NOTES ON THE RELATIONS OF THE YELLOW LIMESTONE (TRAVERTIN), OF GEILSTON BAY, With other FLUVIATILE AND LACUSTRINE DEPOSITS IN TASMANIA AND AUSTRALIA, Together with DESCRIPTIONS OF TWO NEW FOSSIL HELICES.

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[*Read 8th September*, 1879.]

The freshwater limestone in the neighbourhood of Geilston Bay, Hobart Town, is most interesting to geologists on account of the richness of its included organic remains. It attracted the attention of the illustrious Mr. Darwin during the visit of H.M.S. Beagle to Hobart Town, and was afterwards briefly alluded to by him in his "Journal of Researches," p. 448, thus :—

"A solitary and superficial patch of yellowish limestone, or travertin, which contains numerous impressions of leaves of trees, together with land shells not now existing. It is not improbable that this one small quarry includes the only remaining record of the vegetation of Van Diemen's Land during one former epoch."

Strzelecki also notices it in his "Physical Description of N. S. Wales and V. D. Land," and refers it to Pliocene age. He also gave figures of three fossil plant remains, one of which is the prevailing leaf form in all similar lacustrine deposits. In addition he described and gave figures of two land shells—*H. Tasmanicus*, G. B. Sowerby, *Bulimus Gunnii*, G. B. Sowerby—to which I shall refer hereafter.

Various other writers since that time have contributed to our knowledge of this interesting deposit, chief among whom was the late Mr. Morton Allport, whose contributions and indefatigable labors in the cause of science have made his name so widely known, and his loss so deeply deplored. To him we owe the knowledge that the fossil bones of *Phalangista fuliginosa*, *Hypsiprimni*, etc., are of later date than the

travertin with which they were closely associated. Formerly both Mr. Gould and Mr. Allport concluded from the bone remains that the "travertin must be of Recent Tertiary or Post Tertiary age," and consequently that the intrusive basalt must be of still more recent origin.

The discovery of fossil seeds of plants, which have since proved to be closely allied to fruits widely distributed throughout Australia and Tasmania, led Mr. Allport to enquire more particularly into the circumstance connected with the discovery of the fossil bones. This enquiry fully justified his supposition that the bones were obtained from a matrix derived from the originally deposited travertin, and deposited in crevices of the same rock probably formed by the intrusion of the overlying basalt; and he concluded (notice of Roy. Soc. Proc. of Tas., 13th June, 1876), "We must, of course, regard the basalt referred to as an earlier formation than the *diluvium* from which the bones referred to were obtained, but still as of later date than the travertin."

In my second paper on the Launceston Tertiary Basin, read before this Society in the year 1876, I suggested that the travertin beds might belong to the same series as those in the neighbourhood of Launceston, and possibly of the same age as the marine beds at Table Cape and elsewhere in Australia. I made this suggestion because I observed a close resemblance between certain of the undetermined leaf remains common in the respective deposits, and from the circumstance that all the deposits referred to are capped by a more or less decomposed basalt, which, upon analysis, proves to be the same chemically and structurally. Prof. Ulrich also informed me that the basalts at Geilston Bay, Breadalbane, and Table Cape, are essentially the same as the rock known as the "Older Volcanic" in Victoria, which, also, frequently caps certain marine beds in Victoria, that are now certainly proved to be of the same horizon as our marine beds of Table Cape.

I have since gathered abundant evidence of the very wide distribution of this rich soil-maker from nearly all parts of Tasmania, particularly in the plains about Campbell Town, Fingal, Avoca, Piper's River, Myrtle Bank, Ringarooma, Deloraine, George Town, Torquay, Flinders Island, Lake St. Clair, Mt. Bischoff, Middlesex Plains, Cattley Plains, &c., &c., in all which places it forms the rich chocolate soil of the district, and in auriferous and stanniferous regions it frequently overspreads the alluvial drifts and stream tin. It is of importance that miners should take cognisance of

this feature. The rock referred to is a *feld-spar* basalt, and is easily distinguished from the less valuable *diabase*, or Augite-greenstone, which gives such a peculiar character to the crests of our mountain chains, particularly Ben Lomond and Mount Wellington. The latter rock was formerly supposed to be a Diorite, or Hornblende Greenstone, and Prof. Ulrich, who pointed out this fact, states that " this may explain its non-auriferous character."

Through the praiseworthy labours of R. A. F. Murray, A. W. Howitt, Norman Taylor, Daintree, Brough Smythe, and other Australian geologists, abundant materials for the determination of the Tertiary beds have been gathered together, and, recently, in the hands of leading palæontologists they have yielded important results. From the writings of the gentlemen named I learn that the extensive fluviatile and lacustrine formations in Australia, particularly at Haddon, Bacchus Marsh, Malmsbury, Daylesford, Werribee, Beechworth, Tangil River, Gulgong, Richmond River, Orange River, and in the Darling Downs, Queensland, are the equivalents of similar deposits in Tasmania at Beaconsfield, Nine Mile Springs, Muddy Creek, Tamar, Breadalbane, Avoca, included within my definition of the Launceston Tertiary Basin, and also of the yellow limestone of Geilston Bay, Hobart Town, and the leaf beds of Macquarie Harbour. These freshwater deposits are undoubtedly of vast extent and of great thickness. The relations of the isolated though closely related groups of beds cannot be definitely ascertained, nor, when we take into consideration existing distribution of particular vegetable and animal forms, can we hope to draw sharp inferences in regard to their exact sequence. The preponderance of proteaceous forms in one locality, or of coniferous remains in another, give no clue to chronological sequence. It may only indicate the existence of varied forms of contemporaneous vegetable life under, perhaps, slightly altered circumstances as regards area, soil, or altitude.

No better conception of the restriction of particular forms to certain areas can be had than from a glance at the distribution of existing local well known forms, *e.g.*, in vegetation take *Fagus Cunninghami*, *Frenela australis*, *Anodopet alum biglandu losum*, *Arthrotaxis cupressiformis*, Acacia dralbata, Eucalyptus globulus, Banksia serrata; in land mollusca, take *Helix Launcestonensis*, *H. antialba*, *H. Weldii*, *H. Pictilis*, *H. Bischoffensis*, *H. Lampra*, and *Bulimus Tasmanicus*. I am of opinion, with respect to land and freshwater contemporaneous remains, that we ought to expect greater local difference in separate areas than in more widely separated contemporaneous areas of marine formations.

I am also inclined to think that we have better means of detecting, from fossil remains, the influences which affect contemporaneous distribution in marine mollusca than can be discerned from among corresponding remains in regard to a terrestrial flora.

In reading Lyell's description of the lacustrine formations of the Lower Miocene of France, I was much struck with their characteristics. If the local names be left out, we might apply his account as an excellent general description of the extensive lacustrine formations of Australia or Tasmania. He remarks :—

"Lacustrine strata, belonging for the most part to the same miocene system, as Calcaire de la Beauce, are again met with further south in Auvergne, Cental, and Velay. They appear to be monuments of ancient lakes, which, like some of those now existing in Switzerland, once occupied the depressions in a mountainous region, and have been each fed by one or more rivers and torrents.

"The country where they occur is almost entirely composed of granite and different varieties of granite-schist, with here and there a few patches of secondary strata much dislocated, and which suffered great denudation. There are also some vast piles of volcanic matter, the greater part of which is newer than the freshwater strata, and is sometimes seen to rest upon them, while a small part has evidently been of contemporaneous origin.

"The study of these regions possess a peculiar interest very distinct from that derived from the investigation, either of the Parisian or English tertiary areas, for we are presented in Auvergne with the evidence of a series of events, astonishing magnitude and grandeur by which the original form and features of the country have been greatly changed, yet never so far obliterated but that they may still, in part at least, be restored to imagination. Great lakes have disappeared, lofty mountains have been formed by the reiterated emission of lava preceded and followed by showers of sand and scoriæ, deep valleys have been subsequently furrowed out through masses of volcanic origin ; at a still later date new lakes have been formed by the damming up of rivers, and more than one assemblage of quadrupeds, birds, plants, eocene, miocene, and pliocene, have followed in succession. Yet the region has preserved from first to last its geographical identity, and we can still recall to our thoughts its external condition and physical structure before these wonderful vicissitudes began, or while a part only of the whole had been completed."

This remarkable picture of the lacustrine formations of the south of France would be a wonderfully faithful

description if taken with special reference to similar formations of vast extent in Victoria and Tasmania. Take, for example, the following description of one single local deposit (the Launceston Tertiary Basin) given by me in a former paper:—

"The height of the remains of the original strata of this system indicates that the lake must have stretched over a very wide expanse of country in the direction of the existing valleys and plains, and its extent must have been not less than 600 square miles. The denudation which has taken place subsequently has been very great . . . . . It is no exaggeration to say that 15 to 20 miles of strata, one-half to two miles broad, and 400 to 500 feet thick, have been swept away from the immediate vicinity of Launceston alone."

Upon palæontological grounds, as well as upon other important evidences, I am of opinion that the so-called "deep leads" of Beaconsfield (Brandy Creek), referred to in a former paper, are members of the Launceston Tertiary Basin, and upon considerations of a similar character I think there is now little room for doubt but that the auriferous and associated drifts at Haddon, Ballarat, Bacchus Marsh, Tangil River, Daylesford, Werribee, Beechworth, Gulgong, Orange River, Richmond River, Darling Downs, &c., &c., are of the same age. In Tasmania, for similar reasons, I would include the leaf beds of Macquarie Harbour, referred to by Mr. Gould, and the freshwater limestone of Geilston Bay, and vicinity of Trinity Hill, Hobart Town.

The characteristic genera are common to all the beds named, viz., *Laurus*, *Penteune*, *Conchotheca*, *Platycoila*, *Spondylostrobus*.

Remains of *Spondylostrobus Smythii*, F.v.M., foliage fruit, or woody tissue, are found abundant in the various drifts in New South Wales, Victoria, and Tasmania, particularly at Haddon, Orange River, Beaconsfield, and Breadalbane.

Conchotheca turgida, F.v.M., has a still wider range, as it is also found on the Darling Downs, Queensland, and Mr. Brough Smythe adds "probably in drift underlying volcanic rocks."

Platycoila Sullivani, F.v.M., is the most abundant fruit in the deep leads at Beaconsfield. It is also most plentiful in the Haddon leads, and I think I have traced casts of it in the travertin. Certain seeds figured by Mr. Morton Allport approach it very closely. The genus *Penteune* is common to the beds at Beechworth, Victoria, and the travertin, Hobart Town.

Penteune Allporti, F.v.M., of the travertin, approaches very close to *P. Clarkei*, F.v.M., of Beechworth.

Araucaria Johnstonii, F.v.M. Cone nearly perfect, asso-

ciated with abundance of foliage found by me at Geilston quarry during my last visit, together with other fruits of various genera, not yet described by Baron von Mueller, to whom they have been referred.

I have frequently seen impressions of *A. Johnstonii* in the beds of the Launceston Tertiary Basin.

The table of distribution prepared by me will give a more comprehensive view of the links which relate the widely separated deposits.

I think much of the uncertainty spoken of by Victorian geologists arises from association with the older classification. Prior to the determination of vegetable remains the various gold drifts were from very doubtful data assigned relative positions as Oligocene, Miocene, Lower, Middle, and Upper Pliocene, Alluvial and Post Pliocene.

The newer classification merely substitutes other names for those stated, giving the impression that the separate names still represent different geological periods. I do not think that the mere sequence of eruptive rocks should divide periods. I am inclined to think upon palæontological grounds that the majority of the leaf beds are of much older date than is generally supposed. If we must decide between Pliocene and Miocene, I should certainly, with Professor McCoy, incline to the latter period. My confidence in this opinion is increased, when I think of the immense amount of valuable work performed by such men as Rev. J. E. Tenison-Woods, Professor Tate, Professor McCoy, Professor Duncan, Robert Etheridge, jun., Baron von Müeller, and others.

The former gentleman has up to the present time determined the greater part of our tertiary marine fauna, and the latter the terrestrial flora.

I agree with Mr. Woods in a statement recently made before the Royal Society of New South Wales, that, although "it was not easy to judge by the percentage system, as our knowledge of the existing fauna is so imperfect, yet I think, upon consideration, that the imperfection of this knowledge has been exaggerated."

I also agree with him that we know a good deal of the Corals, Foramenifera, Mollusca, and Flora, although there is hardly time yet for the knowledge to be very widely circulated. The splendid catalogue compiled by Mr. Robert Etheridge, jun., however, will speedily dispose of the latter difficulty.

Of tertiary marine testaceæ alone there are nearly 300 species described. Thirty new species were recently described by myself in a paper read before this Society.

Of the testacea only about five per cent. are known to exist. This continual lessening of the percentage of living to extinct

forms as our knowledge increases is most significant. According to the principle which has been adopted by Mr. Lyell, and, through him, by nearly all the English geologists, this low percentage of living representatives indicate rather more an eocene than a miocene age for our marine beds of Table Cape. This, too, is in accord with views recently expressed by Mr. Woods.

There is no reason why the same principle, that of percentage of extinct to living species, should not apply to Australia as well as to Europe. The only objection which I have raised against tracing relations with European beds referred more to identification with particular deposits than to periods based upon the degrees of difference between the life of the past and present. The objection to applying the percentage principles in the latter respect is insufficiency of material for purposes of comparison, but I think the force of this objection, in the light of our present knowledge, is not of great weight.

To Baron von Müeller, more than to any other, we owe the knowledge we have of our relations between the present and past of our Australasian Botany. There are now nearly 100 fossil plant remains of the tertiary drifts figured and described, the greater part of which has been carefully determined by the learned Baron from fruits; and, though, for the most part, conclusions based upon plant remains are, as compared with testaceous remains, less satisfactory, yet the acknowledged skill and scrupulous care of our leading phytologist are sufficient warrant for taking the evidence from plant remains as of equal value with the evidence from testaceous remains. With the doubtful exception of remains of two ferns, *Lomaria* and *Trichomanes*, found by me near Launceston, all the plant remains figured or described are of extinct species. This fact, more than any other, speaks of the great antiquity of the formations in which they occur. Although the orders are principally of the same character as the existing ones, yet both the genera and species are for the most part distinct from existing genera and species.

I believe there is yet much undescribed material in local museums and in collectors' hands, but I do not expect that it will, when described and published, do more than confirm conclusions already inferred from existing data. Much may yet be done towards increasing our knowledge of our land and freshwater fauna of tertiary age. Such evidence will be of considerable importance in determining the relations of isolated leaf beds.

In this respect the fossil shells of the Geilston Bay yellow limestone are of great value. Hitherto only two of them

have been discovered, viz., *Helix Tasmaniensis*, G. B. Sowerby, and *Bulimus Gunnii*, G. B. Sowerby. By the kindness of Messrs. Legrand and Roblin I have been permitted to examine their respective collections, and have succeeded in determining two new species, viz., *H. Huxleyana*, mihi, and *H. Geilstonensis*, ibid. I have also been able, from various specimens, to identify another shell as a variety of the existing well-known Tasmanian species, *H. Sinclairi*.

This latter form appears to be the only representative of existing species, although there are characteristics of *H. Tasmanensis*, which relate it to that group of existing shells of which *H. Stephensi* may be taken as the type.

To enable other workers to know readily the features of our lacustrine deposits I have prepared a table of the distribution of the flora and fauna of the fluviatile and lacustrine deposits of Australia and Tasmania of tertiary age. The post tertiary deposits are not included.

I also append descriptions of the following species, viz. :—

Helix Tasmaniensis, G. A. Sowerby (amended.)

Helix Huxleyana, n.s., mihi.

Helix Geilstonensis, n.s., mihi.

Helix Sinclairi, var. Cox (still existing.)

A species of Unio, occurring abundantly in the Launceston Tertiary Basin, is now being described by Mr. Robert Etheridge, jun., F.G.S.

As, out of the six shells only one is represented among the living species, the percentage of existing, as compared with extinct forms, is about 17 per cent.

Of course a percentage from such a small number taken by itself, is of doubtful value, but as it supports conclusions drawn from the remarkably rich fossil flora it is of the greatest importance to those who may wish to study the matter.

Helix Tasmaniensis, G. B. Sowerby.

As the description given by Mr. Morris, p. 298, Strzelecki's N.S.W. and V.D.L., is somewhat defective, having been taken from an imperfect cast. I submit the following amended description :—

Shell thin, globosely conical, umbilicated; whorls $4\frac{1}{2}$, rapidly increasing, ornamented with fine obliquely-arcuate striæ, crossed by fine spiral lines as in the *H. Stephensi* group, flatly convex above, convex below, last whorl tumid, and slightly descending in front; suture somewhat impressed, spire depressly conical; umbilicus deep, narrow, scarcely one-sixth of the diameter; aperture oblique, ovately lunate, peristome simple; margins slightly approximating basal margin, slightly dilated and reflexed. Greatest dia., 30 mil.; least, 25 mil.; height, 20 mil.; dia. of umbilicus, 4 mil.

Fossil Yellow Limestone (travertin), Geilston Bay, Hobart Town. This, with the exception of the living species, *H. Launcestonensis*, is the largest known Helix in Tasmania. In certain characteristics, especially in sculpture, it approaches more closely to the group of shells represented by *H. Stephensi* than to any other species now existing in Tasmania.

Helix Huxleyana, n.s.

Shell very minute, sub-discoid, widely umbilicated; whorls $4\frac{1}{2}$, regularly increasing, flatly convex above and below; no trace of sculpture; suture impressed; spire slightly elevated; umbilicus open, shallow, one-third the diameter; aperture lunately oval, margin simple. Greatest dia., $2\frac{1}{2}$ mil.; least, $2\frac{1}{4}$ mil.; height, 1 mil.

Fossil, Yellow Limestone (travertin), Geilston Bay, Hobart Town. This shell was described from the cast of a solitary specimen, kindly sent to me by Mr. Roblin, from the Museum collection.

Helix Geilstonensis, n.s.

Shell orbicularly depressed, narrowly deeply perforate, smooth (?); whorls, $3\frac{1}{2}$ to $3\frac{3}{4}$, rapidly increasing, flatly convex above, markedly convex below; spire flatly convex; suture impressed; base sharply, suddenly excavate around the deep, narrowly-crateriform umbilicus; aperture large, sub-quadrately lunate; columellar margin, somewhat obliquely produced and reflexed; margins approximating, simple, slightly expanded above and below. Greatest dia., 22 mil.; least, 18 mil.; height, 13 mil.

From Yellow Limestone, Geilston Quarry, near Hobart Town. The species is described from a well-preserved cast. No trace of sculpture could be detected on the specimen examined by me, although it is probable the whorls may have been ornamented by transverse striæ like most of the existing species in Tasmania.

Helix Sinclairi, Var.

Shell depressed, discoid, umbilicate; spire flattened; whorls 4, rapidly increasing, flatly convex above, convex below, ornamented by somewhat coarse regular obliquely-arcuate striæ;* umbilicus narrow, almost perforate, scarcely one-fourth the diameter; aperture obliquely lunate ovate; columellar margin, approximate, slightly reflexed below, scarcely expanded above; lip simple, thin. Greatest dia., 13 mil.; least, 10 mil.; height, 7 mil.; dia. of umbilicus, 3 mil.

Fossil, Yellow Limestone (travertin), Hobart Town. The above species is without doubt identical with the living species, so far as external characters go. Of course such

*The ornamentation was observed by me in a specimen sent to England. The cast only is preserved in the specimen sent to me by Mr. Legrand.

transient features as colour and transparency, which separate the existing shells *H. Sinclairi* and *H. bombycina* are not preserved, but as the existing species named are only recognised by me as varieties of one species, the absence of such features are unimportant.

Bulimus Gunnii, G. B. Sowerby.

Strzelecki's N.S.W. and V.L., p. 298. Shell oblong-oval, thin, whorls 4 to 5, subventricose, smooth (?); suture conspicuous. A species, says Mr. Morris, which resembles *Bulimus granulosis* in form, differing from that species, however, in being exceedingly thin. As we have only the cast of the inside we cannot further describe it.

Loc. near Yellow Limestone, Hobart Town. From the fragments of the species submitted to me, I should infer that it is closely allied to the existing species, *B. Tasmanicus*. The whorls are striated, irregularly, transversely, as in the existing species, *B. Tasmanicus*.