Diemen's Land, is one published in the *Relation de divers voyages curieux.* 4 parties en 2 vol. fol. Paris. 1663-96.§ This work, edited by Melchisedech Thévenot, contains a portion of what is known as the Stadthouse Map, which consisted of two projections of the terrestrial and one of the celestial sphere carved in stone on the floor of the great hall of the Amsterdam Stadthouse, which was built in the year 1648. The portions relating to New Guinea (here separated from Australia), *Hollandia Nova, Zeelandia Nova,* and *Anthoni Van Diemens Landt* are evidently based upon the two earlier charts, and have been preserved by Thévenot and reproduced by Harris in his *Navigantium atque Itinerantium Bibliotheca,* 2 vols. fol. Lond. 1744-48. Marion, Furneaux, Cook, Dentrecasteaux, Flinders, and Baudin, have left charts which are to be found in the works abovementioned.

There is a chart of the Derwent emanating from the expedition of Hayes; but that, along with the memoirs of the expedition was captured by a French man-of-war, and transferred to a public institution in Paris. (v. Low's *History of Indian Navy,* i. p. 200.)

SUMMARY OF OBSERVATIONS ON EARTHQUAKE PHENOMENA MADE IN TASMANIA DURING 1883 AND 1884.

By Commander Shortt, R.N., Meteorological Observer, Hobart.

[*Read November* 17, 1884.]

During the last eighteen months Tasmania has been visited by so many earthquake shocks, that general interest has been excited and favourable opportunities afforded for studying some of the phenomena connected with them.

Unfortunately for scientific purposes we have not yet experienced a really serious and destructive shock, such as would have rendered the island famous, and perhaps have afforded the survivors opportunities of adding largely to what is known about earthquakes. Some of the shocks, however, have been sufficiently pronounced to be readily felt over large areas, and a number of intelligent observers have carefully recorded what they observed, and the reports received

C About centre of disturbance
Numbers represent localities
Shocks felt on curves nearly contemporaneously

Inside dotted line from 0 to 200 fathoms
" the blue trough 2000 to 5000 fathoms

Photo-lithographed at the Crown Lands Department Hobart

TABLE GIVING DATE AND FORCE OF THE SEVEREST EARTHQUAKE SHOCKS FELT IN TASMANIA DURING THE YEAR 1884.

S=Very severe. *s*=Severe. *R*=Long and loud rumblings. *r*=Rumblings. *l*=Slight. A.=A.M. P.=P.M. *T*=Twin shocks.

Month.	*Date.*	1 *Falmouth.*	2 *George's Bay.*	3 *St. Mary's.*	4 *Fingal.*	5 *Gould's Country.*	6 *Moorina.*	8 *Swan Island.*	9 *Cape Barren Island.*	10 *Goose Island.*	11 *Kent's Group.*	12 *Ross.*	13 *Launcestan.*	14 *Hobart.*	15 *Circular Head.*
January	4	11 A. *s*	..	10·55 A. *l*	..	..	10·40 A. *s*	..	..	..	..	..	..	10·51 A. *l*	
February....	8	9·10 A. *s*	..	8·40 A. *S*	..	..	9 A. *s*	..	..	..	..	..	..	8·57 A. *l*	
Ditto ..	14	9·55 P. *s*	..	9·30 P. *S*, 9·45 P. *s*	..	..	9·40 P. *S*	..	..	..	9·20 P. *S* 60″	..	..	..	
Ditto ..	17	3·30 P. *s*	..	3·35 P.	3·40 P. *R*	..	3·37 P. *s*	..	..	..	3·25 P. *S*	..	..	..	
Ditto ..	28	..	..	..	..	..	3·20 A. *s*	..	..	..	3·50 A. *s*	..	..	4 A. *s*	
March	26	..	..	..	..	11·55 P. *S*	11·12 P. *S*	..	..	11·20 P. *s*	11·40 P. *s*	..	11·36 P. *S*	11·45 P. *s*	
Ditto ..	5	7·45 P. *s r*	..	7·35 P. *s*	..	..	..	..	..	..	7·45 P. *s*	..	..	..	
April	12	7 A. *s*	..	7 A. *s*	..	..	6·58 A. *s*	..	..	..	..	..	7 A. *l*	7 A. *s*	
Ditto ..	22	8·45 P. *s*	..	8·30 P. *s*	..	..	8·48 P. *s*	..	..	..	..	..	8·35 P. *s*	..	
May	10	10·30 P. *s*	10·50 P. *s*	10·45 P. *s*	..	10·55 P. *S r* 20″	10·54 P. *s* 60″	..	..	10·45 P. *s r*	10·40 P. *s*	10·35 P. *s r*	10·42 P. *s R*	10·43 P. *s r*	
Ditto ..	11	7·30 A. *s*	..	7·30 A. *S*	7·35 A. *s r*	7 55 A. *S r* 30″	7·46 A. *s R T*	..	..	8 A. *s r*	7·35 A. *s*	7·37 A. *S*	7·36 A. *s R*	7·40 A. *s*	8 A. *l*
Ditto ..	27	..	..	8·30 P. *s*	..	..	8·22 P. *S T*	..	..	8·30 P. *s r*	8·25 P. *S* 60″	..	8·25 P. *s*	8·28 P. *s*	
June	9	..	..	7·45 P. *S*	..	..	7·35 P. *S*	7·30 P. *s*	7·45 P. *s*	7·40 P. *s R*	7·30 P. *s*	..	7·38 P. *s*	7·40 P. *l*	
Ditto ..	17	8·30 P. *s*	..	8·30 P. *s R*	..	..	8·35 P. *s T*	8·26 P. *s*	8·20 P. *S*	8·25 P. *s r*	8·17 P. *S*	..	8·25 P. *s*	8·28 P. *l*	
Ditto ..	23	..	..	..	6·50 A. *s*	..	6·45 A. *s*	..	..	..	6·50 A. *S*	..	6·56 A. *S*	7 A. *s*	
July	12	1·40 P. *s*	1·40 P. *s*	1·30 P. *S R*	1·45 P. *l*	1·50 P. *s R*. 60″	1·40 P. *s R*	1·35 P. *s*	..	1·40 P. *S*	..	..	1·42 P. *s*	1·45 P. *l*	
Ditto ..	13	1·55 P. *S*	1·55 P. *R S*	1·50 P. *S*	2 P. *s*	2 P. *S*	1·55 P. *S R*	1·20 P. *S R*	..	1·50 P. *S*	1·35 P. *S*	..	1·56 P. *S*	1·57 P. *S R*	8·35 P. *l*
August.....	11	2·45 P. *s*	..	..	..	2·40 P. 30″	2·30 P.	..	..	2·37 P.	..	..	2·43 P.	2·45 P.	
Ditto ..	15	7·48 P. *l*, 7·32 P. *l*	..	7·30 P. *s R*, 7·35 & 7·40 P. *l*	7·40 P. *s*	..	7·35 P. *s*, 7·50 P. *l*	7·30 P. *s R*	..	..	..	..	7·40 P. *s*	7·42 P. *s*	
Ditto ..	29	11·15 A. *S*	..	11 A. *S*	11·15 A. *S* 20″	11·10 A. *s R*	11·5 A. *S R*	10·55 A. *s R*	..	..	11 A. *S* 60″	..	11·5 A. *s*	11·6 A. *s*	
September ..	19	8·50 P. *S*	8·35 P *S*	8·35 P. *S*, 60″	8·30 P. *S* 90″	8·35 P. *S*	8·40 P. *S*	8·39 P. *S R*	..	8·40 P. *S*	8·27 P. *S* 40″	..	8·38 P. *S* 30″	8·40 P. *S* 30″	8·40 P. *l*
October ..	31	..	..	10 P. *s*	10 P. *s*	..	10·5 P. *s T*	10·10 P. *s*	..	10·15 P. *l*	..	..	9·56 P. *s R*	..	
November ..	3	..	..	..	10·50 P. *l*	..	..	10·50 P. *l r*	..	..	..	..	10·46 P. *l*	10·45 P. *l*	
December ..	..	..	..	..	..	..	11·3 P. *l*	..	..	..	..	..	..	10·59 P. *l*	

have been tabulated and arranged. Although it would be useless to attempt to reproduce all the reports, yet it seems desirable to bring a short abstract of them before the Royal Society as the chief scientific body in Tasmania, so that members and others may be put in possession of what has really happened, and of the results which may be fairly deduced from the observations. It is hoped that interest in these observations may be thus stimulated, so that any shocks which occur in the future may be more carefully observed and recorded, and we may hope that in time many of the questions which remain for solution may be satisfactorily answered, and others on which one has to speak with great caution may be completely established.

Before discussing reports received it may be well to state briefly the direction in which our enquiries and observations should be made, and what we may fairly hope to learn by careful observation.

In the first place we can hope to learn little as to the causes of earthquakes. With these, although a fertile field of controversy for those who delight in it, we, as observers, have little to do, and therefore they will only be alluded to briefly at the end of the paper.

But there are many problems awaiting solution to which we may devote our attention. Thus we ought to try and find the point directly above the disturbance which causes the earthquake, and from which the "seismic vertical" passes down to that centre. Then to find the directions in which the shock travels out from the centre, and the places at which it arrives simultaneously, so as to determine the coseismic lines, and whether they are circles, ellipses, or quite irregular. To observe the rate at which the wave of disturbance travels; whether the rate varies in passing through different descriptions of rock, and if so, by how much.

If it is ever reflected or thrown back at the junction of dissimilar rocks,

To determine, if possible, the angle at which the vibration reaches the surface of the ground at different places, and thence to calculate the depth of the disturbance and length of the seismic vertical.

Then the exceedingly important and difficult problem whether any change in the level of the ground has accompanied or followed the earthquake, and if so, whether the change, either elevation or depression, is permanent. Again, whether the shock has been felt equally at all places in the same neighbourhood, and if not, what determines the difference.

These are some of the points on which we may hope to obtain information, but there are others which can be

obtained in particular places, or under special circumstances, such as the effect produced on the waters of the sea, or of lakes, and if any alteration is observed in the flow of rivers and streams, how far the shock was felt in mines, and in what way, etc.

Now, let us see what can be gathered from the observations which have already been made in Tasmania.

Unfortunately, as already mentioned, the shocks have been too slight for us to hope for any information on many of the points enumerated, while the reports do not agree sufficiently as a rule to enable us to speak with much confidence on others.

The first thing that strikes one on looking over the tabulated reports is the enormous number of shocks which have been felt. Thus, in the month of February, 1884, nearly one hundred shocks and tremors were felt at St. Mary's, and in some months of 1883 and 1884 this number has been exceeded. Similarly numerous are the reports from Gould's Country and Moorina, so that since April 12, 1883, when the first shock was recorded at Gould's Country, over one thousand distinct shocks have been felt, besides many which must have passed unnoticed. Of course a very large number of these were mere tremors, and such as would be likely to pass unnoticed by most people. Indeed, one doubts whether they would be felt at all were not their attention attracted by the noise which so often appears to *precede* the shock.

Any one who has lived in the vicinity of a railway, especially one on which heavy luggage-trains pass at a high rate of speed, will know what very slight tremors may be felt at a comparatively long distance from the source of vibration. Although every shock reported is carefully tabulated at the Meteorological Office, with the date, alleged time, whether severe, slight, etc., it will only be desirable to allude individually to a few of those which, from their severity and the wide area over which they were felt, are of special importance and interest.

The great majority of the slight shocks do not seem to have been felt beyond the N.E. parts of Tasmania, so that the centre from which they originated would seem to be not very far off, although probably under the sea. As to the severer shocks, I have prepared a table showing the places where some of them were felt, and the reported time of occurrence. Before discussing the table it may be well to state briefly what is to be learned from it.

It is, of course, known that the shocks are supposed to originate at about the same place; and if we find that the same shock is felt at certain places at the same time, we

can draw through those places on a map a co-seismic line, and if the shocks travel at an equal rate in all directions, the co-seismic lines will be circles, and of course places near the centre of disturbance will feel the shock earlier than those more remote. Further, if we can show that two places are on the same line drawn from about the centre of disturbance we ought to be able to demonstrate the rate at which the vibration travels between the places.

The times reported for the different shocks do not agree very well, so that it is difficult to base any reliable conclusions upon them. Something, however, may be done by comparing the reports of several shocks. Thus, if we take a few dates, and arrange the places in the order of the time at which the shocks are said to have occurred, we find :—

November 14, 1883.—Kent's Group, 2·45 p.m.; St. Mary's, 2·50; Swansea, 2·52; Launceston, 2·55; Gould's Country, 2·55; Falmouth, 3; George's Bay, 3; Moorina, 3·5; Hobart, 3·10.

December 12.—Kent's Group, 6·45 p.m.; Gould's Country, 6·48; Launceston, 6·59; Falmouth, 7; St. Mary's, 7.

March 28, 1884.—Goose Island, 11·28 p.m.; Launceston, 11·36; Kent's Group, 11·40; Hobart, 11·45.

On May 10 and 11 the shocks were severe, and we find—

10.—Falmouth, 10·30 p.m.; Ross, 10·35; Kent's Group, 10·40; Launceston, 10·42; Hobart, 10·43; Goose Island, 10·45; St. Mary's, 10·45.

11.—St. Mary's, 7·30 a.m.; Falmouth, 7·30; Kent's Group, 7·35; Fingal, 7·35; Launceston, 7·36; Ross, 7·37; Hobart, 7·40; Goose Island, 8; Circular Head, 8.

Then, June 17.—Kent's Group, 8·17 p.m.; Cape Barren Island, 8·20; Goose Island, 8·25; Swan Island, 8·26; Launceston, 8·26; St. Mary's, 8·30; Falmouth, 8·30; Hobart, 8·30; Gabo Island, 8·55.

July 13.—Swan Island, 1·20 p.m.; Kent's Group, 1·35; Goose Island, 1·50; St. Mary's, 1·50; Falmouth, 1·55; Moorina, 1·55; George's Bay, 1·55; Upper Ringarooma, 1·55; Launceston, 1·56; Hobart, 1·57; Gould's Country, 2 p.m.; Wilson's Promontory, 1·43; Eden, 2 p.m.; Gabo, 2·20.

August 29.—Swan Island, 10·55 a.m.; St. Mary's, 11; Kent's Group, 11; Moorina, 11·5; Launceston, 11·5; Hobart, 11·6; Gould's Country, 11·10; Falmouth, 11·15; Fingal, 11·15.

The severe shock on September 19 is reported as—Kent's Group, 8·27; Fingal, 8·30; St. Mary's, 8·35; Gould's Country, 8·35; George's Bay, 8·35; Launceston, 8·38; Swan Island, 8·39; Hobart, 8·40; Circular Head, 8·40.

These observations may help to fix the centre of disturbance. Thus the slight shocks, as mentioned, are confined to N.E. Tasmania, while the severer shocks may reach the West Coast of Tasmania, South Victoria, and New South Wales. The places which appear to feel the shocks earliest are Kent's Group, St. Mary's, Swan Island, and places round, later, Launceston, and afterwards, Hobart, Circular Head, etc., and later still, Gabo, and places on the Continent.

Some time since an opinion was published by me that the disturbances originate under the sea to the E. of Barren Island, and this is confirmed by a consideration of subsequent observations, some of which are given above, as well as by reports from ships at sea in that neighbourhood.

It may be admitted, however, that there are serious discrepancies in the times reported for many of the shocks, and this is what we might expect, as such may arise from various causes. For instance, it is almost certain that the correct time is not in all cases reported. Clocks and watches are often out of time, and again, many persons would forget to look at the clock at the time of shock, and afterwards guess it approximately. As one cannot tell how often such mistakes occur, it is only by comparing the reports of a considerable number of shocks that one can speak with any confidence. Another explanation of the discrepancies would be to suppose that the shocks emanate from different centres. This is possible, but must be used with great caution in reasoning, as, unless we suppose the shocks originate about the same place, the value of the observations made as yet would be very small indeed. At the same time, it is very possible that the centre of disturbance is not at a point, but may be along a line. It is also possible that all the shocks do not travel at the same rate. As to this, although a subject of great interest, we cannot say anything at present.

As to the direction from which the shock seems to come, few reliable reports have been received, and even those which have come to hand are little more than rough approximations. In many cases, too, observers appear clearly to have reported the shock as travelling in exactly an opposite direction to the real one, *e.g.*, S. to N. instead of N. to S. However, the reports which seem to be tolerably reliable give a direction such as we might expect if they originate about the place stated.

Of the angle of emergence of the vibration scarcely anything is known, as the shocks are generally much too slight to leave permanent traces, such as cracks in buildings, from which evidence might be obtained on the point, so that we are not yet in a position to calculate the depth at which the disturbance takes place. Similarly we have no direct

evidence of alteration in the level of the land. This, however, is always very difficult to determine even on the sea shore, while inland it is very unlikely indeed to be noticed if slight. It may be well to allude here to the idea that the source of disturbance was or is near New Zealand. This seems to be very unlikely, as most of the shocks are only felt over a small area, and in the case of the severer ones in which there are discrepancies in time, besides the sources of error already mentioned, it must be remembered that the "coseismic lines" are not likely to be true circles, since, in the case of earthquakes in Europe, a shock has been known to travel twice as fast in one direction as it does in the opposite, and it is well known that in South America most of the earthquakes are felt over much longer distances parallel to the chain of the Andes than transverse to that line. Besides this, we have reports from New Zealand that few shocks or tremors have been felt there recently.

It is probably known to most here that Tasmania is united to Australia by a submarine plateau, and that the water is never deeper than 100 fathoms. Beyond the East Coast of Tasmania and Australia the sea bottom rapidly sinks to a depth of over 2,000 fathoms, and continues deep until approaching the coast of New Zealand, so that a deep trough divides us from New Zealand, and earthquake shocks originating there would have to be at a considerable depth to be strongly felt here.

We may therefore claim, I think, to produce our own earthquakes, and not to be dependent for the supply on New Zealand.

As to whether we shall be favoured with a really serious and interesting shock, of course no one can say. But while it would be foolish to deny the possibility of its occurrence here, as it would be in any other part of the world, it would be equally unphilosophical to imagine that, because we have had many slight shocks, we shall therefore have a great one, since it is well known that really severe shocks, which are never common, while they are sometimes preceded by slight ones, in many cases occur without any warning at all. The great earthquake of Lisbon of 1755 is a case in point, and many others might be mentioned. Many places also, such as Comrie, in Perthshire, Scotland, have very many slight shocks, but have never been known to experience a serious one.

The great interest, indeed, of our earthquakes, in a scientific point of view, is the occurrence of such a large number of slight shocks close together in a country where they were previously very rare.

About the causes which produce earthquakes, but little

need be said. It is admitted by the best authorities that we know but little of the condition of the interior of the earth, or how the forces with which we are familiar at the surface, act within the earth so as to produce earthquake and volcanic phenomena.

We know that many, perhaps most, rocks even near the surface, are in a state of strain, and that if at any time they yield to this strain a vibration will result which will be propagated through the earth as a tremor or shock. We know also that at a short distance from the surface of the earth in most parts of the world a very high temperature prevails. Also that water is present in most rocks, and that either in the liquid or gaseous state it appears to play a great part in all volcanic eruptions, and to have been present during the formation of most granite and other crystalline rocks. But when we have said this we have to admit that almost all the rest is still in the region of theory or hypothesis.

Of course it is easy to shew that, if the temperature goes on increasing at the rate of about 1° F. for 65ft. of depth, as it does near the surface, we should have at a depth of a few miles an enormous heat. But then we are not sure that it does go on thus increasing, and even if it does we don't know the materials which exist within the earth, or how thew would behave at temperatures, and under pressure of which we have no experience at the surface. It is tolerably clear also that volcanoes are allied to severe earthquakes, but whether all earthquakes are due to similar causes is not so clear.

We know that vast masses of molten rocks must exist within the earth in some places and at some times, since they are poured out at the surface, but we are not, therefore, justified in assuming that the whole interior of the earth is liquid.

Under these circumstances it is far better for those who desire to advance the cause of science to confine themselves to observing rather than to propounding theories.

From what has been said it will be seen the directions in which observations of earthquake phenomena are wanted, and any intelligent person may be placed in a position where careful and judicious observation will lead to valuable results. The time of shocks should be noted with especial care, and if an observer is not sure of the exact time, that should be stated, so that it may be tabulated accordingly. Again, some rough form of seismometer may be devised to determine approximately the direction of the wave. A basin of mercury or treacle, a few pieces of wood, or similar arrangement may furnish a good result if carefully attended to, as an elaborate seismograph or seismometer which may be out of order at the very time it is wanted. If clocks are

stopped by a shock, it may possibly be found that those only stop whose pendulums vibrate in a particular plane. This should be noted.

In conclusion, it is only right to acknowledge the large amount of trouble which has been taken by many observers in all parts of the island in recording and forwarding reports of the shocks they have felt. Especial mention may be made of:—

Mr. J. R. Hurst, District Surveyor, Moorina,
Mr. A. Campbell, of St. Mary's,
Mr. O. C. Heiden, Gould's Conntry,

owing to the very large number of shocks which they have had to record.

NOTES ON THE INFUSORIAL PARASITES OF THE TASMANIAN WHITE ANT.

By W. Saville-Kent, F.L.S., F.Z.S., Superintendent and Inspector of Fisheries, Tasmania.

[*Read, November* 17, 1884].

So long since as the year 1856, Mr. C. Lespes, in a memoir devoted to the organisation of the European White Ant (*Termes lucifugus*), recorded the fact that the contents of the intestine of this insect is represented by a brown pulp consisting chiefly of a living agglomeration of Infusoria. No specific description of these Infusoria has been published up to the present date, and it is only so recently as the year 1881, that a detailed account, with illustrations, of the analagous parasites of the American White Ant (*Termes flavipes*), has been contributed by Dr. Joseph Leidy to the "Proceedings of the Academy of Natural Sciences," Philadelphia. Through the kind courtsey of Dr. Leidy, I was enabled to include re-prints of his drawings of these parasitic animalcules in my monograph of the Infusoria then in course of publication, and subsequently received from him while residing in London, a supply of the White Ant with its accompanying parasites for personal examination.

It was with much interest that I discovered soon after my arrival in Tasmania, that a species of White Ant (specific name at present undetermined) abounds in this colony, feeding after the manner of the North-American type upon decaying timber, and having its intestine similarly laden with parasitic Infusoria. On making a close examination of these Infusoria I ascertained furthermore that they agreed with