

Mus. The whole Mammals of Tasmania may then be classed thus:—

CHEIROPTERA	3
CARNIVORA (Seals)	3
CETACEA	5
RODENTIA	6
MARSUPIALIA	19
MONOTREMATA	2
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	38
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Penquite, 1st September, 1851.

X. *Report on the Coal said to have been found at the Don River, and upon the West Bank of the Tamar River, in Tasmania. By JOSEPH MILLIGAN, Esq., F. L. S. [Read 9th July, 1851.]*

Hobart Town, 11th June, 1851.

SIR,—I have the honour to report that, in obedience to instructions from His Excellency the Lieutenant-Governor, I recently proceeded to the Mersey and Don Rivers to examine the tract of country there on which Coal was said to have been found; and that I also devoted a week to the examination of both banks of the Tamar, from Whirlpool Reach downwards, with reference to a surmise of Coal existing there.

The entrance to the Mersey River, which is not wide, lies open and exposed to the full sweep of the winds, and has but little shelter from the roll of the sea directly in from Bass's Strait. There is a bar well out to seaward, which is said to

consist of sand, mud, and gravel; and there is, according to various reports, a depth of four to seven feet upon it at low water, with a rise of tide of from eight to ten or twelve feet. It is certain that, whatever the depth may be in the channel at low water, this river has ever been considered unfordable at the mouth by those who have been constrained to make the experiment.

The length of the estuary, in which there is deep water and absolute shelter for vessels, is about six miles. On the eastern side, the shore rises rather steeply into a chain of rounded hills of greenstone, heavily timbered, and covered with a deep-red ferruginous soil. Half-way up the bay, on the same side, the basset edges of sandstone, probably carboniferous, appear at the water's edge, rising into a cliff about twenty feet in height, with a dip under the hill to the north and east: it would therefore seem that this greenstone range reposes on a basis of sedimentary rocks. It is on the eastern side of the broad estuary that the deep and nearly straight channel runs; while on the western side there is shoal water and extensive mud flats, succeeded by densely-timbered forest land, which recedes some distance to the westward, with much of the same low and flat character.

A band of greenstone, through which the Mersey has found or forced a passage to the sea, runs along the coast, communicating with successive ridges of greenstone, which, running inland in a direction nearly *south*, determine, in the main, the course of the principal rivers and streams. The distance of the average course of the Don River from that of the Mersey is about four miles: at the head of the estuary of the latter, the interval is somewhat greater. A line carried south-west from the fresh waters of the principal stream of the Mersey, opposite the township of "La Trobe," would reach the Don River at or near the point where the Coal crops

out, and the distance there would probably be about five miles.

The intervening space is for the most part densely clothed with heavy timber trees and brushwood, consisting of Stringybark (*Eucalyptus gigantea*), White gums, Muskwood (*Eurybia argophylla*), Hop-pole trees (*Pomaderris elliptica*), &c. &c.

The fresh waters of the Mersey run for two miles, before they merge in those of the estuary, through an even and comparatively level piece of alluvial land, admirably fitted for the plough, and yielding a rich natural pasturage, with no inconsiderable sprinkling of clover: this area narrows as it retires from the bay, until the hills on one or both sides shelve down abruptly to the very margin of the river. At different points on both sides of this flat may be traced a succession of terraces, each a few feet in elevation, indicating the recurrence at intervals of an elevation of the surface, leading to increased depth of river channel and narrower volume of contents. Leaving the stream of the Mersey at its junction with the estuary on a south-west course, the grassy flat is soon found to be hemmed in by a highly-inclined bank of sand and pebbles, more or less rounded,—the *detritus* of a conglomerate formation, which is very prominently developed over the tract of country extending on the eastern side of that river in the direction of the “Native Plains” and Deloraine. This highly-inclined bank, on the western side of the valley, corresponds to or is equivalent for *two* if not *three* terraces on the opposite side, and is crowned with a flat of some extent, which is thinly covered with grass upon a somewhat peaty and very moist soil: to this flat succeeds a series of rounded eminences, or, rather, ridges thrown out from an elevated tier of greenstone, stretching to the southward. These rises are at first gentle, with a soil of sandy loam and

a little peat, supporting a vegetation of low ferns, with thickets of Prickly Mimosa (*Acacia verticillata*), and of various species of Tea-trees (*Leptospermum* and *Melaleuca*), interspersed amongst *Eucalypti* of moderate size, and comparatively thin on the ground.

Pursuing the bush-road as it winds close round the shoulder of the greenstone tier, the ridges or prolongations from it become higher and more steep; the water-courses more frequent and deeper, and the soil acquires the character of a stiff, tenacious, and humid loam, and is densely clothed with large and lofty trees of Stringy-bark, and umbrageous underwood, Tree-ferns, &c. &c.

The Don, running almost immediately at the base of this tier, on its western side, is but a small stream, with a channel for the most part shut in between high ridges, much obstructed with dead timber, and everywhere overhung with the sombre and massive foliage of the myrtle trees (*Fagus Cunninghamii*): its tributaries, though perennial, are insignificant rills, and drain but a small portion of the tract of country between it and the Mersey. The Coal rocks crop out here in the channel of the Don River, where it makes a rather sudden bend to the eastward, but only along a space of twenty to thirty yards. It was in this water-course, and more or less covered with water, that I had the opportunity of examining them. I was able to make out three beds of Coal, varying from about ten inches to fifteen and sixteen inches in thickness, dipping *quick* to the eastward. These are interstratified with a bluish white clayey sandstone, rich with impressions of strap-shaped leaves, and with layers of hard black bituminous shale, which breaks in slaty fragments—soils the fingers, yields a sooty black streak, and in a common fire crackles and burns with a bright steady flame of no long continuance: there is also associated a thick bed of blue

bituminous slate, having a cleavage across the plane of stratification, and breaking in wedge-shaped fragments—hard, but yielding slightly to the nail a whitish brown streak, and in a common fire burning with a long white flame and a crackling noise. With these occur a white gritty sandstone, the relative position of which I could not ascertain.

For upwards of 100 yards higher along the stream, the Coal beds are concealed under fragments of a very hard siliceous and siliceo-ferruginous conglomerate, which then stretches *in situ* across the course of the stream, and rises on the western bank, with a nearly perpendicular face, into hills of considerable elevation, having some appearance of stratification, with a slight inclination to the southward. It does not therefore appear to be conformable with the Coal series below. Lower down the stream, the banks which rise into steep rounded hills on the eastern side are composed of consolidated and nearly horizontal beds of a soft yellowish and schistose clay, probably of date long posterior to that of the Coal.

In the channel of a tributary of the Don River, about a mile higher up and on its eastern side, where the surface has again become comparatively even, fragments of a bituminous Coal occur over the schistose clay rock just mentioned, indicating the upheaval of the Coal beds, and their intersection by the rivulet at a still higher level.

Vague reports reached me of the existence of Coal at various points other than those now stated; but I found that they were not to be depended upon. With respect to the economical value of the Coal beds at the Don River—the quality of the Coal appears to be of the character of that of the West of England, bituminous, but not caking. The seams appear to be too thin, and far too much inclined, to be worked profitably: but they are unexplored, and need to be *proved*

equally as to thickness, direction, and extent; and it would be rash to determine what the character and value of them may be at some distance to the dip, without borings to prove their continuousness, and to determine whether or not the interstratified shale may thin out, and the several layers of Coal get so close as to be worked as one bed.

Supposing that this were satisfactorily determined, it remains to state the facilities for conveyance to market. I have shown that the distance in a direct line is at least four and a half miles to water-carriage; and that the high intervening ridge of greenstone sends out spurs of such magnitude and extent that a long curve, or rather series of curves, must be made to accomplish a practicable line for a tramway, which is considered to be the only description of road likely to pay. It appears to me, from a rough eye survey of the ground, that a good gradient could not be obtained under six miles; and that to effect it in about this distance a heavy expense must be incurred in filling up or throwing permanent bridges over several gullies.

In the present densely-timbered and unexplored condition of the country in the neighbourhood of the Don River, it is impossible for an individual explorer, without great labour, if at all, to acquire data upon which to form a positive opinion of the extent, direction, or value of the Coal beds there; while there seems no room whatever to doubt its excellent quality.

Returning to the Mersey River, its channel for two or three miles up was found to consist, with the exception of intrusive basalt at one place, of massive beds of hard bluish clay and clayey conglomerate, abounding in fossil shells,—amongst which appear *Productæ*, *Spiriferæ*, a few *Pachydomi*, *Platyschismæ*, *Turritellæ*, *Pectenides*, and some others: imbedded in the conglomerate are numerous smoothly-rounded pebbles,

from the unfossiliferous and compact blue limestone of the Western Marshes and Circular Pond Plains. In the bed of a creek which discharges into the Mersey on its western side, and about two miles above the estuary, the same fossiliferous clayey beds present themselves. In the channel of the Mersey itself these beds rise as they approach the dyke of basalt mentioned. This basalt traverses the bed of the river, and swells almost immediately into a hill 200 to 250 feet high on its eastern bank. There is, on the right bank of the river, upon the upper side of this eruptive dyke, and dipping towards it, a series of beds of a brown schist,* of a nature highly combustible: its surface is usually finely punctated—it is semi-soft, sectile, fissile, flexible, and slightly elastic, and when held to a candle burns with a strong yellowish white flame, emitting dense volumes of sooty smoke, and giving out a peculiar and highly-diffusive odour, somewhat like the smell of resin: so pervasive is the smell, that a small fire made of this fuel in the open air will sensibly “taint the gale” to more than a quarter of a mile. The residuum, when imperfectly burnt, is a brownish black slate, which, when more perfectly calcined, becomes white. As a fuel it yields both heat and flame, and remains incandescent, in the manner of earthy anthracite, after its more inflammable constituents have been consumed. The same brown combustible schist presents itself a mile higher up the river, and on the same side, but at an elevation of more than 100 feet above the water, and then it appeared to dip slightly into a high and rather steep hill, composed of a siliceo-ferruginous conglomerate, containing fragments of sea shells; but whether it dipped actually under this conglomerate, or abutted against it, could not be distinctly ascertained: I incline, however, to the opinion that it passes under the breccia.

* Allied to *Dysodite*.

The brown combustible schist exhibits at the elevation last mentioned a thickness of six to seven feet in one distinct seam, passing upwards into laminated clay rock of a yellowish colour, interstratified with thin layers of the schist.

Below the six feet seam there is, *for a space*, the same alternation as above,—but uninterrupted beds of compact yellowish and bluish white clays succeed; and near the river's level there occur, in the clay pebbles of quartz, fragments of *Pachydomi*, and rounded pieces of the blue unfossiliferous limestone of the Circular Pond Plains, which flanks the extreme Western Bluff, and afterwards crops out in great force along the course of the Mersey itself, far inland. Abounding in olefiant gas, as this combustible mineral of the Mersey does, it is scarcely possible to say whether it may be found available for any useful purpose: its peculiar and powerful odour would, to most persons, be a strong objection to its use as an ordinary domestic fuel; and for the purpose of making illuminating gas it would have these disadvantages—it would not form a coke, and the earthy and slaty residuum would tend to choke up the retorts. The occurrence in considerable numbers of rounded pebbles of the compact blue limestone of the Circular Pond Plains and the upper portions of the Mersey in these sedimentary beds suggests the probability of this limestone existing now *in situ* at no great distance; and indicates a period when the relative height of land and water was such as to allow the ocean to lash and abrade its massive sides, and to deposit at its bottom the smoothly worn fragments, intermingled with the various shells mentioned, in a matrix of clay with some sand. The occurrence of thick beds of fine clay and clay-schists without organic remains above the fossiliferous masses denote a tranquil condition of superstant waters, compatible only with the character of a capacious and sheltered bay, or

deep and extensive lake; to which supposition the subsequent deposit of repeated layers of a highly combustible schist of undoubted vegetable origin lends great probability. But, having mentioned the evidences for such a period of repose, the turbulent state of things which followed must be noticed. The immense masses of siliceous and siliceo-ferruginous conglomerate which overlie these clayey strata, and overspread the country far to the east and southward, must have been swept down from a higher level,—either from the rupture of the boundaries of large inland waters pent up at higher levels, and liberated by some disruptive action within the crust of the earth, or from a temporary submergence of the dry land, or a great portion of it under the sea, subjecting the surface to powerful and irregular currents in a shallow ocean kept unusually turbulent, probably by repeated elevation and depression of the land at short intervals. I have mentioned that the casts of marine shells occur occasionally, imbedded in the substance of the conglomerate.

An extended and close examination of these beds, and the formations with which they are associated, and a careful comparison of their fossil contents, will be required thoroughly to establish their ages in relation to each other, and to geological changes and epochs generally.

The coast from the mouth of the “Mersey” to the mouth of the “Rubicon,” (Port Sorell), is comparatively flat, presenting seaward a line of sand-banks, more or less elevated and rounded, with broad beaches, broken only at long intervals with projecting points of basalt, which, with the exception of the Bluff Head, running out on the western side of the entrance to Port Sorell, are low and acuminate, affording no shelter anywhere, and scarcely sufficient as a bulwark to defend the land from the lowering and encroaching influence of the sea.

I said before, that a strip of igneous rock, of which these points are spurs, skirts the coast on both sides of the Mersey River; and there is every reason to believe that, like most of the higher and more massive ranges inland, with which it is connected, it overlies sedimentary rocks. Having "passed the ubicon," a similar series of low dunes or sand-hills, with extensive flat beaches, recur, stretching to the foot of the Asbestos Hills, where the transition clay-slates present themselves in a nearly vertical position, rising from the sea level into mountain masses, having their planes of stratification variously bent and contorted, and crossed and re-crossed in every imaginable direction with veins of ferruginous matter and quartz. The two headlands, known as "Badger Head," and "Little Badger Head," are of this structure and composition. Between West Head and Badger Head there is a long, flat, sandy beach, hedged in with high dunes, behind which there stretches along the eastern flank of the Asbestos Range a valley, chiefly formed in the sedimentary beds succeeding to the slate, and at some places in the clay-slate itself. The clay-slates usually, from the large portion of siliceous matter intermingled, yield but a cold, meagre, and ungenerous soil. Nor is this valley a marked exception, though at some places, where limestone comes to the surface, patches of desirable land with good herbage do exist. Many of the undulations look as if the surface had been sown with fragments of quartz. As in the case of the embouchure of the Mersey and of the Rubicon, the entrance of the Tamar River is guarded on either side with heavy masses of eruptive rock. From the West Head to Whirlpool Reach a chain of low rounded hills of greenstone, though interrupted by the intervals of the "*West*" and "*Middle*" Arms of the estuary of the Tamar, and broken by vallies of denudation, is still traceable, and to the south of Middle Arm tolerably

continuous. From Low Head, on the eastern bank, greenstone lies in one continued mass all the way up. Traces of sedimentary deposits are visible, however, under the greenstone at several points on the margin of the river between Point Effingham (opposite to Middle Island) and the "East Arm" of the Tamar: they consist of arenaceous clay beds and hard, compact, ferruginous grits, rich enough in *iron* to be applied, if required, to the purposes of smelting as an ore of that metal. Entering the "West Arm" of the estuary, sandstones and brown arenaceous shales are found extending nearly to the junction of "Anderson's Creek," within a mile of York Town. These beds dip regularly, but slightly, to the eastward. Near the creek some soft blue argillaceous beds present themselves, and in the mouth of the creek alternate with layers of calcareous conglomerate, enclosing small *Turritelle*: soft schistose yellowish clays succeed, and are in their turn replaced by a long series of slightly inclined beds of gray compact and very hard limestone, some of the layers of which yield *Spirifera*. This limestone passes from a close, fine-grained homogeneous rock into beds of fine conglomerate: the fine-grained breaks with difficulty into conchoidal fragments, and yields to the smart stroke of the hammer a peculiar odour, not unlike that of resin.

Time did not allow me to trace the rivulet to the Asbestos Hills,—a range which, from its composition and structure, and the various products it is known to yield, must be well worth a careful examination wherever sections of the rocks can be obtained. In the channel of Anderson's Creek they are clearly exposed; and it was with great reluctance that, as night closed in, I abandoned the place without being able to refer the series of nearly horizontal beds there to any formation already familiar to me. That ramification of the

estuary of the Tamar known as the "Middle Arm" trends to the southward and westward, and the strata along its banks have a general, inconsiderable, and nearly uniform dip toward the east; therein agreeing with the disposition of the beds in the "West Arm."

The rocks which present, first, are white sandstone, succeeded by arenaceous brown shale and clayey conglomerate, with which occur silicified stumps and roots of trees: grits, clayey conglomerates, and slaty argillaceous beds, all more or less fossiliferous, follow. The channel is very devious and very shoal, with extensive mud-flats on one hand or the other, or on both: on the south shore the land is low and nearly level, with a line of greenstone-capped hills between it and the main course of the Tamar. The mud-flats prevented the exact survey which ought to have been made of this portion of the bay. At the extremity of the "Middle Arm" a rivulet enters the bay, and on the eastern side of the junction is the site of the lime-quarries formerly worked by Government: they consist of arenaceous conglomerate, argillaceous slaty beds, and massive beds of limestone, the first and last of which abound with fossil shells; amongst them *Bellerophon*, *Micromphalus*, *Pachydomi*, *Pectenides*, *Platyschisma rotundatum*, and another species—*Productæ* and *Spirifer Stokesii* and *Tasmaniensis*, &c.; together with several species of *Fenestellæ*, of *Stenopora*, &c. &c. The colour of this limestone varies from brownish yellow, through ashy gray, to slate blue: the dip of the beds is to the eastward.

About a mile distant, in a north and westerly direction, a limestone is quarried, burnt, and prepared for the market by Mr. De Little, which differs in many particulars from that already described. It is nearly homogeneous in substance,

but has a marked tendency to crystallized structure, and is intersected with numerous very thin veins of calc-spar : its colour is a pale blue ; it has yielded no fossils, and gives no indication of stratified form, notwithstanding it lies close alongside an almost vertical wall of regularly stratified clay-slate. The quarry is situated in a little valley, almost surrounded by low hills of clay-slate, whose beds dip to the eastward, at a high angle. Contiguous to the limestone the clay-slate is dark-coloured and fissile, and contains much sulphuret of iron. Upon a little hill on the eastern side the slate becomes bluish yellow, and its laminæ split easily into thin rhomboidal plates ; but the formation then alters almost immediately, passing through a soft laminated clayey flagstone into thicker beds of arenaceous conglomerate : the slate is at best too soft and absorbent to be of any economic importance.

Discovered at first by some accident, this limestone has been worked over a limited area, but to a considerable depth ; and latterly at a serious cost, water having become so troublesome as to render the employment of several pumps, moved by a powerful water-wheel, necessary.

It is probable that when fully known this limestone will prove to be of the same age as that at Crickton, an estate of Mr. Abraham Walker, on Norfolk Plains ; and that upon Lachlan Marshes, at the foot of the Frenchman's Cap range, on the western side : but data are still required either to establish or disprove the identity conclusively. The surface of the country between Mr. De Little's lime-kilns and the Asbestos Hills is moderately timbered, and yields only a scanty pasturage : clay-slate undulations of no great elevation, capped at some points by greenstone, with narrow intervening vallies running nearly parallel to the line of the Asbestos Tier, constitute its geological character.

Having been informed of the existence of a bed of gypsum in one of these vallies, I visited the place, and found it situated in the centre of a plot of good land in a low flat : it proved to be a hard, white compact limestone, traceable only over a very circumscribed space, and nowhere rising above the general level of the surface. There was no appearance of stratification ; but where exposed the rock appeared smoothed and water-worn, disclosing drusy-looking cavities, lined with crystallized carbonate of lime. Supposing this calcareous bed to be as originally deposited, it would seem to have been formed as a chemical precipitate : but it is far more probable that it owes its crystalline character to the metamorphic agency of *heat* ; and the fact of the existence of erupted rock in mass within a few paces lends countenance to the opinion. Nor is the probability lessened by the consideration that beds of a fine white marl of granular structure, and so highly calcareous as to be capable of being burnt into lime, now exist on the flats at Kelso ; as they are also known to do at Woolnorth, and on some of the Islands in Bass's Strait. Returning to the immediate left bank of the main channel of the Tamar, I found the greenstone cap of the low rounded eminences, which stretch uninterruptedly from Whirlpool Reach nearly to Middle Island, descending for the most part to within a few feet of high water-mark ; and at one or two places, Point Rapid for instance, it goes down *en masse* under the water : whether thus still connected with the massive body of greenstone emerging on the opposite side, as doubtless at one time it must have been, remains to be settled. Sedimentary deposits, in the shape of clay-ironstone beds, clayey and arenaceous shales, and beds of clay with carbonaceous intermixture, are exposed to a great width, occupying at low water the flat shore above " Middle Island," from Ralston's farm to Wil-

more's residence : thence to Point Rapid the same beds are more or less continuously visible a little above high water-mark ; and they may be traced even in Whirlpool Reach, where Mr. Reid has sunk no less than three shafts near the margin of the river, under the impression that they were the sure indications of coal. These clayey and ferruginous shales dip but very slightly towards the greenstone hills ; and at Ralston's establishment, where a shaft has been sunk upwards of thirty feet, they are covered with post-tertiary beds of clay, containing impressions of leaves of trees and pieces of half decomposed *kino*, associated with lignites, and a small *Modiola*-looking shell. The shore at high water-mark is strewn with casts and impressions of shells, resembling *Nucula* and the *Solenaceæ* mineralized in iron, and with fragments of *Reddle* or red chalk : in both cases derived from the argillaceous ironstone beds. The clay-ironstone is nodular ; and in each of the nodules is a nucleus, which on fracture will turn out the internal cast or external impression of the two sides of a bivalve shell, more or less perfect : in the nodules occur also other organic forms, which close and repeated examination may hereafter afford to observers the means of determining.

It is probable that the thick beds of ferruginous grit and iron conglomerate already stated to crop out from under the greenstone on the Point Effingham estate, on the east side of the river near to Middle Island, were at one time continuous with these beds of clay and clay-ironstone which pass under Mr. Wilmore's property. At Macquarie Harbour, on the eastern side of its capacious and beautiful bay, I was so fortunate as to find good sections of similar strata, which, besides containing shells, exhibited a profusion of impressions of the leaves and seed-vessels of plants peculiar to or characteristic of warmer climates than

that of Tasmania of the present epoch. The tertiary beds at Macquarie Harbour lie in a nearly horizontal position, and contain seams of lignite, nearly approaching jet, of varying and often of considerable thickness and extent. Mr. Reid, in a shaft sunk at Whirlpool Reach, passed through a thin seam of jet or lignite imbedded in clayey schists, under which lay a bed of quicksand, which obliged him to abandon the sinking. The two formations, that at Macquarie Harbour and this on the Tamar, appear to be of the same age, geologically speaking, and neither is likely to yield a good economical coal,—an opinion which I have ventured to give to Mr. Reid, Mr. Wilmore, Mr. Ralston, and other persons interested in the discovery of coal on the banks of the Tamar River. The sandstones and brown shaly beds seen along the margins of the “West and Middle Arms” of the estuary of the Tamar dip so as to pass under the edges of these tertiary beds, and migrate into a long series of distinctly marked palæozoic rocks, believed to lie beneath our carboniferous system wherever they are developed in connection. It is therefore possible, though most unlikely, that a large fragment of bituminous coal, overrun on its surface with the calcareous deposit of coral insects, and which was asserted to have been recently broken off and heaved up from the bottom of the Tamar River, nearly opposite to Mr. Wilmore’s house, should actually have been met with there *in situ*; but in such case it must have been torn from a suite of beds lying entirely under the tertiary series now described, and dipping in a contrary direction.

I embraced the opportunity of being in the neighbourhood to visit, and very cursorily examine, some slate quarries about a mile to the east of the George Town and Launceston Road, nearly opposite to Point Rapid. The formation appears to be extensive, and the quality of the slate superior

to any that I have seen before in the colony : it well deserves further exploration. Specimens of the rock formations which I have seen are placed in the Museum.

I have, &c.,

JOSEPH MILLIGAN.

The Hon.

The Colonial Secretary.

XII. *On the Law of Storms in the Pacific and High Southern Latitudes.* By THOMAS DOBSON, Esq., B.A., Head Master, High School, Hobart Town. [Read 12th November, 1851.]

THE importance of a practical knowledge of the Law of Great Storms has induced me to draw up a brief exposition of their most striking phenomena. In bringing this subject under the notice of the Royal Society of Van Diemen's Land, I am not without a hope of securing the co-operation of its members in the desirable attempt to develop the Law of the Progressive Motion of the Storms of the Pacific Ocean, and of those of High Southern Latitudes.

Information on these points of the theory may reasonably be looked for by the scientific world from a Society placed in the very field of observation, in a comparatively high southern latitude, and comprising the scientific representatives of a community largely interested in maritime pursuits.

The laws of the great hurricanes which traverse the low and middle latitudes of the North Atlantic and Indian