census of Australian Plants*, Part I., 1889; *Eucalyptographia*, 1879-1884), many of which yield much volatile oil. Hitherto the oils have been investigated almost exclusively in Europe, where however only limited varieties of the oils have been accessible; so it seemed to me that, as a detailed examination of certain typical oils was being carried out by European chemists, the most advantageous work to begin on in Australia would be a general preliminary examination of the oils from as many distinct Eucalypts as possible. Accordingly eighty-seven samples were gathered (practically all in Victoria), some from the Botanic Garden Museum, some from the Pharmaceutical Society's Museum, and the rest directly from the distilleries, which during the last few years have increased greatly in number. It was an essential part of the inquiry to ascertain the botanical source of as many of the oils as possible, and in a number of cases it has been with great kindness determined by Baron F. von Mueller, our distinguished Government Botanist, on specimens submitted to him. For the purposes of a general preliminary examination it was desirable to select a few definite physical properties capable of exact measurement for defining and differentiating the oils, and the density, specific rotation, refractive index and specific refractive energy were chosen as most suitable; the boiling points of the oils were not taken, as their range is small, and because the boiling points of mixtures such as these oils is not a satisfactory physical constant. The only chemical test applied to all the oils has been Cahours' nitrite reaction for Phellandrene (*Ann. der Chem.* 41, p. 76), as modified by Bunge (*Zeit. für Chem.* 5.; *Bull. Soc. Chim.* 1870, pp. 272-273) and Wallach and Gildemeister (*Ann. der Chem.* 246, p. 282).

The densities were taken with a pyknometer holding about 25 grammes of water, and in each case at 15°C., referred to water at 15°C. The specific rotation was measured in a column of liquid 10 c.m. in length at 15°C., using the Sodium-flame; if a is the angle of rotation and d the density, then the specific rotation in the usual notation is

$$[a]_D = \frac{a}{d}.$$

The refractive index was measured at 20°C. for the D line of Sodium with a spectrometer read to minutes but not to fractions of a minute, the index in each case being calculated from three independent measurements of the angle of deviation δ according to the usual formula

$$\mu = \frac{\sin. \frac{A+\delta}{2}}{\sin. \frac{A}{2}}$$ where A is the angle of the prism.

To obtain the specific refractive energy $\frac{\mu_D - 1}{d}$ at 20° $\left(\frac{\mu - 1}{d}\right.$ being only slightly variable with temperature$\left.\right)$, the densities at 20° were calculated from those determined at 15° by means of the formula $d_{20^\circ} = d_{15^\circ}(1 - 5b)$ where b is the coefficient of change of density of the oil for 1°C.; b was determined for four oils by means of measurements of their densities at 15° and 100°C. as now given.

TABLE I.

$d_{\cdot 15^\circ}$	$d_{\cdot 100^\circ}$	b
·8532	·7846	·000945
·8753	·8072	·000916
·9134	·8411	·000931
·9213	·8481	·000934
	Mean. ...	·000931

The values of the physical constants are given in the following table for the 87 Eucalyptus-Oils, arranged in the order of ascending density :—

Table II.

EUCALYPTUS-OILS.

Progressive Number.	Botanical Source.	Density 15°/15°	Specific Rotation $[\alpha]_D^{15°}$	Refractive Index $\mu_D^{20°}$	Specific Refractive Energy $\frac{\mu_D - 1}{d}$	Phellandrene Reaction.
1	E. amygdalina	·8532	−88·9°	1·4758	·5603	P
2	,, ,,	·8544	−82·5°	1·4765	·5603	P
3	,, ,,	·8560	−80·7°	1·4758	·5584	P
4	,, ,,	·8561	−73·9°	1·4769	·5596	P
5	,, ,,	·8568	−81·1°	1·4781	·5606	P
6	,, ,,	·8582	−71·1°	1·4769	·5583	P
7	,, ,,	·8625	−69·5°	1·4813	·5606	P
8	,, ,,	·8641	−63·6°	1·4789	·5570	P
9	,, ,,	·8695	−68·5°	1·4829	·5580	P
10	,, ,,	·8726	−36·2°	1·4725	·5439	P
11	,, citriodora	·8745	0·0°	1·4527	·5200	N
12	,, amygdalina	·8750	−35·9°	1·4745	·5447	P
13	,, ,,	·8753	−56·3°	1·4813	·5524	P
14	,, ,,	·8767	−68·4°	1·4785	·5483	P
15	,, ,,	·8777	−84·0°	1·4777	·5467	P
16	,, ,,	·8789	−44·6°	1·4749	·5428	P
17	,, ,,	·8806	−42·6°	1·4717	·5381	P
18	,, citriodora	·8817	−58·4°	1·4793	·5461	P
19	,, dumosa	·8842	+ 0·6°	1·4701	·5341	S.pt.
20	,, amygdalina	·8884	−55·7°	1·4761	·5383	P
21	,, ,,	·8893	−16·3°	1·4713	·5323	P
22	,, ,,	·8894	−70·8°	1·4789	·5410	P
23	,, ,,	·8894	−64·9°	1·4757	·5373	P
24	,, ,,	·8908	−56·1°	1·4797	·5410	P
25	,, ,,	·8925	−35·3°	1·4829	·5435	P
26	,, ,,	·8940	−22·4°	1·4693	·5273	P
27	,, ,,	·8942	−17·8°	1·4701	·5281	P
28	,, pauciflora	·8943	+16·7°	1·4629	·5200	N
29	,, globulus	·8958	+17·3°	1·4641	·5205	N
30	,, amygdalina	·8967	−59·9°	1·4869	·5454	S.pt.
31	,, cneorifolia	·8991	−13·3°	1·4677	·5226	S.pt.
32	,, oleosa	·9066	+ 5·5°	1·4624	·5124	N
33	,, cneorifolia	·9071	−12·1°	1·4705	·5211	N
34	,, Mallee (mixed var.)	·9081	+ 5·5°	1·4580	·5067	N
35	,, gracilis	·9090	+ 9·3°	1·4612	·5097	N
36	,, globulus	·9120	+ 1·1°	1·4596	·4952	N
37	,, rostrata	·9120	+ 8·7°	1·4604	·5072	N
38	,, globulus	·9125	+ 3·8°	1·4612	·5077	N
39	,, ,,	·9127	+ 4·9°	1·4632	·5098	N

Progressive Number.	Botanical Source.	Density 15°/15°	Specific Rotation $[\alpha]_D$ ·15°	Refractive Index $\mu._D{}^{20°}$	Specific Refractive Energy $\frac{\mu_D - 1}{d}$	Phellandrene Reaction.
40	E. piperita - -	·9133	+ 1·6°	1·4592	·5051	N
41	„ Mallee (mixed var.) -	·9134	+ 2·7°	1·4608	·5068	N
42	„ globulus - -	·9142	+ 1·1°	1·4793	·5465	S.pt.
43	Eucalyptol - -	·9143	+ 4·1°	1·4608	·5063	N
44	E. Mallee - - -	·9145	+ 3·8°	1·4608	·5062	N
45	„ amygdalina - -	·9148	– 3·3°	1·4612	·5064	N
46	„ globulus - -	·9152	– 6·2°	1·4580	·5027	N
47	„ dumosa- - -	·9152	+ 6·8°	1·4624	·5074	N
48	„ Leucoxylon - -	·9154	+ 0·7°	1·4634	·5085	N
49	„ oleosa - - -	·9155	+ 5·2°	1·4629	·5080	N
50	„ dumosa - -	·9159	+ 6·5°	1·4829	·5296	N
51	Eucalyptol - -	·9161	+ 3·8°	1·4616	·5062	N
52	E. Leucoxylon - -	·9164	+ 0·5°	1·4596	·5037	N
53	„ amygdalina - -	·9168	– 35·9°	1·4801	·5260	P
54	„ Stuartiana - -	·9175	– 7·1°	1·4709	·5156	N
55	„ (mixed var.) - -	·9175	+ 4·9°	1·4616	·5054	N
56	„ (mixed var.) - -	·9192	– 2.2°	1·4624	·5053	N
57	„ globulus - -	·9196	+ 2·2°	1·4596	·5020	N
58	„ goniocalyx - -	·9197	– 4·3°	1·4705	·5140	N
59	„ globulus - -	·9197	+ 4.4°	1·4632	·5060	N
60	„ pauciflora - -	·9200	+ 6·0°	1·4604	·5027	N
61	„ citriodora - -	·9200	0·°	1·4612	·5036	N
62	„ cneorifolia - -	·9200	– 2·7°	1·4640	·5066	N
63	„ globulus - -	·9202	+ 2·7°	1·4592	·5013	N
64	„ „ - -	·9207	+ 2·7°	1·4612	·5032	N
65	„ (mixed var.) - -	·9209	+ 0·5°	1·4649	·5071	N
66	Eucalyptol - -	·9213	+ 3·8°	1·4604	·5020	N
67	E. cneorifolia - -	·9215	– 5·4°	1·4652	·5071	S.pt.
68	„ rostrata - -	·9216	+ 2·2°	1·4600	·5014	N
69	Eucalyptol - -	·9221	+ 5·9°	1·4559	·4965	N
70	E. cneorifolia - -	·9221	– 4·1°	1·4640	·5055	N
71	„ rostrata - -	·9222	+ 0·5°	1·4607	·5018	N
72	„ Lehmanni - -	·9236	+ 5·9°	1·4616	·5021	N
73	„ occidentalis - -	·9236	+ 2·7°	1·4628	·5034	N
74	„ diversicolor - -	·9240	+ 9·7°	...	...	N
75	„ globulus - -	·9265	+ 3·2°	1·4624	·5013	N
76	„ oleosa - - -	·9267	Too dark to observe	1·4729	·5126	N
77	„ Leucoxylon - -	·9271	+ 2·7°	1·4608	·5000	N
78	„ fissilis - - -	·9282	0·°	1·4592	·4970	N
79	Black Oil (Redistilled) -	·9311	– 41·8°	1·4845	·5226	S.pt.
80	E. Stuartiana - -	·9327	– 16·6°	1·4849	·5222	S.pt.
81	Eucalyptol - -	·9341	+ 6·9°	1·4620	·4968	N
82	„ - -	·9382	+ 5·6°	1·4661	·4989	N
83	Black Oil (Redistilled) -	·9403	– 15·9°	1·4877	·5208	S.pt.
84	E. globulus - -	·9430	+ 2·1°	1·4636	·4938	N
85	„ amygdalina - -	·9507	– 5·8°	1·4928	·5205	S.pt.
86	„ globulus - -	·9512	+ 1·6°	1·4628	·4877	N
87	„ amygdalina - -	·9651	– 10·9°	1·4821	·5016	S.pt.

First, as regards density, it will be noticed that it ranges from ·853 to ·965, and if the last five oils, Nos. 83-87 (on account of probable alteration with age) and the two preceding Eucalyptols are omitted, the range is from ·8532 to ·9327, which is not inconsiderable. Separating out the numbers of oils whose densities lie within the ranges ·85 to ·86, ·86 to ·87, and so on, we get

TABLE III.

Density - - -	·85 *to* ·86	·86 *to* ·87	·87 *to* ·88	·88 *to* ·89	·89 *to* ·90	·90 *to* ·91	·91 *to* ·92	·92 *to* ·93	above ·93
No. of Oils - -	6	3	7	7	8	4	24	19	9

The first point to notice in this last table is, that up to a density of ·91 the numbers of oils are fairly evenly distributed through the successive intervals of ·01 in density, while at the two higher intervals from ·91 to ·92 and ·92 to ·93 the numbers increase markedly; 35 oils have their density between ·85 and ·91, while 24 have a density between ·91 and ·92, and 19 between ·92 and ·93, so that there is a tendency towards a classification of the oils by density.

Second, as regards specific rotation, it may be stated that on the whole a progressive alteration of the specific rotation accompanies the alterations of density, the lightest oils having the greatest lævo-rotation, which diminishes with increasing density to 0 at about a density of ·907, after which with a few exceptions the oils are slightly dextro-rotatory.

Third, as to refractive index, the alteration here is also progressive, the lighter oils having the higher index, which diminishes with increasing density except in the last few oils, which are altogether exceptional; but the specific refractive energy is much the better form in which to study the relations of the oil to light, and the specific refractive energies of the oils show a range of variation which is larger than that of the density, the values progressing from about ·56 to ·49 (diminishing with increasing density).

Fourth, as to the Phellandrene reaction, it will be seen from the table that all the oils which give the Phellandrene reaction are of low density and lævo-rotatory, though some few that are lævo-rotatory do not give the Phellandrene reaction.

These results are in harmony with the general conclusions so far obtained in the study of the chemistry of the Eucalyptus-Oils, the chief result of which is to show that these oils contain two main ingredients of different densities, rotation and specific refractive energies; differences in the proportion of the ingredients producing such differences as are recorded in the tables. The researches of Wallach (*Ann. der Chem.*, 225 et seq.; *Ber der Deut. Chem. Ges.*, 24) have established that the two main ingredients are a Terpene or mixture of closely related Terpenes $C_{10}H_{16}$, and Cineol (Eucalyptol) $C_{10}H_{18}O$. The values of the above physical constants for some of these Terpenes and Cineol are approximately as follow, the values of different authorities varying too much to allow of any but approximate values being given :—

TABLE IV.

——		B.Pt.	d_{15°	$\frac{\mu_D - 1}{d}$
Cineol	- - - - -	176°	·9275	·495
Terpenes	Limonene - -	172° - 179°	·848	·562
	Pinene - -	155° - 160°	·862	·544
	Phellandrene -	170°	·856	·560

The range of density ·848 to ·927 corresponds closely to that pointed out as holding in the natural Eucalyptus-Oils, namely ·853 to ·933, and the range of specific refractive energy is ·495 to ·562, to be compared with the range ·49 to ·56 of the natural oils. Thus it is quite clear that in the Eucalyptus-Oils as a whole we have to do with mixtures in varying proportions of bodies of the two types, Cineol $C_{10}H_{18}O$ and Terpene $C_{10}H_{16}$.

To determine which of the many isomerides possible for both of these types are really present in any one oil, the methods of investigation developed by Wallach will have to be applied; but at present it can be seen that the values of physical constants give a good measure of the relative proportions of the ingredients $C_{10}H_{18}O$ and $C_{10}H_{16}$.

As regards compounds other than $C_{10}H_{18}O$ and $C_{10}H_{16}$ in Eucalyptus-Oils, Sesqui-terpenes $C_{15}H_{24}$ appear to be present, and certain Aldehydes have been observed in quantity sufficient to give a characteristic smell to various oils, and in the case of the oil of *E. maculata* (var. *citriodora*) Citronellal (Citronellon) and Geraniol are present; but the chief work to be done in the immediate future ought to be confined to characterising and isolating the great variety of isomerides of the two main substances $C_{10}H_{18}O$ and $C_{10}H_{16}$. That to do this will be no light undertaking may be gathered from the study of Wallach's work, although he has so simplified the confusion existing as to the number of Terpenes and their derivatives. The closeness of the boiling points of Cineol, Limonene and Phellandrene shows that the method of fractional distillation can give but little help towards even a preliminary separation of a Eucalyptus-Oil into separate chemical compounds; and a brief account of two series of systematic fractionations, carried out on two typical oils, will make this clear. As it is important to realise that other methods of separation will have to be resorted to in working out the chemistry of the Eucalyptus-Oils, as has been done in certain cases by Wallach, the following tables are given to show the amount of separation achieved by a thorough fractionation. Of the two typical oils chosen the first was of the Terpene type, with low density and high negative specific rotation, and the second of the Cineol type, of high density and small positive specific rotation. To secure steadiness in the fractionations a special apparatus was put together, consisting of a copper flask of 350 c.c. capacity, with brazed joints and a neck 12 c.m. long and 19 m.m. diam.; this was inclosed in a cubical chamber of asbestos-millboard of 16 c.m. edge; into the neck of the flask was inserted by means of a thin perforated cork a ⊢ tube contracted for insertion in the flask, the large limb of the ⊢ tube was 23 m.m. diam. and the side tube 5 m.m. The ⊢ tube was enclosed in a wooden chamber with a mica-front, through which could be read the fractionating thermometer divided into $\frac{1}{5}$°C., wholly immersed in the wide limb of the ⊢ tube. The burner, which heated the cubical asbestos-chamber, was protected from draughts by a sheet-iron case. The apparatus was found to attain the desired end of causing the thermometer readings to rise quite steadily during a fractionation.

Of the oil number 1 in Table II., 250 c.c. were twice distilled from calcium chloride to dry it, the end product being clear and almost colourless, with a dark, strongly-smelling residue left in the flask. The physical constants were slightly altered by distillation, the values being

Density	$\cdot 8484^{15^\circ/15^\circ}$
Specific rotation ...	$[\alpha]_D - 85\cdot4^\circ$
Refractive index	μ_D 1·4769
Sp. ref. energy	·5637

Of the distillate 200 c.c. during one complete fractionating in the above apparatus gave the following fractions, of which the physical constants were determined as before, except the density, which was measured by a Westphal specific gravity balance; some of the fractions were so small that the measurements could not be conveniently made.

TABLE V.

t° C.	Per-centage.	Density 15°/15° C.	$[\alpha]_D$	$\frac{\mu_D - 1}{d}$.
Below 170	·7	...	...	...
170-172	3·7	·845	...	·5600
172-173	5·8	·846	− 84·6°	·5646
173-174	14·5	·846	− 84·0°	·5630
174-175	20·8	·846	− 84·6°	·5641
175-176	19·8	·846	− 88·1°	·5646
176-177	11·5	·847	− 86·3°	·5650
177-178	5·0	·849	− 83·7°	·5645
178-179	5·0	·850	− 81·3°	·5637
179-180	2·5 }	·854	− 73·3°	·5616
180-185	5·3 }			
185-195	1·8	...	...	...
Above 195	3·6	...	...	...

These numbers show that a process of separation is going on, as the density increases and the rotation varies with rising boiling point. To see how far this separation could be carried, the 11 individual fractions boiling between 155° and 195°C. were each redistilled with the same intervals of temperature as before, when the boiling point of the first of the above fractions reached 170°; the second was added, and when the b.p. rose to 172° the third, and so on; the distillates from each fraction being collected for the intervals of temperature given in the following table, which represents the final result after several complete repetitions of the above operations.

TABLE VI.

$t°$ C.	Percentage.	Density 15° / 15° C.	$[\alpha]_D$	$\frac{\mu_D - 1}{d}$
155-170	1·8	...	...	...
170-172	6·3	·844	− 71·8°	·5601
172-173	7·9	·845	− 83·6°	·5610
173-174	9·5	·845	− 84·9°	·5633
174-175	17·5	·847	− 92·2°	·5645
175-176	10·9	·848	− 91·5°	·5648
176-177	14·5	·849	− 87·6°	·5648
177-178	6·8	·849	− 83·2°	·5658
178-179	3·3	·850	...	·5652
179-185	5·4	·853	− 72·4°	·5642
185-195	5·0	·859	− 55·2°	·5606
Above 195	11·1	...	...	...

The process of separation noticed in the first fractionation is still going on, as again indicated by increasing densities and varying rotations. To ascertain how far this separation had gone, the Phellandrene test was applied to the fractions 155 - 170°, 179 - 185°, and 185 - 195° (Wallach and Gildemeister, *Ann. der Chem.*, 246, p. 282). The three fractions gave the Phellandrene reaction strongly, the test tubes presenting a solid mass of crystals of Phellandrene nitrite $C_{10}\ H_{16}.\ N_2\ O_3$.; after washing with water, then absolute methyl alcohol, and crystallising from chloroform, the crystals melted at 103°C. (m. p^{t}. 103° - 104°C. Wallach and Gildemeister, ibid.); this is sufficient to show the practical impossibility of the satisfactory fractional separation of the Terpenes present. Attempts to prepare Bromine addition compounds from the three fractions 170 - 172°, 176 - 177°, and 185 - 195° by Wallach's method (*Ann. der Chem.*, 227, p. 280) were unsuccessful in each case; only oily compounds separated, which refused obstinately to crystallise even when strongly cooled. The crystalline addition compounds of the Terpenes with two molecules H.Cl. (Wallach, *Ann. der Chem.*, 239, p. 3) could not be obtained from the four fractions boiling at 170 - 172°, 172 - 173°, 174 - 175°, and 179 - 185°, only liquid hydrochlorides resulting. This is in agreement with the experience of Wallach and Gildemeister in their research on *E. amygdalina* oil (*Ann. der Chem.*, 246, pp. 278-284).

The fraction 175 - 176° is of interest on account of its high specific rotation $[\alpha]_D$ – 91·5° and low density ·843; after removing the Phellandrene the remaining oil is still strongly lævo-rotatory, the optical activity being probably partly due to lævo-limonene.

For studying the behaviour of the other type of oil in the fractionating apparatus, a sample of number 34 of Table II. was taken and distilled from calcium chloride with slight alteration of the physical constants as in the last case, the values being:

Density	·909.$^{15°/15°}$
Specific rotation	$[\alpha]_D$ + 5·5°.

A slight yellow colour in this oil should be mentioned. Several fractionations on 200 c.c. were carried out in the manner described for the other type of oil. The results of the first and final operations being given in the two following tables:—

Table VII.

t°C.	Percentage.	Density 15° / 15° C.	$[\alpha]_D$.	$\frac{\mu_D - 1}{d}$
160-170	4·0	·898	...	·5150
170-171	11·8	·903	+ 11·6°	·5137
171-172	13·5	·904	+ 10·5°	·5131
172-173	16·8	·907	+ 8·7°	·5114
173-174	13·0	·909	+ 6·2°	·5102
174-175	12·0	·912	+ 4·4°	·5070
175-177	17·3	·915	+ 1·5°	·5055
177-179	6·0	·918	– 0·5°	·5047
179-185	3·5	·919	...	·5054
185-190	1·7	...	...	...
Above 190	0·4	...	...	...

TABLE VIII.

t° C.	Per-centage.	Density 15° / 15° C.	$[\alpha]_D$.	$\frac{\mu_D - 1}{d}$
160-170	10·0	·893	+ 18·1°	·5190
170-171	9·5	·897	+ 15·6°	·5166
171-172	7·3	·902	+ 11·7°	·5125
172-173	6·8	·906	+ 9·1°	·5100
173-174	11·8	·910	+ 6·6°	·5072
174-175	11·5	·913	+ 3·7°	·5051
175-177	26·8	·917	+ 1·3°	·5029
177-179	8·0	·920	− 0·9°	·5025
179-185	4·1	·921	− 2·7°	·5408
185-190	1·0	...	...	...
Above 190	2·2	...	...	..

The colour of the original oil appeared almost all in the first fraction 160 - 170°. The result here is as before to show clearly enough that we are dealing with a mixture of substances, the change in the specific rotation from a fairly large positive value at 160 - 170° to a small negative one at 177 - 179° being specially noticeable as accompanying an increase of density. As the oil was chosen as a typical Cineol-oil, the best method of determining how far a separation had been accomplished was to test for Cineol in each fraction according to the method of Wallach (*Ann. der Chem.*, 227, p. 280); in every case the characteristic unstable splendid prismatic crystals of Cineol di-bromide were formed, readily decomposing on exposure to the air.

Dry hydrogen chloride also produced in each of the well-cooled fractions white crystals of the unstable Cineol di-hydrochloride. From the results it will be seen, as in the first type of oil, that we are dealing with a mixture, in which fractionating effects only a limited separation.

On account of the difficulty of separating the two chief constituents of Eucalyptus-Oils by fractional distillation, it seemed to be advisable to use the measurements of the physical constants to obtain at least an approximate estimate of the proportions in which they are present. For instance, in the case of the density, if we assume that an oil is composed of p_1 parts by weight of a mean Terpene of density ·855, and p_2 parts of Cineol of density

·927, and if on mixture the shrinkage is negligible, as in the case of most mixed liquids, then the density d of the mixture is given by

$$\frac{p_1 + p_2}{d} = \frac{p_1}{d_1} + \frac{p_1}{d_2} \quad (1).$$

If $p_1 + p_2$ is 100, then $p_1 = 100 \dfrac{\frac{1}{d} - \frac{1}{d_2}}{\frac{1}{d_1} - \frac{1}{d_2}}$ (2);

so that from the density d it is possible to calculate the percentage by weight p_1 of the Terpene. Of course as a mean value ·855 is adopted for density of Terpene, while the actual densities range from ·848 to ·862; this formula should not be applied to mixtures containing only a small proportion of Cineol. If the Terpene present is known, then in the above formula its density must be taken as d_1; the mean value ·855 being used only when the nature of the Terpene is unknown.

To verify the applicability of the above formula to mixtures of Terpenes and Cineol the following mixtures were made and their densities determined for comparison with those calculated by the formula above.

Mixture I.—Equal volumes of turpentine with $d_1 = {\cdot}866$ at 15°C. and Cineol $d_2 = {\cdot}9213$ at 15°, density of mixture ·8936 at 15°, calculated value ·8936; the agreement being absolute it follows that formula (2) would give absolutely the percentage of Terpene and Cineol actually mixed.

Mixture II.—Three vols. of turpentine $d_1 = {\cdot}866$ and one vol. of oil No. 34. $d_2 = {\cdot}9081$ at 15°, density of mixture found $d = {\cdot}877$ at 15°, calculated by (1) ·879; conversely using (2) to calculate first the percentage of the two ingredients by weight, we get 26·2 Eucalyptus-Oil and 73·8 of turpentine, which corresponds to one volume of oil to 2·8 of turpentine instead of the 1 to 3 by experiment.

These two experiments show that given an oil consists of only a Terpene and Cineol the proportions of these can be obtained with a certain amount of accuracy by a single determination of the density of the oil, and if the density of the Terpene present is known, then the formula will allow its amount to be determined with fair accuracy by a single determination of the density of the oil.

This determination of the proportions of the two ingredients from the density of the mixture can be controlled by a similar calculation in connection with the specific refractive energy. It is well known, that if r_1 and r_2 are the specific refractive energies of two substances present in proportions p_1 and p_2 by weight and r the sp. ref. energy of the mixture

$$(p_1 + p_2) r = p_1 r_1 + p_2 r_2.$$

$$\text{and } p_1 + p_2 = 100, \text{ then } p_1 = 100 \frac{r - r_2}{r_1 - r_2}$$

According to this formula the sp. ref. energies ought to vary steadily with the densities, if the oils consisted of two main ingredients, and they do vary steadily on the whole, but with marked exceptions, showing that individual oils cannot be taken as mixtures of only the two main substances. By applying the two formulæ (density and sp. ref. energy) to the measurements for an oil, it can be ascertained by the agreement of their results whether the oil is a mixture of a Terpene and Cineol or not.

As another physical constant, whose measurement might be expected to give definite indications as to the proportions of the two main ingredients in a Eucalyptus-Oil, the viscosity seemed promising, as the viscosity of Cineol at ordinary temperatures would naturally be expected to be much larger than that of a Terpene, seeing that it is much nearer its solidifying point; thus, to test the applicability of measurements of viscosity to the analysis of the Eucalyptus-Oils, the following experiments were made.

A cylindrical glass separator of 170 c.c. with a tap at the bottom had 40 c.m. of circular capillary tube connected to it by an india-rubber joint. The whole was so arranged that the capillary hung vertically from the separator, so that its upper end was 30 c.m. from the mark on the neck of the separator to which the oil was filled up in every case. The time was noted for 20 c.c. to run through the capillary; under these circumstances the viscosity is proportional to the time taken and to the density of the liquid; to obtain the specific viscosity referred to, water at 16·5°C. as 100, all that is necessary is to multiply 100 times the time taken by any oil by its density, and to divide by the time for water. The following are the results for certain oils and mixtures:—

TABLE IX.

Substance.	Time in Minutes.	Density 15° /15° C.	Specific viscosity (Water at 16·5° = 100).
Turpentine - - - - -	29·0	·866	148
Oil, No. 10 - - - - -	31·0	·873	159
,, ,, 13 - - - - -	30.0	·875	154
,, ,, 34, 1 vol. - - } Turpentine, 3 vols. - - }	31·8	·877	164
Oil, No. 15 - - - - -	30·0	·878	155
,, ,, 34, 1 vol. - - } Turpentine, 1 vol. - - }	33·0	·883	171
Oil, No. 34, 3 vols. - - } Turpentine, 1 vol. - - }	34·0	·889	180
Cineol 1 vol. - - } Turpentine, 1 vol. - - }	38·5	·893	202
Oil, No. 41, 1 vol. - - } ,, ,, 13, 1 vol. - - }	40·0	·8936	210
,, ,, 34 - - - - -	40·0	·908	214
,, ,, 41 - - - - -	57·0	·913	306
No. 66, Cineol - - -	56·0	·921	303

It will be seen, that there is a wide range in the values of the viscosity for the different oils and mixtures, from 148 for turpentine to 303 for Cineol, moreover that a body like oil No. 13, which according to its density and specific rotation must be almost exclusively Terpene (Phellandrene), has the viscosity 154 near that of turpentine, while the oil No. 41, which according to its density contains a large amount of Cineol, also has a large viscosity, viz., 306, which indeed is too large for even pure Cineol, so that probably small amounts of still more viscous substances than Cineol are present. With only slight irregularities the viscosity rises with increasing density. From the densities the amount of Cineol in each oil or mixture can be approximately calculated as already explained, and, as increasing density means increasing content of Cineol, the viscosity rises with increasing content of Cineol.

It thus appears that conclusions drawn as to the composition of an oil from its density and specific refractive energy could be controlled in a general way by viscosity determinations.

Appendix.

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ART. XVII.—*Report of the Antarctic Committee of the Royal Society of Victoria.*

[Read 16th November, 1893.]

Your Committee has held a few meetings during the year, sitting with the corresponding Committee of the Royal Geographical Society of Australia, as hitherto. There has been very little work to do since Baron Dickson decided to withdraw his co-operation in the proposed Swedish-Australian expedition to have been despatched in the charge of Baron Nordenskiöld. Nevertheless, our efforts to direct attention to this region have, during the past year, borne their first fruits in the despatch of five steam whalers. These vessels carried a limited staff of observers and the scientific work done was subordinated very strictly to the commercial purposes of the owners of the ships. The vessels having found a plentiful supply of seals in latitude 64° S., under the lea of Trinity land, went no further south. Dr. Donald and Mr. W. S. Bruce have written important papers descriptive of their observations on board the *Balæna* and *Active*, and these will shortly be published by the Royal Geographical Society of Great Britain. A fine collection of southern birds has been brought back, and a collection of drawings and photographs which was exhibited at the last meeting of the British Association attracted considerable attention, and has led to a vote of money to enable Mr. Bruce to spend next year upon one of the Antarctic Islands making further observations.

As the owners of the ships are sending them out again this year it may be concluded that the cargoes brought home last year were of a sufficiently payable nature to ensure further exploration of the region for commercial purposes. Further, we shall shortly be able to record an effort to re-open the Antarctic on the meridian of Australia or New Zealand, as a steam whaler, the *Antarctic*, left Tonsberg in Norway on 19th September, under the command of Captain Bull. She will go direct to Newcastle N.S.W., where she will fill her bunkers and then start for the south. A small bonus from our Government would induce her owners to allow her to return with her cargo to Melbourne, and thus to initiate the new industry which we have long sought to get our local shipowners and merchants to embark in—so far without success. Efforts should also be made to secure a passage for a scientific observer, whose work need not impede the work of the voyage whilst it should be of the greatest scientific value.

We must congratulate the Society upon the efforts made by the joint Committee during the past seven years, as they have resulted in the re-opening of the Antarctic Seas, after fifty years of absolute neglect.

G. S. Griffiths,

Hon. Secretary Antarctic Sub-Committee.

Art. XVIII.—*Report of the Gravity Survey Committee of the Royal Society of Victoria.*

[Read 16th November, 1893.]

Your Committee has much pleasure in reporting that good progress has been made in the work of the Survey during the past year. The apparatus sent out from the Kew Observatory by the Royal Society of London has been erected at the Melbourne Observatory in an underground apartment, under the supervision of Mr. Ellery; the observing telescope described in the last report was completed and placed in position last autumn: and an elaborate series of observations taken of the pendulums by Mr. Baracchi, in order to connect Melbourne with the Kew and Greenwich base stations.* Mr. Love has obtained practice in observing, and is now engaged on a series of observations intended partly to supplement those of Mr. Baracchi, partly to form a starting point for the Australasian Survey.

In the course of the work a number of—as the observers think—radical defects in Kater's design for an invariable pendulum have manifested themselves (see appendix). It is hoped that some of these disadvantages will be overcome in the new type of pendulum now under construction by Mr. Ellery at the Melbourne Observatory.

The Committee has expended £12 6s. of its grant, partly cost of package and transport of the pendulums, partly in necessary mechanical work upon them.

Your Committee respectfully asks for re-appointment, with the addition of the name of Mr. Baracchi; and that the unexpended balance of the grant of £25 be placed at its disposal.

E. F. J. Love, *Hon. Sec.*

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* Proc. Roy. Soc. Victoria, vol. vi., p. 162.

Appendix A.

On the design of Pendulum Apparatus for Differential Observations of Gravity. By E. F. J. Love, M.A.

The work of the Gravity Survey Committee, of which I have the honour to be secretary, has forced upon my attention the subject of the various theoretical points which come up for consideration in the designing of pendulums for use in differential observations of gravity. A good many different forms of pendulum are now employed for this purpose by observers in different parts of the world: and it seems not altogether without interest to examine the various types in use, with the view of seeing to what extent they agree with what we may look upon as the ideal pendulum, and, where they differ, to indicate the manner in which improvements might be effected.

(a) The first point to which attention should be directed is the fact that the only measurement which has to be made on pendulums for differential work is the determination of the vibration number in different parts of the earth. This at once places the possible accuracy of the work on an altogether different level from that obtainable in any absolute measurement of gravity: in absolute measurement we are definitely limited by the degree of accuracy obtained in the measurement of the length of the pendulum, an operation very inferior in this respect to the determination of a vibration number by the method of conicidences. But the whole value of the work depends on the extent to which the vibration number of the differential pendulum at any one place maintains its constancy; in other words, *on the degree of invariability of the pendulum.*

It might seem superfluous to insist on the necessity of so constructing a differential pendulum that it shall be, as far as the nature of material structures will allow, invariable in form and dimensions, but such is not the case. Some observers have conceived the idea that it would be convenient to be able to make both differential and absolute measurements with the same pendulum: notably Commandant Defforges,* who has con-

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* Comptes-Rendus des séances de la Commission Permanente de l'Association Géodésigne Internationale, 1888. Annexe vb. p. 12, *egg.*

structed for use in the French geodetic surveys an instrument which he terms a "reversible invertible pendulum:" this instrument has two fixed knife-edges, and two interchangeable weights, which are transferred from end to end of the pendulum in each observation. Commandant Defforges is of opinion that such a mode of construction will do away with the errors inseparable from the use of so-called invariable pendulums. I cannot agree with him here: for it seems to me very doubtful whether we should ever get the weights after displacement back to exactly their original positions: and the errors thus commissible, though small, are quite likely to be of a higher order of magnitude than those which the method is designed to eliminate. For instance, suppose a fine dust particle should get lodged between the weight and its seat: this might well be the ten-thousandth of an inch thick, and yet escape observation: yet it would alter the vibration number in a half-seconds pendulum by one and a half vibrations per day. Moreover, the large amount of extra handling, screwing up, etc., involved seems to me to militate seriously against the trustworthiness of the arrangement. I have entered into this matter at considerable length because Commandant Defforges is looked upon, and rightly so, as one of the foremost of living geodesists, and his work demands very careful consideration.

Positing then the necessity for invariability, as far as it can be attained, let us see how we are to seek it.

I am strongly of opinion that the pendulum should be rigid; this, indeed, was the first point forced on my attention when handling the Indian pendulums. However much care be taken, a five-foot bar of thin brass, with comparatively heavy weights at its ends, is continually undergoing flexures of a rather alarming magnitude during the processes of handling which necessarily go on in the course of the transfer of the pendulum from its case to the cylinder in which it is vibrated; I have serious doubts whether any amount of care can prevent such flexures as will introduce a permanent set and alter the vibration number. Nor are these doubts without solid foundation; we know that these pendulums have been bent in the past, and have had to be re-straightened—a process which necessarily destroys the continuity of the observations made with them—and one of them is certainly not quite straight now. On these grounds I should view with suspicion any design which included a flexible bar; among these may be mentioned the pendulums lately employed by Professor Mendenhall,* which were of the same general pattern as the Indian pendulums, though much shorter, and consequently less liable to injury. The best pattern I have seen is that adopted by Lieut.-Col. von Sterneck, which consists of a rigid rod, carrying at its lower end a bob composed of two frustra of cones united at the base.

Recent practice inclines more and more, and rightly so, to the use of half-second pendulums; for a pendulum of one-fourth the length is, at least, ten times as free from risk of injury in handling. A five-foot bar is distinctly awkward, but a thirteen-inch bar is just about as comfortable a size to handle as could well be imagined, to say nothing of the increased rigidity. This method secures the further advantage of portability, a matter of great importance in survey work.

Not merely should the pendulum be short and rigid, its structure should be, as far as possible, continuous throughout. This, unfortunately, cannot be fully attained; the best which can be done is to have the different parts so made that they can be attached together by a process of shrinking on and riveting. Solder is always objectionable, and its use can be avoided by employing a suitable design.

One great obstacle to the attainment of invariability is the old practice of attaching the knife-edges to the pendulum and swinging it on a plane suspension; for the knife-edges get dulled and have to be reground; each regrinding of course changes the effective length of the pendulum, and destroys the differentiality of the observations. Professor Mendenhall† took a great step in advance when he attached the planes to the pendulum, and swung it on a knife-edge suspension: for a good agate plane requires only to be kept clean; while the knife-edges, if separate from the pendulum, may be reground at pleasure without sacrifice of differentiality. Incidentally this mode of suspension introduces a good many other improvements, which may as well be summarised here.

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* U.S. Coast and Geodetic Survey Report for 1891, appendix 15, p. 503.

† *L.c.*, p. 530.

1st. The difficulty of setting the knife-edges accurately in line is entirely got rid of; for they can be attached, once for all, to their seats in the suspending apparatus, and ground up together *in situ*.

2nd. The difficulty, never yet overcome, of setting the knife-edges accurately perpendicular to the axis of the pendulum is done away with: for the setting of the agate planes can be tested by optical means to any required order of accuracy, and the head to which the planes are attached can be altered till they attain their proper positions. This fact removes the only possible advantage of a flexible pendulum bar. Kater's object in making the bar flexible was to ensure its verticality even if the knife-edges were not quite accurately set; this advantage has always seemed to me rather a doubtful one,* even with Kater's original pattern, but whether it be so or no, the attachment of the agate planes to the pendulum makes any flexibility in the bar quite superfluous.

(b) Not merely should the pendulum be invariable, its shape is a matter of importance; for it must be so designed as to render the resistance of the air to its motion a minimun. This is a serious objection to a form which would otherwise be highly advantageous; Captain Basevi† suggested that a rigid cylindrical rod with a spherical bob would be a good form, because for it, alone of all known figures, the pressure connection could be determined directly by calculation; unfortunately this form offers a great deal of air resistance, and such a pendulum would have its oscillations damped too rapidly for convenient observing. A lenticular figure is probably the best, but it is difficult to make symmetrical; and on the whole, the most convenient seems to be the double-cone pattern of von Sterneck, which can be figured in the lathe with all desired accuracy.

Another point in connection with the shape is the position to be assigned to the pendulum bob. The usual practice is to set its broadest plane vertical and in the plane of swing; but von Sterneck puts it horizontal. I believe this was done by him for constructional reasons, but a further advantage is incidentally secured in this way. It is well known that a flat body moving in a fluid

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* Sir G. G. Stokes however thinks differently. *Vide* appendix B.

† G. T. Survey of India, vol. v., p. 92.

tends to set itself broadside on to the direction of motion; if then the bob be vertical and its broadest plane parallel to the plane of motion, it is always trying to rotate about its vertical axis, and in this way either the knife-edges will wabble on the suspension, or (if the pendulum be too heavy for that) a torsional stress is applied to the knife-edge, the direction of the stress being reversed twice in each oscillation: of course this stress is only small, but just as constant dropping wears away stones, so a constantly reversed stress wears out a knife-edge. The case is very different if the broadest plane of the bob be horizontal; here the only effect is a bending stress on the pendulum rod, a stress too small to produce any effect on a rod of ordinary dimensions. If we bear in mind that von Sterneck's rod is about $\frac{2}{5}$ of an inch thick, but that a decent steel knife-edge is not $\frac{1}{100,000}$ of an inch across, the advantage of transferring the stress from the knife-edge to the rod is at once evident.

Another point to be attended to is the position at which the starting lever gives its impulse to the rod. If this be not—as it generally is not—at or near the centre of oscillation, the operation of starting tends to produce a sideways shift of the head of the pendulum, and so to bend over and dull the knife-edge. Now to determine the dimensions of a pendulum of given form which shall have its centre of oscillation at a given point is a matter for calculation; the calculations are rather complicated, but quite manageable by known mathematical methods, so need not be detailed here.

(c) The supports of the pendulum must of course be as frictionless as possible. This is secured by attending to the construction of the knife-edges and planes of suspension; and here we have the advantage of the experience gained by the manufacturers of chemical balances, among whom the general consensus of opinion seems to be that a steel knife-edge and agate planes affords less friction than any other combination. Agate knife-edges cannot be given so fine an edge as steel, and the similarity of the material of planes and knife-edges is a further objection, and although there is of course no risk of rust, there is some danger of splitting the knife-edge; the advantage here is on the side of the steel, for a rusty steel knife-edge can be reground, but a split agate is of no further use and must be replaced by a new one.

(d) However carefully we construct our pendulums we shall always have to correct the observed vibration number for temperature and air pressure, and the corrections are by no means small. Temperature changes affect both the dimensions of the pendulum and the general properties of the medium in which it swings, while pressure affects only the second of these. We therefore require to determine both these quantities with considerable accuracy; for pressure this is easy enough, a good syphon barometer gauge being all that is wanted; but the determination of the temperature is not so simple, and observers are by no means agreed as to the best method of attaining it. The general assumption appears to be that a thermometer will follow the changes of temperature of the air more quickly than will the pendulum. Accordingly many observers, including Sabine and Mendenhall, sink the thermometer bulbs in a metal bar of the same thickness as the pendulum rod, while von Sterneck encloses the whole thermometer in a wide glass tube. The latter plan is almost certainly bad; for the heat has first to make its way through a glass tube, then across a layer of air, and then to heat up the thermometer. But is Sabine's plan very much better? If we consider the structure of a thermometer bulb, viz.: a thin layer of glass, which is notoriously a bad conductor of heat, and then a cylindrical mass of mercury about as thick as, and a worse conductor than, the pendulum rod, and if we bear in mind that convection currents probably play only a secondary part in equalising the temperature of different parts of the thermometer bulb, and further that all delicate thermometers are sluggish in their indications, I think we shall see that an unprotected thermometer with a tolerably large bulb, set as near as possible to the pendulum, will probably lag in temperature behind the air of the containing vessel by about the same amount as the pendulum itself, and in consequence the thermometer is more likely to give the actual temperature of the pendulum if arranged in this way than if sunk in a metal bar or otherwise modified. In any case delicate thermometers are required; they should register at least to one-twentieth of a degree Fahrenheit, preferably to one-fiftieth of a degree Centigrade.

(e) But little need be said as to the containing apparatus. It should certainly be of metal, in order as far as possible to secure

uniformity of temperature throughout the enclosure, and should be painted of a light colour externally, so as to diminish the rate of absorption of heat: it cannot very well be left bright, as the light reflected from it would be a serious obstacle to observing. The apparatus should of course be rigid and tolerably heavy, otherwise the pendulum when swinging will set it in vibration; it should also be a form of very stable equilibrium, else external disturbance may shake it and interefere with the motion of the pendulum. A truncated cone of thick brass seems to answer every purpose; glass windows can be introduced where necessary, and the case should be mounted on *large* levelling screws, which stand in metal grooves on a heavy support of stone or timber. Such an apparatus need not weigh more than half-a-hundred-weight or so all told, and need take up but little room; a striking contrast to the Indian apparatus, which is extremely bulky and weighs nearly a ton.

Appendix B.

Part of a Letter from Sir G. G. Stokes, Bart., P.R.S., *to the Secretary.*

7 Queen's Parade, Bath,
6th August, 1891.

Dear Mr. Love,

You do not say expressly, but I take for granted that in the contemplated gravity survey you mean to use invariable pendulums, not Kater's pendulum, or some other form available for absolute determinations. It is generally, I think, allowed that for determining the *variation* of gravity from place to place the results obtained by invariable pendulums are the more accurate. The series of determinations would be rendered absolute by transporting the pendulums to some station where gravity has been well determined absolutely and swinging them there. It will suffice if the station last mentioned be one for which gravity is accurately known absolutely by comparison, by means of invariable pendulums used by previous observers, with some other station where gravity had been determined absolutely.

At least two pendulums just like each other should be used, in order that any accidental derangement of a pendulum may be detected. Sabine said to me in conversation that there ought to be three, as that would enable you, in the event of any derangement taking place in course of transit or handling, to tell which pendulum it was that had got altered. If you had only two, and one got slightly deranged, you could only tell which it was by going back to one of the stations where they had been previously used and swinging them afresh. However, I think two only have as a rule been all that have been used in gravity surveys, and I believe that with care in packing, transporting, and handling, such derangements are not likely to occur.

Before fixing on the form we must answer the question, Is the correction for the resistance of the air going to be determined by calculation or by experiment?

(a) If by calculation, we are restricted to forms for which it is possible to effect the calculation. The pendulum might be a plain cylindrical rod, or such a rod with a sphere at the end. In an invariable pendulum, soundness of casting would not be of any very great moment, the observations being strictly differential. If a rod be used, I should prefer the ends being made hemispherical, or thereabouts. The exact form is of no particular consequence, for for a small portion of the rod near the end the calculation cannot be effected, whether the rod be left plain, or formed into a hemisphere. The calculation for a sphere would not apply to a hemisphere joined on to a cylinder. But the part of the resistance which depends on what is near the end of the rod forms only a small fraction of the whole, and if we are obliged to have recourse to estimation for that small portion, the uncertainity thence arising can be only very small, since the rod is supposed to be but narrow for its length. The alternative is to adopt the form mentioned by General Walker, a cylindrical rod with a sphere at the end. I do not think there is much to choose between these two forms. I think the latter would keep up its oscillations somewhat longer, and the former would have to be about five feet long (for a seconds' pendulum) which might perhaps be a little inconveniently long. I do not know however that this would be any serious inconvenience.

As to the calculation it is to be remarked that the numerical value of the index of friction given in my paper is much too low. This arises in great measure from my having corrected for the residual air in Baily's swings at reduced pressure (about one inch of mercury) on the supposition (which seemed to be conformable to the single experiment that Sabine had made on the subject) that the coefficient of viscosity, the μ of my paper, varies as the density. We know that Maxwell's law, according to which it is independent of the density, is very accurately true in experiment. The true coefficient is now well known for air. I have not got here books of reference, but towards the end of a paper of Tomlinson's in the Phil. Trans., in which he treats of the viscosity of air, you will find collected the numerical results of various observers, himself included. The effect of reducing, in my paper, by a law as to the relation between viscosity and density now known not to be the law of nature was to exaggerate the effect of reduction of pressure, in other words to under-estimate the effect of the residual air, and therefore, in equating the theoretical expression for the difference between thirty inches pressure and one inch in the observed result, to bring out a coefficient which was decidedly too small. The adoption however of the true law, though it raises considerably the coefficient of viscosity as got from Baily's experiments, leaves it still too small. I do not see how to account for this except on the supposition that the motion of the pendulums was not small enough to allow of a strict application of the formulas of my paper. I have remarked in my paper (at least with reference to a suspending wire, and the same would of course be true generally) that the effect of the formation of eddies would be to tend to throw the effect of the resistance from off the time on to the arc. Whether any sensible part of the resistance is due to the formation of eddies, may be tested by seeing whether the arc of vibration decreases strictly in geometric progression as the time increases in arithmetic. I examined in this way some of Sabine's experiments in the Phil. Trans., and some of Bessel's experiments with the long and short pendulums. Plotting a curve with the time and log-arc for co-odinates, it came a straight line for the long pendulum, but the curve, though very nearly a straight line for the shorter pendulums, had a sensible though slight curvature. It appears therefore that with the amplitude of vibration usual in pendulum experiments, at least in the early portion of the swing the effect of eddies is not wholly insensible, and therefore it may well be that the formula in which the motion is assumed to be small enough to be regular may not be quite applicable to the actual experiments. However, beyond the discrepancy between the calculated and observed decrement of the arc of vibration, which I have mentioned in my paper, and also the decrement being not quite strictly in geometric progression, there was nothing to indicate that the formulas were in any way in fault, so very good seemed the agreement between theory and observation, until it was shown that the correction of the assumed law as to the relation between the viscosity and the density still left the numerical value of the index of friction as determined from the pendulum experiments slightly too small. But in merely differential observations, such as those carried on with invariable pendulums, I think any uncertainty of this kind would be quite insensible provided that care were taken that the observations should be strictly differential or very nearly so. Hence, if you wish to connect a group of Australian stations with Indian stations it is a perfectly open question whether you shall choose a pressure of say twenty-eight inches for the Australian set or a pressure of say four inches (or whatever the usual Indian pressure for India was). That is on the supposition, which I gather from your letter is intended, that you mean to construct new pendulums. The pendulums being different, the two series cannot be connected till the new pendulums are swung at one of the old stations, unless you are ready to trust to a reference of each series to an absolute determination belonging to it. But in either case if the higher pressure were thought the more convenient for the Australian stations, and it were not wished to trust to a correction for so great a difference of pressure as twenty-eight and four inches, it would merely be requisite to swing the invariable pendulums twice in succession at the reference station, once at the higher pressure, to connect with the Australian series, and once at a low pressure to connect with the Indian series or with the absolute determination as the case may be. If the vacuum apparatus be not quite staunch, as I fear may prove to be the case, it might be better, as a matter of convenience and indeed accuracy, and as Colonel Herschel has proposed, to use the vacuum apparatus only for ensuring a constant pressure of say twenty-seven or twenty-eight inches, except of course for the one set of swings at low pressure taken at the station of reference. However, much would depend on the condition of the vacuum apparatus.

I will mention here lest I should forget it that it is well to allow an observation (whether by a single swing, as may be done in vacuo or by a succession of swings does not much matter) to extend over twenty-four hours, or if that be inconvenient at least from dark to dark, through day or night as may be chosen, so as to rate the clock by transits for the interval of time over which the observations extend. For you cannot trust a clock, even though the rate from day to day be very uniform, to be quite exempt from a diurnal inequality of rate.

(b) Suppose now that we prefer to depend on experiment for the correction for the air. Then we may choose our form of pendulum as we please. That usually employed has the bar somewhat thin, in a fore and aft direction, so as to be slightly flexible. Without this there is, I believe, some difficulty in ensuring that the weight shall bear well on *both* agate planes, so as not to run the risk of turning slightly about a vertical axis to and fro as it swings. I recollect someone (Sabine, I think), telling me that someone, I forget who, did not like the flexibility, and proposed to make the pendulum stiff, and Kater (I think it was) said, "He'll find it will not do."

The form having been chosen, we have to find the correction for the air experimentally. This demands the use of a vacuum apparatus. I think the most convenient plan would be to get a *fac-simile* of the pendulum made of wood. The resistance of the air depends only on the form and time of vibration of the pendulum, I mean supposing the state of the air given, and these would be the same for the actual pendulum and for the wooden model. By avoiding a specially dense wood we might easily get the model ten or twelve times as light as the actual pendulum, and the effect of the air on arc and time would be magnified ten or twelve times. The whole time of the swing would be reduced in the same proportion; but this would not signify as regards having a shorter interval by which to divide any error of observation of the initial or final coincidence, for the method of coincidences is so exact that it may be deemed perfect; that it is to say any error from this would be swallowed up by much larger errors from other sources; and that being the case there is a great saving of time in using the model, besides which we are less exposed to errors from variations in the clock's rate, changes of temperature, etc. However the actual pendulum might of course be used, and probably in any case an observation or two would be taken with this for controul. And besides the saving of time in taking the observations, resulting from using a wooden model, the possibility of taking swings at different pressures in close proximity, merely allowing an interval sufficient to allow the disturbance of temperature consequent on the exhaustion or admission of air to subside, would I think be conducive to accuracy as securing a more near identity in the rate of the clock on the occasion of the two swings that are to be compared.

You mention the corrections for pressure and temperature. The latter depends partly on the expansion of the metal, partly on the effect of temperature in altering the state of the air, and therewith the correction on account of the air. I am not sure whether or not you meant to include the effect of the expansion of the metal.

If it is intended to keep the two parts separate, I suppose it is meant to calculate the part due to the metal from the linear expansion either ascertained by direct observation or assumed as known for the kind of metal employed. As to the air, the correction for buoyancy, and that portion of the correction for inertia which would form the whole if there were no viscosity, both one and the other vary as the density, and therefore in a known manner as regards the temperature. The rest of the correction for inertia depends in a more complicated manner on the temperature. The whole of this residue for a sphere, and the first term and most important part of it for a not too narrow cylindrical rod, varies as $\sqrt{\mu\rho}$. ρ of course varies inversely as $1+\alpha\theta$ (θ the temp. α the co-eff't. of expansion) but μ increases as the temperature rises, according to what law does not appear to be known for certain. I think experiments on transpiration gave it about as $(1+\alpha\theta)^{0.7}$, but I am away from books of reference, and I do not remember exactly.

If the temperature correction should be determined directly as a whole, *i.e.* effect on metal and on air together, by swinging the pendulum in air at two pretty widely separated temperatures, it is to be remembered that as it is made up of two different parts (effect on metal and effect on air) following different laws, the result will not be available unless some element (say the pressure) be kept constant. The experiment would involve the use of an apartment artificially heated in an equable manner,* unless we were content to wait all the time from one season to another, say summer to winter. The temperature correction so determined for a pressure of say 28 in. would not apply (on account of that part of it which depends on the air) to a pressure of say 3 in. It would seem to be best to correct as best may be for that part which is due to the air so as to get the part which is due to the expansion of the metal. I think the effect of the air can be got well by using a wooden model, and altering the observed effect in the ratio of Mh to $M'h'$, and M/M' can be got by weighing, and h/h' by balancing separately the model and actual pendulum on their edges.

I shall be happy to reply to further enquiries.

Yours very truly,

G. G. Stokes.

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* P.S.—With a wooden model the effect of the air is so much larger, the time of swinging so much shorter, and the expansion of the material by heat so much smaller, that there would be little difficulty in rigging up an apartment which would serve quite well enough for that.

Art. XIX.—*A Description of a New Pendulum Apparatus, with Half-Seconds Pendulums.*

By R. L. J. Ellery, C.M.G., F.R.S., F.R.A.S.

[Read 14th December, 1893.]

When the Kater's Invariable Pendulums, lent by the Royal Society of London for the Gravity Survey of Australia initiated by this Society, arrived and were installed at the Observatory, the cumbrous character of the whole apparatus convinced me that the cost of transport and of installation at the various observing stations would be a serious hindrance to the undertaking. When, therefore, some months later, an Austrian officer of the warship *Saida* brought a set of half-seconds pendulums, for making a series of gravity observations at the Observatory for connection with the Vienna base, I was struck with the immense convenience of transport and facility in making the necessary observations which these instruments afforded, and as I soon ascertained that the results appeared in every respect as good as with the larger pendulums, I determined to get a set made to test the question, hoping that they might be found efficient for the survey work. These pendulums and apparatus are now complete, and are on the table for the inspection of members. They are made after the plan adopted by Colonel von Sterneck of Vienna, but with certain modifications, and are in some respects similiar to the half-seconds pendulums recently used in the United States Coast and Geodetic Survey, and described by Mendenhall in his report for 1891.

The apparatus consists of three half-seconds pendulums, a coincidence or flash apparatus, a pendulum-stand, thermometers, air-pump, &c., as well as a break circuit chronometer.

In the design and construction of the pendulums, the chief and essential requirement of invariability and symmetry of form have had the first consideration. Great care was also taken as regards the metal of which they were first formed, to secure solidity, evenness of texture and a good surface. The form is simple, and, with the exception of the cross-heads, are figures of revolution. It has been usual to have the knife-edge on which the pendulum oscillates on the pendulum itself, but it is almost impossible in that case to secure invariability of length, owing to gradual blunting of the knife-edges by wear; they are therefore made part of the stand, while the planes are on the pendulum cross-head; by this means, wearing of the knife-edges or sharpening them brings about no variation in the lengths of the pendulums.

Of the pendulums themselves, two are made from phosphor bronze, and one from ordinary gun-metal, and care was taken that the metal is solid and homogeneous throughout. In shape they are all alike, the "bob" or "weight" of the pendulum is in the form of two low truncated cones, base to base in one solid casting 98mms. diameter at base of cones, and 36mm. thick; the rod is truly cylindrical, 1cm. diameter, the length of pendulum over all 303mm., and from planes to bottom of bobs 235mms. The rod is fixed to the bob by being turned down at one end to a very long cone, which nearly fitted a hole in the bob of a similar conicity; the rod was then ground into the hole until it fitted nearly up to a small shoulder at the top of the conical part of the rod. The bob was now immersed in boiling water to expand it, when the rod was inserted and driven up to the shoulder; in cooling, the bob and rod became to all intents and purposes solidly connected. The lower end of the rod projected slightly through the bob, while the bottom of the hole through the bob was slightly countersunk; the projecting rod was here carefully rivetted, and the bottom of the bob then finished off.

The suspensions are agate planes attached to metal cross-heads, which are made to fit accurately and symetrically on the rods, great care being taken to secure as perfect rectangularity of the agate planes with the pendulum rod as possible. The suspension cross-heads consist of cubes of gun-metal truly bored to fit on the pendulum rods. The lower part of the cubes are widened out on two sides to give a bearing for the planes as well as to form two cylindrical arms, by which the pendulums are lifted and lowered on to the knife edges of the stand. On the two faces of the cube that are not widened out are fixed two small mirrors of parallel glass, silvered at the back. The agate planes are fitted into a separate piece of gun-metal by means of a groove planed out on one face with V's at the sides; the agates are ground to a bevelled edge on two sides to fit into this groove, and are driven in tight in such a way as to be free from any strain that would crack or splinter them. The agate planes thus fitted are then ground and polished as one plane. The agates and their matrix of gun-metal fit precisely on planes at the bottoms of the cross-heads, and are secured by four small steel screws. Now, as it is absolutely necessary the agate planes should be accurately at right angles to the pendulum rods, they had to be carefully tested, for no matter how accurate may be the workmanship in fitting the cross-heads, some small errors are sure to remain. To do this I arranged a spectrometer with a piece of metal exactly the size of the pendulum rod, fixed horizontally, on which to place the cross-head and agates, then illuminating the slit of the collimator, read the angle of reflection from one of the planes in both horizontal and vertical direction with the telescope. The cross-head was then reversed 180° till the other plane came under the collimator, and the angles read again; any difference of angles was got rid of by lightly scraping the bottom surface of the cross-head on which the agate plate rested. By this means the agate planes were brought practically at right angles with the rods in both directions. Great care was also taken in securing the cross-heads to the rods. They fitted sufficiently tight to enable swings to be taken for ascertaining their times of vibration, and when this was satisfactory, a hole was bored through cube and rod and a conical steel pin driven firmly through both. The top of the rod and cross-head were then finished off together, and the pendulums were thus completed. Every part had been well smoothed and highly polished previously to the final fixing of the cross-head. The weights of the pendulums are approximately as follows:—No. I., 1814 grammes; No. II., 1787 grammes; No. III., 1811 grammes. Arrangements are made to avoid the necessity of handling or touching the pendulums, except with a leather-lined lifting handle and a leather strap, by which they can be lifted from their chamois-lined couches in the packing case, and placed on the lowering forks of the stand without touching any part with the fingers. To preserve their invariability, all touching that might cause corrosion, oxidation, or usage likely to cause abrasion, has to be most carefully avoided.

There are two stands: one which is exhibited is the vacuum stand or receiver, in which the pendulums are swung in vacuo or at any atmospheric pressure below the normal; it is a hollow cone of gun-metal with a wide base, and formed with a flange at the top to receive the dome, which has a similar flange at the bottom. These flanges are ground together, and when greased with tallow form an air-tight joint. The inner part of the flange of the stand carries a strong moveable metal stage, accurately fitted on, which carries the knife-edges, lifting lever, a fixed mirror, and a thermometer. This stage is secured by two strong milled head screws, and can be readily removed for putting in or taking out the pendulums. The requisite attachments for exhausting the chamber, attaching a barometer or manometer, as well as a lever for giving the necessary impulse to the pendulums, are provided; the latter working through stuffing-boxes. The stand in use rests by three studs on a stout tripod with three levelling screws. The receiver and dome with the tripod weigh about fifty-two pounds.

The knife-edges, like the agates, are necessarily in two pieces, but they are practically in one by the mode of construction. A block of gun-metal 50mm. wide, 64mm. long, and 10mm. thick, to carry the knife-edges, is strongly screwed on to the platform of the stand, the opposing surfaces being ground together; the front of the block is 25mm. thick for 10mm. back, and this forms the matrix for the knife-edges; this front part of the block is divided by a recess to admit the pendulum rod, 20mm. wide, and 15mm. front to back. The knife-edges are made of the finest steel "glass hard." The mode of construction was as follows:—The steel prism, from which the knife-edges were eventually formed, was first fitted into a groove on the top of the block which was planed out to the proper form and the prism driven in as a "drift." The prism was then taken out, cut in two and hardened, then the grooves were slightly closed at the upper edges, and the pieces fixed finally in their place. The knife-edges were then ground, sharpened and polished as one piece by means of a special tool. This is a square base of cast-iron in which the gun-metal block carrying the knife-edges can be fixed precisely at right angles to a double pair of V grooves in the base, on which a block of cast-iron carrying a grinding cylinder and running parallel to the knife-edges can be traversed as in a planing machine. The cylinder receives rapid rotation from any outside motor, while the grooved block is traversed to and fro in its grooves by hand. A means of approaching the knife-edge block towards the grinder is supplied by a fine pushing screw.

To obtain accurate horizontality of the knife-edges, a delicate level resting on agate planes similar to the pendulum cross-heads, with a light rod and bob below, forming a small pendulum, is used, and is lowered on the knife-edges exactly as the pendulums themselves are.

A second stand of cast iron is used when swings are made at ordinary atmospheric pressures. This is formed of two A-shaped uprights joined at the top by a rectangular platform, and a heavy circular base, resting on three rounded feet. On the platform, 100mm. square, is the platform carrying the knife-edges and other arrangements as described already ; but in this case the final levelling of the knife-edge is done by levelling the platform on the stand by special levelling screws.

The coincidence apparatus consists of a stand with levelling screws carrying a rectangular metallic box, within which are an electro-magnet, armature and lever, a mirror, and a mechanical shutter. Horizontally over the metal box is mounted a telescope with a horizontal wire at its focus. In front of the box is a narrow horizontal slit, about an inch and a half below the object-glass of the telescope, and on one side of the box a circular opening admits light from a lamp, candle, or other source on to the mirror within the box, whence it is reflected on to the slit in front ; the shutter, however, occults the slits except at the instant the electro-magnet acts on the lever, when an instantaneous flash is projected through the slit. A flash would occur both at the rising and return of the lever but for the shutter (a modification of an ingenious arrangement described by Mendenhall, report cited above) which keeps the slit occulted for either the up or down stroke of the lever, as may be desired. There is a black and white scale, divided to three millimetres spaces in front of the box, with an opening for the slit above-mentioned in its centre.

The mode of observing is as follows:—The stand being placed on a solid pier of stone, brick-work, or other material, and properly levelled, it is so placed that when a pendulum is placed in it, one of the mirrors shall face the observer, who sits down from five to seven feet away, with a good steady table or tripod stand in front of him to support the coincidence apparatus, the candle or lamp for illuminating the slit, a break circuit chronometer, a telegraph key or commutator, and a portable galvanic cell. He then arranges the apparatus so that he can read his millimetre scale in front of the box as it is reflected by the mirror on the pendulum. He now connects up his coincidence apparatus with his clock or chronometer, when the electro-magnet lifts the shutter every second, and an instantaneous flash is seen by means of the telescope reflected from the mirror. He next sets the pendulum swinging through a very small arc by means of the impulse lever, when the images of the scale and slit, as seen reflected from the pendulum mirror, oscillate in a vertical direction over a distance magnified by both the telescope and the distance of the mirror from the telescope. The fixed mirror on the stand reflects a stationary image of the flash at each occurrence, while the reflection from the pendulum mirror occurs successively at all parts of the vertical arc over which it oscillates. The moment of coincidence is when the latter appears in a horizontal line with the flash reflected by the fixed mirror. The time elapsed between coincidences in the same direction of the pendulum's motion is the "coincidence period," the mean value of which in twenty-four hours is what is sought, so as to obtain the true number of vibrations made in a solar day by the several pendulums of the set, from which a mean value is deduced.

In a brief description it is undesirable to describe in detail the various adjustments and corrections, which are numerous; but what I have given here will afford some idea of the new set of half-seconds pendulums and the method of using them.

Art. XX.—*The New Chain Test Range at the Melbourne Observatory.*

By R. L. J. Ellery, C.M.G., F.R.S., F.R.A.S.

[Read 14th December, 1893.]

The old chain test range laid down in the Observatory grounds in March, 1871, was found in January, 1892, to have a small increasing error, and being only six inches above the ground surface, was found inconvenient to use. It was formed by five cubical blocks of sandstone, set on brick and cement foundations, one at either end of the 100 feet range, others at 50 feet, 33 feet, and 66 feet. Gun-metal plates fixed to the stones carried the fiducial marks. In March, 1893, a new range was erected, consisting of four heavy brick and cement piers, 2ft. 5in. high, 2ft. long, by 18in. wide, capped with blocks of rubbed "bluestone." A platform from pier to pier was built of stout deal planks, T-shaped, supported on 6in. by 6in. red-gum posts firmly fixed in the ground. The height of this platform and surface of cap-stones is about 2ft. 5in., and very convenient for measuring and comparing. The fiducial marks are on gun-metal blocks, fastened to the stone caps at 0ft., 50ft., 66ft., and 100ft. On the 66ft. pier are two marks 12in. apart; one is 16ft. from the 50ft., and the second 33ft. from the 100ft., so as to obtain a standard foot and a half-chain measure. At the terminal piers wooden pillars are fixed to hold the adjusting screws and tension springs for stretching chains and tapes, and the fiducial marks are arranged to measure from end handles ("bût a bût") or marks ("traits"). Tension can be given to any chain, tape, or other measure at any intermediate point by means of a shifting toggle, to which the tension screws can be attached. The measures of this range were made with the 10ft. steel bars used for the Victorian base line, the measurement being made in the same manner—that is, bars placed end to end, but about one-fourth of an inch apart, aligned and levelled, the space being measured by a graduated wedge of bell-metal. The lengths are found to be as follows (reduced to a temperature of 62° Fahr): 0 to 100 = 1199·9749 inches, 0 to 50 = 599·9647, 50 to 100 = 600·0103.

The old range measured at 66 and 100, when first put up, 792·18 inches and 1200·20 inches; but just before removal the measure was 792·22 and 1200·32.

The stability of such ranges is found to be extremely good, but not absolutely perfect, for a secular change in the old range of 0·12 inches took place. This, however, is of no moment, as no standard measures are absolutely correct or perfectly permanent; the only point necessary is that the value of the standard should be obtained from time to time, and persons using the test should always obtain the value from the latest measures.

For very accurate comparisons and for determining expansions in high temperatures, a heavy iron block, with reading microscope, has been made, by which variations of $\frac{1}{1000}$ are easily measured.

MEETINGS OF THE ROYAL SOCIETY, 1893.

ANNUAL MEETING.

Thursday, 9th March.

The President (Professor KERNOT) in the chair.

On the motion of Mr. RUSDEN, seconded by Mr. HOGG, the following Annual Report and Balance Sheet were taken as read and adopted :—

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1892.

The Council of the Royal Society herewith presents to the Members of the Royal Society the Annual Report and Balance Sheet for the year 1892.

The following Meetings were held, and Papers read during the Session :

March 5.—"Preliminary notice of Victorian Earth-worms. Part II. The Genus Perichæta," by Professor W. Baldwin Spencer, M.A.

May 12.—"On Confocal Quadrics of Moments of Inertia, pertaining to all Planes in Space ; and Loci and Envelopes of Straight Lines whose Moments of Inertia are of constant magnitude," by Martin Gardiner, C.E. "Further Notes on the Oviparity of the larger Victorian Peripatus, generally known as *P. leuckartii*," by Arthur Dendy, D.Sc. "The Responsibility of Criminals," by Alex. Sutherland, M.A.

June 9.—"On the Nest and Eggs of the Victoria Rifle Bird (Ptilorhis victoriæ)," by D. Le Souëf. "The Blood Vessels of Ceratodus forsteri," by Professor W. Baldwin Spencer. Adjourned discussion on "The Responsibility of Criminals," Colonel J. R. Y. Goldstein.

July 14.—"Notes on the Lilydale Limestone," by Rev. A. W. Cresswell. "Preliminary Note on the Glacial Deposits of Bacchus Marsh," by C. G. W. Officer, B.Sc., and L. J. Balfour. The Report of the Cremation Committee brought up by the Honorary Secretary, and exhibition by F. Chamberlain, Esq., of a model to explain the working of the Govini Incinerator, in use at Woking, Surrey, England.

August 11.—Adjourned discussion on Preliminary Note on the "Glacial Deposits of Bacchus Marsh," by C. G. W. Officer, B.Sc., and L. J. Balfour. "The Conductivity of Copper Sulphate Solutions," by W. H. Steele, M.A. (communicated by Professor Lyle).

September 8.—"Snake-bite," by J. W. Barrett, M.D. "Notes on the Structure of the Poison Fang in certain Australian Snakes," by Professor W. Baldwin Spencer. "Three Rare Species of Eggs, hitherto only described from the Oviduct of the Bird," by A. J. Campbell, F.L.S. (communicated by Professor Spencer). "Synopsis of the Australian Calcarea Heterocœla, with a proposed classification of the group, and descriptions of some new Genera and Species," by Arthur Dendy, D.Sc.

October 13.—"On two new Tertiary Stylasterids," by T. S. Hall, M.A. "Notes on the method of Reproduction of *Geonemertes australiensis*," by A. Dendy, D.Sc. Exhibition by Mr. E. F. J. Love, M.A., of Professor Rowland's Photographs of the Solar Spectrum.

November 10.—"Physical Constants of Thallium," by W. H. Steele, M.A. "Notes on a Poisonous Species of *Homeria*, found at Pascoe Vale, causing the death of cattle and other animals feeding upon it," by D. McAlpine and P. W. Farmer, M.B., Ch.B. "The Lichenology of Victoria, Part I," by Rev. F. R. M. Wilson (presented by W. H. Archer, F.L.S).

December 8.—"Sneezing—Fallacious Observations," by J. W. Barrett, M.D. "Description of a New Victorian Species of Leucosolenia," by A. Dendy, D.Sc.

During the course of the year four Ordinary Members, one Country Member, and eight Associates have been elected; whilst eighteen Members and Associates have resigned.

Your Council recommended the election of Professor Liversidge, F.R.S., as Honorary Member, in recognition especially of his valuable services in connection with the formation of the Australasian Association for the Advancement of Science. Professor Liversidge was unanimously elected an Honorary Member at the Ordinary Meeting of the Society held in December.

Your Council regrets to report the resignation as member of the Council, of Mr. A. H. S. Lucas, who has left the colony to take up the position of Head Master of the Newington College, Sydney.

The Librarian reports as follows :—

"During the past year the Library has been growing rapidly, 954 books or parts having been received. Considerable progress has also been made with the revision and cataloguing of the Library, manuscript catalogue slips having been written out for the majority of the books. The Binding of the books has been continued so far as funds have permitted, 164 volumes having been bound.

"Owing to the great increase in the number of books in the Library, more shelving is very urgently required. As soon as this is ready it is proposed to re-arrange the books according to subjects, instead of, as at present, according to nationality.

"A very large number of valuable Serials still remain unbound, in which condition they cannot be used without great inconvenience to the student, and risk of much injury to the books themselves. It is impossible to place the Library in thorough working order without incurring considerable expense, but when this has once been done there should be no further difficulty in keeping it up. The Library is now a very valuable and comprehensive one, and steps should be taken to render it available to Members and Associates of the Society. When once placed in thorough order and with a catalogue up to date, it ought to prove a great inducement to scientific gentlemen to join the Society."

During the course of the year the following publications have been issued :—"Proceedings," Vol. IV. (New Series) Part I., "Proceedings," Vol. IV. (New Series) Part II., and "Transactions," Vol. II., Part II.

The Society has suffered financially in consequence of the prevailing depression. In addition to the loss of subscriptions, the Government Vote has been reduced from £500 to £250 per annum. In consequence of this, it has been decided to discontinue, for the present, the issue of the "Transactions," and to limit the publications of the Society to "Proceedings." This is much to be regretted, inasmuch as the Council finds itself unable to publish the results of various researches carried on by its Members, and having especial reference to the Australian Colonies. It is hoped that, with the return of prosperous times, the issue of the "Transactions" may be soon continued.

Dr. *The Honorary Treasurer in Account with the Royal Society of Victoria.* **Cr.**

Dr.			Cr.	
To Balance from 26th February, 1892 ...		£216 2 3	By Printing and Stationery	£293 6 9
,, Government Grant—			,, Rates...	4 2 6
Balance of Vote 1891-92	£250 0 0		,, Gas and Fuel	6 12 9
Instalments for 1892-93	110 0 0		,, Salary, &c., of Assistant-Secretary ...	88 3 6
		360 0 0	,, Shorthand Records	10 15 6
,, Entrance Fees		9 9 0	,, Hall-keeper's Allowance	5 10 0
,, Subscriptions—			,, Collector's Commission	23 19 4
Members	110 5 0		,, Insurance	4 0 0
Country Members ...	23 2 0		,, Postages and Telegrams	25 13 8
Associates...	31 10 0		,, Repairs and Furnishing	2 12 6
Arrears	22 1 0		,, Books and Periodicals	11 5 0
		186 18 0	,, Freight	18 10 2
,, Rent of Rooms		21 5 0	,, Refreshments	6 4 8
,, Sale of Transactions		0 14 6	,, Binding	29 14 9
,, Interest		17 10 0	,, Incidentals	8 3 5
			,, Interest	0 6 5
			,, Balance (28th February, 1893)	272 17 10
		£811 18 9		£811 18 9

Dr. PUBLISHING AND RESEARCH FUND. Cr.

Dr.	£	s.	d.	Cr.	£	s.	d.
To Fixed Deposit in Bank	£300	0	0	By Fixed Deposit in Bank of Australasia ...	£300	0	0
,, Interest on same	15	0	0	,, Interest transferred to General Account	15	0	0
	£315	0	0		£315	0	0

Compared with the Vouchers and Bank Pass-book and Cash-book, and found correct,

C. R. BLACKETT,
Hon. Treasurer.

R. E. JOSEPH,
H. MOORS, } *Auditors.*

28th February, 1893.

On the motion of Mr. LOVE, seconded by Mr. HOWITT, the following gentlemen were elected as Office-Bearers and Members of Council:—President: Professor W. C. Kernot, M.A., C.E. Vice-Presidents: E. J. White, Esq., F.R.A.S., H. K. Rusden, Esq., F.R.G.S. Hon. Treasurer: C. R. Blackett, Esq., F.C.S. Hon. Librarian: E. F. J. Love, Esq., M.A. Hon. Secretaries: Professor W. Baldwin Spencer, M.A., and Dr. Arthur Dendy, F.L.S. Members of Council: W. H. Archer, Esq., Dr. J. W. Barrett, J. Dennant, Esq., F.G.S., Dr. J. Jamieson, H. R. Hogg, Esq., Professor T. R. Lyle, M.A., F. A. Campbell, Esq., C.E. The non-retiring members of Council were R. L. J. Ellery, Esq., C.M.G., F.R.S., G. S. Griffiths, Esq., F.R.G.S., Professor Orme Masson, M.A., H. Moors, Esq., Rev. E. H. Sugden, B.A., B.Sc.

The meeting then resolved itself into an Ordinary Meeting.

The minutes of the previous meeting were read and confirmed.

The Librarian's Report showed that 286 volumes and parts of volumes had been received since the last meeting.

Mr. L. J. Balfour and the Rev. Walter Fielder signed the Roll and were introduced to the meeting.

The Rev. F. R. M. Wilson and Mr. P. W. Farmer, M.B., Ch.B., were elected members of the Society.

The Rev. JOHN MATHEW read a paper entitled "Linguistic Points of Contact between the Aborigines of Australia and those of New Guinea." A discussion followed, in which the Rev. LORIMER FISON, Mr. HOWITT and Dr. DENDY took part, and Mr. MATHEW replied.

Mr. G. B. PRITCHARD read a paper by T. S. Hall, Esq., M.A., and himself, entitled "Notes on the Eocene Strata of the Bellarine Peninsula, with brief references to other deposits." A discussion followed, in which Mr. GRIFFTHS and MR. STIRLING took part and Mr. PRITCHARD replied.

The remaining papers were postponed till the next meeting.

Thursday, 13th April.

Mr. E. J. WHITE occupied the chair.

The minutes of the last meeting were read and confirmed.

Mr. D. Avery, B.Sc., and Miss L. J. Little, B.Sc., were nominated as Associates.

The LIBRARIAN reported that 74 publications had been received since the last meeting.

Mr. C. FROST, F.L.S., read a paper by Mr. A. H. S. Lucas, M.A., B.Sc., and himself, entitled "The Lizards indigenous to Victoria." A discussion followed in which Mr. LOVE, Mr. WHITE and Dr. DENDY took part.

The SECRETARY read a paper by Mr. W. M. BALE, F.R.M.S., entitled "Further Notes on Australian Hydroids, with descriptions of some New Species."

Dr. DENDY read a paper entitled "Note on the Hatching of a Peripatus Egg." A discussion followed, in which Messrs. FROST, HOGG, LOVE and GRIFFITHS took part.

Mr. W. H. STEELE read a paper entitled "A new Thermo-electric Phenomenon." A discussion followed, in which Messrs. LOVE, BARNARD, BOOTH, WHITE, HOGG and DENDY took part.

A Collection of Victorian Lizards was exhibited by Mr. FROST during the evening.

Thursday, 11th May.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. D. Avery, B.Sc., and Miss L. J. Little, B.Sc., were elected as Associates.

Mr. J. J. Eastick and Dr. T. Cherry were nominated as Members.

The SECRETARY read a letter from the Secretary of the Field Naturalists' Club, stating that a Committee had been appointed by that Society to endeavour to induce the Government to refrain from revoking the reservation of the Dandenong and Woori-Yalloak State Forest, and inviting the co-operation of the Royal Society. At the request of the Secretary of the Club Mr. GREGORY was permitted to address the meeting on the subject. A discussion followed in which Messrs. ELLERY, LOVE, GRIFFITHS, HOGG, WHITE and the PRESIDENT took part, and on the motion of Mr. Ellery, seconded by Mr. Love, a Committee was appointed, consisting of Messrs. White and Griffiths, to co-operate with the Committee of the Field Naturalists' Club in the manner indicated.

The Librarian's report showed that 92 publications had been received since the last meeting.

The Rev. Lorimer Fison, M.A., read a paper entitled "Notes on the Saibai, Kaurarega and Gudang Languages, with remarks on unsound philological methods." A discussion followed, in which the President, Mr. Howitt and Dr. Dendy took part.

The remaining paper was postponed till the next meeting.

Thursday, 8th June.

The President (Professor Kernot) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Miss L. J. Little, B.Sc., an Associate, signed the roll and was introduced to the meeting.

Mr. J. J. Eastick and Dr. T. Cherry were elected members.

The Rev. H. W. Westmoreland was nominated as a Country Member.

The President read a letter from Mr. White, stating that he had attended the deputation to the Hon. the Minister of Lands, concerning the undesirability of alienating the Dandenong and Woori-Yalloak State Forests, but with no good results.

The Librarian reported that since the last meeting 54 publications had been received.

Mr. E. J. Dunn read a paper entitled "Glaciation of the Western Highlands, Tasmania." A discussion followed, in which the President, Mr. Dennant, Mr. Officer, Mr. Howitt, Mr. Sweet, Mr. Pritchard and Dr. Dendy took part, and Mr. Dunn replied.

Mr. G. C. W. Officer read a paper by himself and Mr. L. J. Balfour, entitled "Further Note on the Glacial Deposits of Bacchus Marsh." A discussion followed, in which Mr. Dunn, Mr. Sweet, Mr. Dennant, Mr. Pritchard, Mr. Love, Dr. Dendy and Mr. Balfour took part, and Mr. Officer replied.

The remaining papers were postponed till the next meeting.

Thursday, 13th July.

The President (Professor Kernot) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Dr. T. Cherry, a Member, and Mr. D. Avery, B.Sc., an Associate, signed the Roll and were introduced to the meeting.

The Rev. H. W. Westmoreland was elected a Country Member.

Mr. E. J. Dunn was nominated as a Member.

The LIBRARIAN reported that 107 publications had been received since the last meeting.

The SECRETARY read a paper entitled "Notes on the Trawling Expedition off the Lakes Entrance," by Mr. T. S. Hart, who had been appointed by the Council to represent the Society on the Expedition.

The Rev. JOHN MATHEW read a paper entitled "Defence of the Position—that there are Linguistic Points of Contact between the Aborigines of Australia and those of New Guinea, and Corroboration of the Theory that the Australian Aborigines entered the Continent on the New Guinea side." A discussion followed, in which the Rev. LORIMER FISON, Mr. HOWITT and Mr. ISAAC TIPPING took part, and Mr. MATHEW replied.

Dr. BARRETT read a paper entitled "Some Statistics showing the Extent of the Damage done to Members of the Medical Profession by the Abuse of Alcohol." A discussion followed, in which Professor KERNOT, Mr. ISSAC TIPPING, Dr. DENDY, Mr. MATHEW, Mr. WHITE and Dr. BARRETT took part.

The remaining paper was postponed till the next meeting.

Thursday, 14th September.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. E. J. Dunn was elected as a Member.

Mr. Elliott Cairns, a visitor, was introduced to the meeting by the President.

The LIBRARIAN reported that 249 publications had been received since the last meeting (two months).

The SECRETARY read a paper by Mr. R. Etheridge, Junr., Corresponding Member, entitled "An Operculum from the Lilydale Limestone."

The Rev. A. W. Cresswell read a paper entitled "Additional Notes on the Lilydale Limestone." A discussion followed, in which Mr. Cresswell, Dr. Dendy, Mr. McAlpine, Mr. Ellery, Mr. Pritchard and the the President took part.

Mr. Elliott Cairns exhibited a number of Mineralogical specimens from the Mount Wills district and made some remarks upon the occurrence of Gold in Granite in that locality. A discussion followed, in which Mr. Dennant, Mr. Pritchard, Dr. Dendy, Mr. McAlpine, Mr. Cresswell and the President took part, and Mr. Cairns replied.

Dr. Dendy read a paper entitled "Note from the Biological Laboratory of the Melbourne University:—On a Crayfish with abnormally developed Appendages."

Mr. Love made some remarks on the forthcoming meeting of the Australasian Association for the Advancement of Science, to be held at Adelaide.

Thursday, 12th October.

The President (Professor Kernot) occupied the chair.

The minutes of the previous meeting were read and confirmed.

The Librarian reported that 91 publications had been received since the last meeting.

Mr. G. S. Griffiths moved the following resolution: "That the Royal Society co-operate with the Royal Geographical Society in urging the Government to adopt and legalise the Hour-Zone system of time-reckoning." Mr. R. L. J. Ellery seconded the resolution, which was discussed by Mr. White, Mr. Haig, Mr. Steele, Mr. Coane, Mr. Love and the President. The resolution was put to the meeting and carried.

The following resolution was moved by Mr. R. L. J. Ellery and seconded by Mr. G. S. Griffiths—"That the Secretary inform the Secretary of the Royal Geographical Society of the resolution *in re* Hour-Zones, and state the readiness of the Royal Society to jointly sign any memorial to the Government which it may be decided to forward." The resolution was put to the meeting and carried.

Mr. Pietro Baracchi read a paper entitled "Results of Observations with the Kater's Invariable Pendulums, made at the Melbourne Observatory—June to September, 1893." A discussion followed in which Mr. ELLERY, MR. LOVE, MR. WHITE, Mr. STEELE and the PRESIDENT took part, and Mr. BARACCHI replied.

The remaining paper was postponed till the next meeting.

Thursday, 16th November.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

The LIBRARIAN reported that 82 publications had been received since the last meeting.

The SECRETARY read the report of the Antarctic Exploration Committee, forwarded by Mr. G. S. Griffiths.* The Report was received and the Committee was re-appointed with the following members:—Professor Kernot, Mr. G. S. Griffiths, Mr. R. L. J. Ellery, and Mr. H. K. Rusden.

In the absence of a formal report Dr. DENDY made some remarks on the works of the Port Phillip Biological Survey Committee; and the Committee was re-appointed with the following members:—Professor Spencer, Rev. A. W. Cresswell, Mr. W. M. Bale, Dr. McGillivray and Mr. J. Bracebridge Wilson.

Mr. BLACKETT read the Report of the House Committee. The Report was received and the Committee was re-appointed with the following members:—Professor Kernot, Professor Masson, Mr. H. K. Rusden and Mr. C. R. Blackett.

Mr. LOVE read the Report of the Gravity Survey Committee, with an Appendix.† The Report was received and the Committee was re-appointed with the following members:—Professor Lyle, Professor Masson, Mr. R. L. J. Ellery, Mr. E. J. White, Mr. E. F. J. Love and Mr. Pietro Baracchi.

Mr. ELLERY and the SECRETARY made some remarks on the work of the Printing Committee, and the Committee was re-appointed, with the Secretary and Treasurer for the time being and Mr. R. L. J. Ellery as members.

Dr. DENDY read a paper entitled "Observations on some new or little-known Land Planarians from Tasmania and South

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* *Vide* p. 211. † *Vide*, p. 213.

Australia." A discussion followed, in which Mr. HOGG, Mr. BLACKETT, Mr. LOVE, Miss LITTLE, the PRESIDENT and Dr. DENDY took part.

Mr. ISAAC TIPPING read a paper entitled "Land Irrigation: Principles governing its Economic Application in Warm Climates." A discussion followed, in which Mr. ELLERY, the PRESIDENT and Mr. DERRY (a visitor) took part, and Mr. TIPPING replied.

Thursday, 14th December.

The President (Professor KERNOT) occupied the chair.

The minutes of the previous meeting were read and confirmed.

Mr. A. G. Fryett was nominated as a member.

The PRESIDENT gave notice that nominations of Officers and Members of Council would be required in time for election at the Annual Meeting in March.

Messrs. MOORS and JOSEPH were re-elected as Auditors for the ensuing year.

A photograph of the Grave of Burke was exhibited, which had been presented to the Society by Mr. A. J. Skene, M.A. A vote of thanks to Mr. Skene for his interesting present was passed.

The LIBRARIAN reported that 119 publications had been received since the last meeting.

Mr. R. L. J. ELLERY read a paper entitled "Description of New Half-Seconds Pendulum Apparatus for Gravity Observations." The apparatus referred to was exhibited, and a discussion took place, in which Messrs. WHITE, LOVE and the PRESIDENT took part, and Mr. ELLERY replied.

Mr. R. L. J. ELLERY also read a paper entitled "Description of a new Chain Test Range at the Melbourne Observatory." A discussion followed, in which Messrs. WHITE, DENDY, FOWLER, LOVE, STEELE, the PRESIDENT and Mr. ELLERY took part.

Mr. C. R. BLACKETT read a paper by Mr. W. Percy Wilkinson, entitled "Preliminary Survey of the Eucalyptus-Oils of Victoria." The discussion on this paper was postponed.

Owing to the lateness of the hour, and the fact of its being the last meeting of the year, Mr. R. ETHERIDGE'S paper entitled "The Largest Australian Trilobite hitherto discovered," was taken as read. A few remarks on the subject matter of the paper being made by Mr. SWEET, Mr. PRITCHARD and Dr. DENDY.

LAWS.

Amended to December, 1892.

I. The Society shall be called "The Royal Society of Victoria." Name.

II. The Royal Society of Victoria is founded for the advancement of science, literature and art, with especial reference to the development of the resources of the country. Objects.

III. The Society shall consist of Ordinary Members residing within ten miles of Melbourne; Country Members residing beyond that distance; Life Members (Law XXV.), Honorary Members (Law XXIV.), Corresponding Members (Law LII.), and Associates (Laws XXV., XXVI., and LIII.), all of whom shall be elected by ballot. Members and Associates.

IV. His Excellency the Governor of Victoria, for the time being, shall be invited to accept the office of Patron of the Society. Patron.

V. There shall be a President, and Two Vice-Presidents, who, with twelve other Members, and the following Honorary Officers, viz., Treasurer, Librarian, and Two Secretaries of the Society, shall constitute the Council. Officers.

VI. The Council shall have the management of the affairs of the Society. Management.

VII. The Ordinary Meetings of the Society shall be held once in every month during the Session, from March to December inclusive, on days fixed and subject to alteration by the Council with due notice. Ordinary Meetings.

VIII. In the second week in March, there shall be an Annual General Meeting, to receive the report of the Council, and elect the Officers of the Society for the ensuing year. Annual General Meetings.

Retirement of Officers.

IX. All Office-bearers and Members of Council except the six junior or last elected Members, shall retire from office at the Annual General Meeting in March. Should a senior Member's seat become vacant in the course of the year, it shall be held by his successor (under Law XIII.), as a senior Member, who shall retire at the next Annual General Meeting. The names of such Retiring Officers are to be announced at the Ordinary Meeting in December. The Officers and Members of Council so retiring shall be eligible for the same or any other office then vacant.

Election of Officers.

X. The President, Vice-Presidents, Treasurer, Secretaries, and Librarian shall be separately elected by ballot (should such be demanded), in the above-named order, and the six vacancies in the Council shall then be filled up together by ballot at the General Meeting in March. Those members only shall be eligible for any office who have been proposed and seconded at the Ordinary Meeting in December, or by letter addressed to one of the Secretaries, and received by him before the 1st March, to be laid before the Council Meeting next before the Annual Meeting in March. The nomination to any one office shall be held a nomination to any office, the election to which is to be subsequently held. No ballot shall take place at any meeting unless ten members be present.

Votes required.

Members in arrear.

XI. No member, whose subscription is in arrear, shall take part in the election of Officers or other business of the meeting.

Address by the President.

XII. An address shall be delivered by the President of the Society at either a Dinner, Conversazione, or extra meeting of the Society, as the Council may determine in each year.

Vacancies.

XIII. If any vacancy occur among the Officers, notice thereof shall be inserted in the summons for the next meeting of the Society, and the vacancy shall be then filled up by ballot.

Duties of President.

XIV. The President shall take the chair at all meetings of the Society and of the Council, and shall regulate and keep order in all their proceedings ; he shall state questions and propositions to the meeting, and report the result of ballots, and carry into effect the regulations of the Society. In the absence of the President, the chair shall be taken by one of the Vice-Presidents, Treasurer, or Ordinary Member of Council, in order of seniority.

XV. The Treasurer may, immediately after his election, appoint a Collector (to act during pleasure), subject to the approval of the Council at its next meeting. The duty of the Collector shall be to issue the Treasurer's notices, and collect subscriptions. The Treasurer shall receive all moneys paid to the Society, and shall deposit the same before the end of each month in the bank approved by the Council, to the credit of an account opened in the name of the Royal Society of Victoria. The Treasurer shall make all payments ordered by the Council on receiving a written authority from the chairman of the meeting. All cheques shall be signed by himself, and countersigned by one of the Secretaries. No payments shall be made except by cheque, and on the authority of the Council. He shall keep a detailed account of all receipts and expenditure, present a report of the same at each Council meeting, and prepare a balance-sheet to be laid before the Council, and included in its Annual Report. He shall also produce his books whenever called upon to do so by the Council. Duties of Treasurer.

XVI. The Secretaries shall share their duties as they may find most convenient. One or other of them shall conduct the correspondence of the Society and of the Council, attend all meetings of the Society and of the Council, take minutes of their proceedings, and enter them in the proper books. He shall inscribe the names and addresses of all Members and Associates in a book to be kept for that purpose, from which no name shall be erased except by order of the Council. He shall issue notices of all meetings of the Society and of the Council, and shall have the custody of all papers of the Society, and, under the direction of the Council, superintend the printing of the Transactions of the Society. Duties of Secretaries.

Meetings of Council.

XVII. The Council shall meet on any day within one week before every Ordinary Meeting of the Society. Notice of such meeting shall be sent to every member at least two days previously. No business shall be transacted at any meeting of the Council unless five members be present. Any Member of Council absenting himself from three consecutive meetings of Council, without satisfactory explanation in writing, shall be considered to have vacated his office, and the election of a member to fill his place shall be proceeded with at the next Ordinary Meeting of Members, in accordance with Law XIII.

Quorum.

Special Meetings of Council.

XVIII. One of the Secretaries shall call a Special Meeting of Council on the authority of the President or of three Members of the Council. The notice of such meeting shall specify the object for which it is called, and no other business shall be entertained.

Special General Meetings.

XIX. The Council shall call a Special Meeting of the Society, on receiving a requisition in writing signed by twenty-four Members of the Society, specifying the purpose for which the meeting is required, or upon a resolution of its own. No other business shall be entertained at such meeting. Notice of such meeting, and the purpose for which it is summoned, shall be sent to every Member at least ten days before the meeting.

Annual Report.

Auditors.

XX. The Council shall annually prepare a Report of the Proceedings of the Society during the past year, embodying the Balance Sheet, duly audited by two Auditors, to be appointed for the year at the Ordinary Meeting in December, exhibiting a statement of the present position of the Society. This Report shall be laid before the Society at the Annual Meeting in March. No paper shall be read at that meeting.

Expulsion of Members.

XXI. If it shall come to the knowledge of the Council that the conduct of an Officer, a Member, or an Associate is injurious to the interest of the Society, and if two-thirds of the Council present shall be satisfied, after opportunity of defence has been afforded to him, that such is the case, it may call upon him to resign, and shall have the power to expel him from the Society, or remove him from any office therein at its discretion. In every case, all proceedings shall be entered upon the minutes.

Election of Members and Associates.

XXII. Every candidate for election as Member or as Associate shall be proposed and seconded by Members of the Society. The name, the address, and the occupation of every candidate, with the names of his proposer and of his seconder, shall be communicated in writing to one of the Secretaries, and shall be read at a meeting of Council, and also at the following meeting of the Society, and the ballot shall take place at the next following Ordinary Meeting of the Society. The assent of at least five-sixths of the number voting shall be requisite for the admission of a candidate.

Votes required to exclude.

Members shall sign laws.

XXIII. Every new Member or Associate shall receive due notice of his election, and be supplied with a copy of the obligation*, together with a copy of the Laws of the Society. He shall not be entitled to enjoy any privilege of the Society, nor shall his name be printed in the List of Members until he shall have paid his admission fee and first annual subscription, and have returned to the Secretaries the obligation signed by himself. He shall, at the first meeting of the Society at which he is present, sign a duplicate of the obligation in the Book of the Laws of the Society, after which he shall be introduced to the Society by the Chairman. No member or Associate shall be at liberty to withdraw from the Society without previously giving notice in writing to one of the Secretaries of his intention to withdraw, and returning all books or other property of the Society in his possession. Members and Associates will be considered liable for the payment of all

Conditions of Resignation.

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* The obligation referred to is as follows :—

ROYAL SOCIETY OF VICTORIA.

I, the undersigned, do hereby engage that I will endeavour to promote the interests and welfare of the Royal Society of Victoria, and to observe its laws, as long as I shall remain a Member or Associate thereof.

(Signed)

Address

Date

subscriptions due from them up to the date at which they give written notice of their intention to withdraw from the Society.

Honorary Members.

XXIV. Gentlemen not resident in Victoria, who are distinguished for their attainments in science, literature, or art, may be proposed for election as Honorary Members, on the recommendation of an absolute majority of the Council. The election shall be conducted in the same manner as that of Ordinary Members, but nine-tenths of the votes must be in favour of the candidate.

Subscriptions.

Life Membership.

XXV. Ordinary Members of the Society shall pay two guineas annually, Country Members and Associates shall pay one guinea annually. Those elected after the first of July shall pay only half of the subscription for the current year. Ordinary Members may compound for all annual subscriptions of the current and future years by paying £21; and Country Members may compound in a like manner by paying £10 10s. Any Country Member having compounded for his subscription, and coming to reside within ten miles of Melbourne, must pay either the balance £10 10s. of the Ordinary Member's composition, or one guinea annually while he resides within ten miles of Melbourne. The subscriptions shall be due on the 1st of January in every year. At the commencement of each year there shall be hung up in the Hall of the Society a list of all Members and Associates, upon which the payment of their subscription as made shall be entered. During July, notice shall be sent to all Members and Associates still in arrears. At the end of each year, a list of those who have not paid their subscriptions shall be prepared, to be considered and dealt with by the Council.

Entrance fees, etc.

XXVI. Newly-elected Ordinary and Country Members shall pay an entrance fee of two guineas, in addition to the subscription for the current year. Honorary Members, Corresponding Members and Associates shall not be required to pay any entrance fee. If the entrance fee and subscription be not paid with one month of the notification of election, a second notice shall be sent, and if payment be not made within one month from the second notice, the election shall be void. Associates, on seeking election as Ordinary or Country Members, shall comply with all the forms prescribed for the election of Members, and shall pay the entrance fee prescribed above of Ordinary or Country Members respectively.

XXVII. At the Ordinary Meetings of the Society the chair shall be taken punctually at eight o'clock, and no new business shall be taken after ten o'clock. Duration of Meetings.

XXVIII. At the Ordinary Meetings business shall be transacted in the following order, unless it be specially decided otherwise by the Chairman :— Order and mode of conducting the business.

Minutes of the preceding meeting to be read, amended if incorrect, and confirmed.

New Members and Associates to enrol their names, and be introduced.

Ballot for the election of new Members or Associates.

Vacancies among officers, if any, to be filled up.

Business arising out of the minutes.

Communications from the Council.

Presents to be laid on the table, and acknowledged.

Motions, of which notice has been given, to be considered.

Notice of motion for the next meeting to be given in and read by one of the Secretaries.

Papers to be read.

XXIX. No stranger shall speak at a meeting of the Society unless specially invited to do so by the Chairman. Strangers.

XXX. Every paper before being read at any meeting must be submitted to the Council. Papers to be first laid before Council.

XXXI. The Council may call additional meetings whenever it may deem it necessary to do so. Additional Meetings.

XXXII. Every Member may introduce two visitors to the meetings of the Society by orders signed by himself. Visitors.

Members may read papers.

XXXIII. Members and Associates shall have the privilege of reading before the Society account of experiments, observations, and researches conducted by themselves, or original papers, on subjects within the scope of the Society, or descriptions of recent discoveries, or inventions of general scientific interest. No vote of thanks to any Member or Associate for his paper shall be proposed.

Or depute other Members.

XXXIV. If a Member or Associate be unable to attend for the purpose of reading his paper, he may delegate to any Member of the Society the reading thereof, and his right of reply.

Members must give notice of their papers.

XXXV. Any Member or Associate desirous of reading a paper, shall give in writing to one of the Secretaries, ten days before the meeting at which he desires it to be read, its title and the time its reading will occupy.

Papers by Strangers.

XXXVI. The Council may for any special reason permit a paper such as is described in Law XXXIII., not written by a member of the Society, to be read by one of the Secretaries or other Members.

Papers belong to the Society.

XXXVII. Every paper read before the Society shall be the property thereof, and immediately after it has been read shall be delivered to one of the Secretaries, and shall remain in his custody.

Papers must be original.

XXXVIII. No paper shall be read before the Society or published in the Transactions unless approved by the Council, and unless it consist mainly of original matter as regards the facts or the theories enunciated.

Council may refer papers to Members.

XXXIX. The Council may refer any paper to any Member or Members of the Society, to report upon the desirability of printing it.

Rejected papers to be returned.

XL. Should the Council decide not to publish a paper, it shall be at once returned to the author.

Members may have copies of their papers.

XLI. The author of any paper which the Council has decided to publish in the Transactions may have fifty copies of his paper on giving notice of his wish in writing to one of the Secretaries, and any further number on paying the extra cost thereof.

XLII. Every Member and Associate whose subscription is not in arrear, and every Honorary and Corresponding Member is entitled to receive one copy of the Transactions of the Society as published. Newly-elected Members shall, on payment of their entrance fee and subscription, receive a copy of the volume of the Transactions last published. Members and Associates to have Transactions.

XLIII. Every book, phamphlet, model, plan, drawing, specimen, preparation, or collection presented to or purchased by the Society, shall be kept in the house of the Society. Property.

XLIV. The Library shall be open to Members and Associates of the Society, and the public, at such times and under such regulations as the Council may deem fit Library.

XLV. The legal ownership of the property of the Society is vested in the President, the Vice-Presidents, and the Treasurer for the time being, in trust for the use of the Society; but the Council shall have full control over the expenditure of the funds and management of the property of the Society. Legal ownership of property.

XLVI. Every Committee appointed by the Society shall at its first meeting elect a Chairman, who shall subsequently convene the Committee and bring up its report. He shall also obtain from the Treasurer such grants as may have been voted for the purposes of the Committee. Committees elect Chairman.

XLVII. All Committees and individuals to whom any work has been assigned by the Society shall present to the Council, not later than the 1st of November in each year, a report of the progress which has been made; and, in cases where grants of money for scientific purposes have been entrusted to them, a statement of the sums which have been expended, and the balance of each grant which remains unexpended. Every Committee shall cease to exist at the November meeting, unless then re-appointed. Report before November 1st.

Grants expire.

XLVIII. Grants of pecuniary aid for scientific purposes from the funds of the Society shall expire on the 1st of March next following, unless it shall appear by a report that the recommendations on which they were granted have been acted on, or a continuation of them be ordered by the Council.

Personal expenses not to be paid.

XLIX. In grants of money to Committees and individuals, the Society shall not pay any personal expenses which may be incurred by the Members.

Alterations of laws.

L. No new law, or alteration or repeal of an existing law, shall be made except at the Annual General Meeting in March, or at a Special General Meeting summoned for the purpose, as provided in Law XIX., and in pursuance of notice given at the preceding Ordinary Meeting of the Society.

Cases not provided for.

LI. Should any circumstance arise not provided for in these Laws, the Council is empowered to act as may seem to be best for the interests of the Society.

Corresponding Members.

LII. The Council shall have power to propose gentlemen not resident in Victoria, for election in the same manner as Ordinary Members, as Corresponding Members of the Society. The Corresponding Members shall contribute to the Society papers which may be received as those of Ordinary Members, and shall in return be entitled to receive copies of the Society's publications.

Privileges of Associates.

LIII. Associates shall have the privileges of Members in respect to the Society's publications, and at the Ordinary Meetings, with the exception, that they shall not have the power of voting; they shall also not be eligible as Officers of the Society.

MEMBERS

OF

The Royal Society of Victoria.

PATRON.

Hopetoun, His Excellency The Right Hon. John Adrian Louis Hope, G.C.M.G., Seventh Earl of.

HONORARY MEMBERS.

Agnew, Hon. J. W., M.E.C., M.D., Hobart, Tasmania.
Bancroft, J., Esq., M D., Brisbane, Queensland.
Clarke, Colonel Sir Andrew, K.C.M.G., C.B., C.I.E., London.
Forrest, Hon. J., C.M.G., Surveyor-General, West Australia.
Hector, Sir James, K.C.M.G., M.D., F.R.S., Wellington, N.Z.
Liversidge, Professor A., F.R.S., University, Sydney.
Neumeyer, Professor George, Ph.D., Hamburg, Germany.
Russell, H. C., Esq., F.R.S., F.R.A.S., Observatory, Sydney, N.S.W.
Scott, Rev. W., M.A., Kurrajong Heights, N.S.W.
Todd, Charles, Esq., C.M.G., F.R.A.S., Adelaide, S.A.
Verbeek, Dr. R. D. M., Buitenzorg, Batavia, Java.

LIFE MEMBERS.

Barkly, His Excellency Sir Henry, G.C.M.G., K.C.B., Carlton Club, London.
Bosisto, Joseph, Esq., C.M.G., Richmond.
Butters, J. S., Esq., 323 Collins-street.

Eaton, H. F., Esq., Treasury, Melbourne.
Elliott, T. S., Esq., Railway Department, Spencer-street.
Elliott, Sizar, Esq., J.P., Were-street, Brighton Beach.

Fowler, Thomas W., Esq., Carlyle-street, Upper Hawthorn.

Gibbons, Sidney W., Esq., F.C.S., care of Mr. Lewis, Chemist, 341 Bourke-street.
Gilbert, J. E., Esq., Money Order Office, G.P.O., Melbourne.

Howitt, Edward, Esq., Rathmines-road, Auburn.

Love, E. F. J., Esq , M.A., Queen's College, University.

Mueller, Baron F. von, K.C.M.G., M.D., Ph.D., F.R.S., Arnold-street, South Yarra.

Nicholas, William, Esq., F.G.S., Melbourne University.

Rusden, H. K., Esq., F.R.G.S., Ockley, Marlton Crescent, St. Kilda.

Selby, G. W., Esq., 99 Queen-street.

White, E. J., Esq., F.R.A.S., Melbourne Observatory.
Wilson, Sir Samuel, Knt., Oakleigh Hall, East St. Kilda.

Ordinary Members.

Allan, Alexander C., Esq., Fitzroy-street, St. Kilda.
Allan, M. J., Esq., 17 Delbridge-street, North Fitzroy.
Archer, W. H., Esq., J.P., F.L.S., F.I.A., Alverno, Grace Park, Hawthorn.

Bage, William, Esq., M.I.C.E., 349 Collins-street.
Balfour, Lewis J., Esq., Tyalla, Toorak.
Barnard, F., Esq., 49 High-street, Kew.
Barnes, Benjamin, Esq., Queen's Terrace, South Melbourne.
Baracchi, Pietro, Esq., F.R.A.S., Observatory, Melbourne.
Barrett, J. W., Esq., M.D., 34 Collins-street.
Bevan, Rev. L. D., LL.D., D.D., Congregational Hall, Russell-street.
Beckx, Gustave, Esq., Queen's Place, St. Kilda-road.
Blackett, C. R., Esq., J.P., F.C.S., Charlesfort, Tennyson-street, South St. Kilda.

Campbell, F. A., Esq., C.E., Working Men's College, Latrobe-street.
Candler, Samuel Curtis, Esq., Melbourne Club.
Cherry, T., Esq., M.D., University, Melbourne.
Cohen, Joseph B., Esq., A.R.I.B.A., Public Works Department, Melbourne.
Coane, J. M., Esq., C.E., care of Coane and Grant, Fourth Floor, Prell's Buildings, Queen-street.

Danks, John, Esq., 391 Bourke-street.
Davidson, William, Esq., C.E., Inspector-General of Public Works, Melbourne.

Dendy, Arthur, Esq., D.Sc., F.L.S., University, Melbourne.
Dennant, J., Esq., F.G.S., F.C.S., Prospect Hill-road, Camberwell.
Dunn, Frederick, Esq., 306 Little Flinders-street.
Dunn, E. J., Esq., F.G.S., 77 Packington-street, Kew.

Eastick, J. J., Esq., Aust. Sugar Refinery, Port Melbourne.
Ellery, R. L. J., Esq., C.M.G., F.R.S., F.R.A.S., Observatory, Melbourne.
Farmer, Paul Ward, Esq., M.B., Hall of Pharmacy, Swanston-street, Melbourne.
Foord, George, Esq., F.C.S., Royal Mint, Melbourne.
Fox, W., Esq., 14 Robe-street, St. Kilda.

Goldstein, J. R. Y., Esq., Office of Titles, Melbourne.
Gotch, J. S., Esq., 109 Albert-street, East Melbourne.
Griffiths, G. S., Esq., F.R.G.S., Waratah, Washington-street, Toorak.

Hake, C. N., Esq., F.C.S., Melbourne Club, Melbourne.
Hart, Ludovico, Esq., 10 Affleck-street, South Yarra.
Heffernan, E. B., Esq., M.D., 10 Brunswick-street, Fitzroy.
Hogg, H. R., Esq., 16 Market Buildings, Flinders-lane West.
Howitt, A. W., Esq., P.M., F.G.S., Secretary Mines Department, Melbourne.

Inskip, Geo. C., Esq., F.R.I.B.A., St. James' Buildings, William-street.

Jäger, Ernest, Esq., North-street, Ascot Vale.
James, E. M., Esq., M.R.C.S., 2 Collins-street.
Jamieson, James, Esq., M.D., 56 Collins-street.
Joseph, R. E., Esq., Electric Light Company, Sandridge-road, Melbourne.

Kernot, Professor W. C., M.A., C.E., University, Melbourne.

Lucas, A. H. S., Esq., M.A., B.Sc., Newington College, Sydney, New South Wales.
Lucas, William, Esq., 113 Leopold-street, South Yarra.
Lyle, Professor T. R., M.A., University, Melbourne.
Lynch, William, Esq., St. James' Buildings, William-street.

M'Coy, Professor Sir F., K.C.M.G., D.Sc., F.R.S., University, Melbourne.

M'Alpine, D., Esq., F.C.S., 5 Wallace-street, Toorak.
Main, Thomas, Esq., City Surveyor's Office, Melbourne

Maloney, William, Esq., 57 Roden-street, West Melbourne.
Masson, Professor Orme, M.A., D.Sc., University, Melbourne.
Mathew, Rev. John, Coburg.
Moerlin, C., Esq., Observatory, Melbourne.
Moors, H., Esq., Chief Secretary's Office, Melbourne.
Muntz, T. B., Esq., C.E., 358 Collins-street.

Nanson, Professor E. J., M.A., University, Melbourne.
Neild, J. E., Esq., M.D., Bilton House, 21 Spring-street.
Newbery, J. Cosmo, Esq., B.Sc., C.M.G., Technological Museum.
Nimmo, W. H., Esq., Melbourne Club, Melbourne.

Officer, C. G. W., Esq., B.Sc., Toorak.
Oldfield, Lenthal, Esq., 36 Nicholson-street, Fitzroy.

Rudall, J. T., Esq., F.R.C.S., corner of Spring and Collins streets, Melbourne.
Rule, O. R., Esq., Technological Museum, Melbourne.

Sargood, Hon. Sir Frederick T., K.C.M.G., M.L.C., Elsternwick.
Shaw, Thomas, Esq., Woorywyrite, Camperdown.
Spencer, Professor W. Baldwin, M.A., University, Melbourne.
Stillwell, A., Esq., 195A Collins-street.
Sugden, Rev. E. H., B.A., B.Sc., Queen's College, Carlton.
Sutherland, Alex., Esq., M.A., Carlton College, Royal Park.
Sweet, George, Esq., Wilson-street, Brunswick.
Syme, G. A., Esq., M.B., F.R.C.S., 74 Collins-street.

Tisdall, H. T., Esq., F.L.S., Washington-street, Toorak.
Topp, C. A., Esq., M.A., LL.B., F.L.S., Grandview Grove, Armadale.

Whitley, David, Esq., 26 Queen-street.
Wight, Gerard, Esq., Phœnix Chambers, Market-street.
Wilson. Rev. F. R. M., The Manse, Highbury Grove, Kew.

Country Members.

Bland, R. H., Esq., Clunes.

Cameron, John, Esq., Orbost, Victoria.
Clarke, Donald, Esq., School of Mines, Bairnsdale.
Conroy, James Macdowall, Esq., Wingham, Manning River, New South Wales.

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