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Narrative of a Voyage Round the World

Founded in 1666, the French Académie des Sciences was a prominent and prestigious organisation behind numerous scientific advances in Europe in the seventeenth and eighteenth centuries. In 1817, commissioned by the Académie, Louis de Freycinet (1779–1841) embarked on a three-year expedition with the main purpose of investigating terrestrial magnetism and taking a series of pendulum measurements. In the course of this voyage around the world, the scientists aboard the *Uranie* also collected an abundance of samples and made significant observations in the fields of geography, ethnology, astronomy, hydrography and meteorology. The progress of this journey was detailed by Jacques Arago (1790–1855), draughtsman on the expedition, in the form of letters to a friend. This illustrated narrative is prefaced by a report to the Académie which summarises the mission's findings. Translated into English and published in 1823, this work is an informative and often witty account, reflecting contemporary ambitions in science and exploration.

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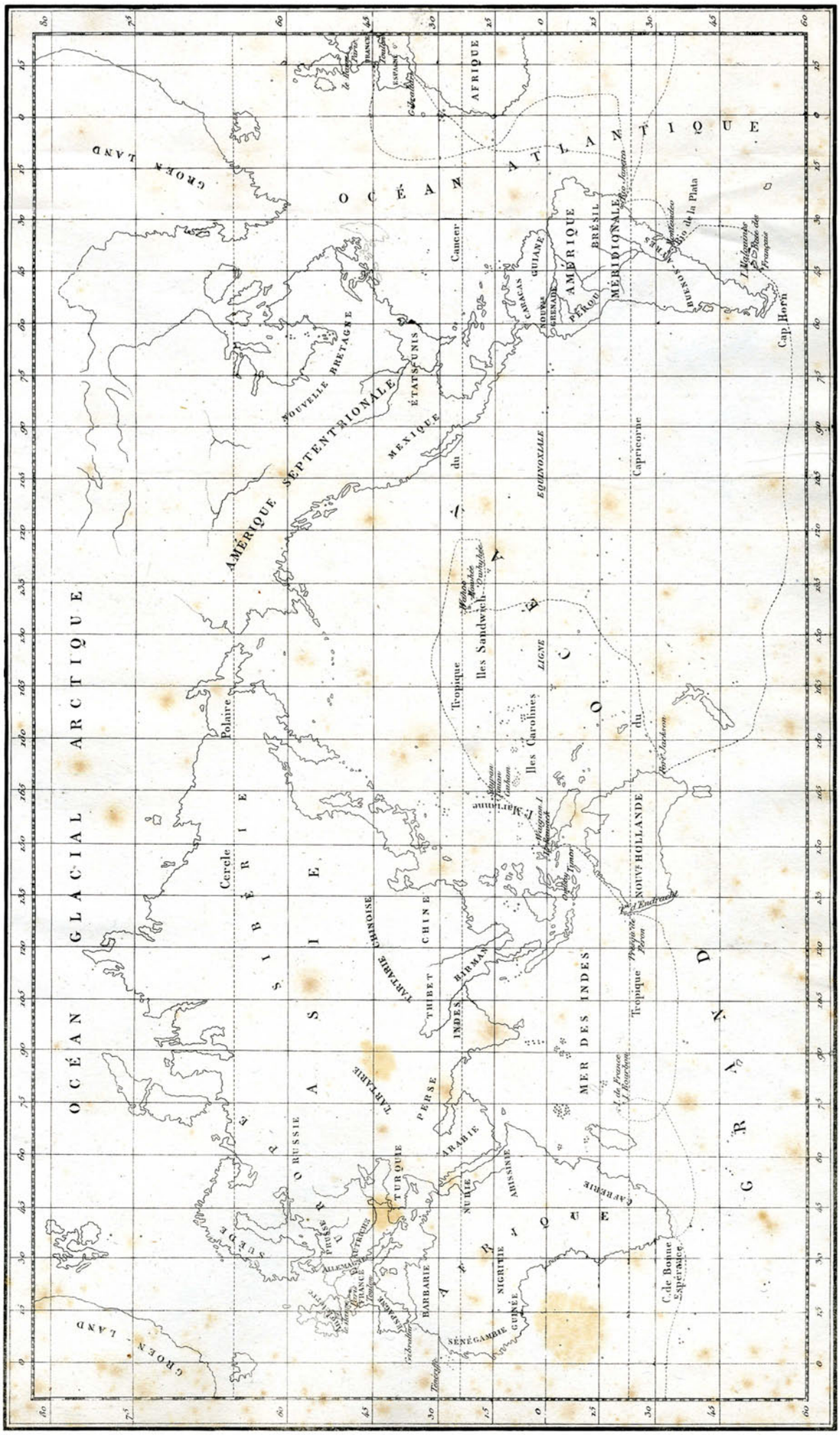

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COMMANDED BY

CAPTAIN FREYCINET,

DURING THE YEARS 1817, 1818, 1819, AND 1820;

ON A SCIENTIFIC EXPEDITION UNDERTAKEN BY ORDER OF THE FRENCH GOVERNMENT.

IN A SERIES OF LETTERS TO A FRIEND,

BY J. ARAGO,

DRAFTSMAN TO THE EXPEDITION.

With Twenty-Six Engravings.

TO WHICH IS PREFIXED,

THE REPORT MADE TO THE ACADEMY OF SCIENCES, ON THE GENERAL RESULTS OF THE EXPEDITION.

LONDON:

TREUTTEL AND WURTZ, TREUTTEL, JUN. AND RICHTER,
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PREFACE

BY THE AUTHOR.

THERE are few readers who are not fond of the perusal of long voyages: the most trifling event, when it takes place at many thousand leagues distance, acquires a degree of importance; and almost any narrative of that kind is sure to excite curiosity, if for no other reason than that the author has returned from the Antipodes.

It must, however, be admitted to be painful to the reader who only seeks for useful relaxation, or agreeable information, to have the interest he feels perpetually broken by a profusion of barbarous and tiresome nautical details. You are disgusted by the eternal repetition of *winds, currents, longitude and latitude, variations of the compass,* &c. with which the narrator annoys you in every page; first making you go *six knots an hour, E. N. E. quarter E.;* then *tacking* you about for whole days, or keeping you in a *dead calm,* waiting for the *wind.*

Who is there that has not read the admirable narratives of Cook, of d'Entrecasteaux, of our unfortunate La Perouse? But who is there also who has read them entirely through? And yet the nautical details with which their narratives are interspersed were then of very superior importance. In traversing vast seas which were nearly unknown, these celebrated navigators felt themselves bound to keep an exact account of winds, monsoons, currents, shoals, and reefs of rocks, so as to leave direction posts on the road for their successors. In the present day, the least disadvantage of these details is, that they are nearly useless. There is scarcely a midshipman in our navy who could not now, if required, steer a vessel to Kamtschatka, to Otaheite, or to New Zealand. The Pacific Ocean has been so frequently explored, that it is almost better known, and certainly less dangerous, than the Mediterranean, which bathes our own shores.

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Like these intrepid navigators, I also have made the Tour of the World, but not as a seaman: the vessel carried me, and I wandered with it. On board the Uranie, commanded by Captain Freycinet, I traversed the Indian Seas; visited the South Sea Archipelago; and after doubling Cape Horn, and spending three years in dangers and fatigues, saluted the Atlantic as an old friend, and re-visited the beloved coasts of ancient Europe. During our long voyage I became acquainted with numerous tribes; hunted with the Brasilian and the Guanche; danced with the negroes of Africa; and slept under the hut of the Sandwich islander.—I participated in the festivals of these children of nature; I sat at their hospitable tables; and, every where welcomed, I every where contributed my share by a cheerful gaiety, or the present of some European trifles. I have seen much, and observed much. I visited some little known islands at which our ship did not anchor. I availed myself of the length of our different rendezvous to make excursions into the interior of countries yet uncivilized, which were always amusing, and sometimes dangerous; but which enabled me to collect a variety of observations on the manners, arts, customs, and habits of the different nations which inhabited them.

I visited the Island of Tinian, which has been rendered celebrated by the residence of Anson, and the eloquent pen of Rousseau. Along with three of my companions, I ventured upon an island (Ombay), the inhabitants of which drink blood out of the skulls of their slaughtered enemies; and we there learned a lesson, that if it is generally prudent to treat as enemies savages who are always hostilely disposed, it is sometimes more useful to make concessions, and exhibit an appearance of confidence and gaiety, to men whose ferocity is sure to be excited by resistance.

I now publish the observations which I addressed as they were collected to the friend and companion of my youthful sports and early studies; and nearly in their original shape, I submit them to the public indulgence.

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April 23, 1821.

THE Academy having commissioned us (Messieurs de Humboldt, Cuvier, Desfontaines, de Rossel, Biot, Thenard, Gay-Lussac, and Arago) to make a report to it, upon the general result of the operations executed during the voyage of the Uranie round the world under the command of Captain Freycinet; we now proceed to acquit ourselves of this duty, by entering into details which appear to us quite necessary, whether we regard the importance or the variety of the results which we have had to examine.

The principal object of the expedition commanded by Captain Freycinet, was the investigation of the figure of the earth, and of the elements of terrestrial magnetism; several questions of meteorology had also been suggested by the Academy as worthy of attention. Although geography certainly formed but a secondary object in the voyage, it was natural to anticipate that so many experienced and zealous officers, well provided with excellent instruments, would not circumnavigate the globe without making some valuable additions to the existing tables of latitude and longitude Though no professed naturalist was attached to the expedition, our navigators undertook the task of collecting for the Museums, if not of investigating, every interesting specimen of the three kingdoms; and we had also reason to expect from the draftsman attached by government to the expedition, a faithful representation of all such specimens as their weight or liability to break

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would not allow them to bring away; and that he should take accurate views of the different coasts, which, besides the useful information they furnish to navigators, would have the advantage of occasionally offering agreeable landscapes; finally, it was to be expected that Captain Freycinet and his companions would add new particulars to the history of savage nations.

The number of manuscript volumes belonging to the expedition, which have been deposited at the office of the Secretary of the Academy, amounts to thirty-one; every part of these we have examined with the greatest care; but not having had time to calculate the whole of the observations, we shall be obliged, on many points, to confine ourselves to a bare catalogue of the valuable stores which Captain Freycinet has brought home. Proceeding methodically, we shall arrange under distinct paragraphs, all that relates to each particular class of observations.

I. ITINERARY.

The expedition sailed from Toulon on the 17th of September 1817; arrived at Gibraltar on the 11th of October, and left it on the 15th, for Teneriffe, where it remained from the 22d to the 28th of the same month. The Uranie cast anchor at Rio Janeiro on the 6th of December. This city being considered a proper station both for the pendulum and compass observations, Captain Freycinet remained there nearly two months. At the Cape of Good Hope, the next place of rendezvous, he stopped from the 7th of March to the 5th of April 1818; and the time there was employed in similar observations, which are of the greater importance, as they can be compared directly with those of Lacaille. The same consideration gives an interest to the observations at the Isle of France, where the Uranie arrived on the 5th of May, and which she left on the 16th of July. After a very short stay at the Isle of Bourbon, Captain Freycinet sailed on the 2d of August for Shark's Bay, which he had visited in his first voyage with Captain Baudin. He arrived there on the 12th, and quitted it on the 26th of September, for Coupang, the capital of the Dutch settlements in the Isle of Timor. Farther on will be found an enumeration of the observations of different kinds made at this port, from the 9th to the

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23rd of October 1818, when the expedition sailed for Diely, the residence of the Governor of the Portugeuse settlement, at the northern part of the Island.

Leaving Diely on the 22d of November, the Uranie steered her course for the little island of Rawak, situated near Waigiou (New Guinea), almost exactly on the equator: she remained there from the 16th of December 1818, to the 5th of January 1819. The next rendezvous was at the Marianne Islands, and was of nearly three months' duration; a delay rendered necessary by the important operations to be executed at those islands, by the necessity of laying in fresh provisions, and of allowing time for the sick, who were then pretty numerous, to recover. On the 5th of April 1819, the Uranie sailed from Guam; she cast anchor at Owhyhee, the largest of the Sandwich Islands, on the 8th of August: on the 16th she touched at Mowhee; on the 26th at Woahoo; and on the 30th, finally quitted that Archipelago for Port Jackson; where it became necessary to refit the vessel, and make the usual observations on the weight of the atmosphere and on magnetism. The expedition left New South Wales on the 25th of December 1819, for Terra-del-Fuego; but scarcely had they cast anchor in the Bay of Good Success, on the 7th of February 1820, when a furious hurricane obliged them suddenly to cut their cables, and to let the ship run under bare poles for two successive days. When the storm abated, it became a matter of consideration, whether, considering the importance of pendulum observations in the high southern latitudes, they should return to Terra del-Fuego, from which they were now a considerable distance, or rendezvous at the Malouine Islands; Captain Freycinet determined on the latter. The Academy has received from this excellent officer complete verbal details of the shipwreck of the Uranie, which took place in French Bay, on the 13th of February 1820, and of the stay made by the ship's company at that desert station. It will be therefore sufficient for us to mention that the expedition quitted the Malouine Islands on the 17th of April 1820, on board an American vessel, which had accidentally come there, and was purchased by Captain Freycinet; that they first put into Monte-Video, and, after a residence of a month in the River Plate, the Physicienne (the name given to the new vessel sailed on the 7th of June for Rio Janeiro, where she arrived on the 19th. During a stay of three months, our navigators repeated the

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observations of different kinds which they had made there on their passage out. Finally, on the 13th of September 1820, the Physicienne quitted Brasil: stress of weather obliged her, on the 10th of November, to put in to Cherbourg; she left that on the 12th, and arrived at Havre on the 13th, where she was laid up.

The duration of the voyage was therefore three years and two months nearly; and the distance sailed amounts to about 23,600 leagues, of 25 to a degree.

II. PENDULUM OBSERVATIONS.

The figure of the earth may be equally deduced from the comparison of the number of oscillations made every twenty-four hours, by the same pendulum of invariable length, in places situated under different latitudes; and from that of the different lengths which a simple pendulum should have to enable it to perform the same number of oscillations at every point in a given time. Each of these methods requires that the number of oscillations made in each station, in a mean or in a sideral day, by the pendulum which is employed, should be ascertained: there is only this difference between them, that in the first it is indispensable that the oscillating apparatus should never undergo the least alteration, either in its form or dimensions; while in the second that condition is not required, as the length is measured after each observation. This last part of the experiment is a very delicate one, and requires a particular establishment, which it would have been extremely difficult to procure on the deserts coasts where Captain Freycinet had to touch. This consideration induced our navigator to confine himself to the use of the invariable pendulum: it was deemed expedient, however, to supply him with two of these instruments, the preparation of which was entrusted to M. Fortin.

Each of the two pendulums first supplied by this skilful artist, is formed of a copper cylinder, with a heavy knob of the same metal at the end, and which makes a part of it, both the cylinder and the knob having been cast at once; at the other extremity of the cylinder is invariably attached the knife-edge, which is destined to support the pendulum: during the

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experiments the knife-edge rests upon a plane of agate, adjusted with the greatest care.

The form and diameter given to the rods of these two pendulums, the care taken in the construction of the cases, and in the packing of them, led to an expectation that they would experience no sensible warping during the voyage. Perhaps there was reason to fear that the thickness of the cylinder would make it difficult to ascertain its temperature; although this is one of those causes of error, the influence of which an attentive observer can easily appreciate, as he has the power of confining it within very narrow limits. No sooner however was this apprehension suggested, than a new invariable pendulum with a flat rod was ordered to be made; our fellow academician M. Breguet, who had already gratuitously entrusted one of his chronometers to Captain Freycinet, was so good as to add a private pendulum, executed under his own direction and at his own cost. Our navigators have therefore had no less than four invariable pendulums at their disposal, viz. two copper pendulums with cylindrical rods, designated in the registers as No. 1 and 3; a pendulum of the same metal, but with a flat rod, also made by Fortin, and designated as No. 2; and finally, the pendulum of M. Breguet, No. 4, which has a rod of varnished wood, a flat and very heavy copper knob, and a knife-edge of a particular alloy, very hard and little susceptible of oxidation.

Previous to the departure of the expedition, these four instruments were observed at Paris in 1817 by Messieurs Freycinet, Lamarche, Mathieu, and one of ourselves (M. Arago.) By this means a mean of comparison was obtained for all the analogous observations which might be made in the two hemispheres; and, what was of not less consequence, a method of ascertaining, whether during the voyage the rods or the knives had undergone any sensible alterations. Such is, in fact, the object of the observations which Captain Freycinet is now engaged in making at Paris, the results of which he will no doubt communicate before long to the Academy.

It would be equally tedious and useless to describe here the plan followed in these first experiments, and to which Captain Freycinet conformed at all the points of rendezvous; it may be sufficient to mention that it was not possible to adopt the method of coincidences which Borda and

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subsequent observers have so advantageously employed, as our navigators took no clock with them; and we should add, that admitting the excellence of the chronometer, the new method is not at all inferior to the old one in point of accuracy, as experience has fully proved. At Paris it would have been easy to discover the most trifling irregularities in the movement of the watch, by the repeated comparisons of it, which were made with the sideral pendulum of the observatory; but as such means of verification could not be found elsewhere, Captain Freycinet confined himself to a comparison seven or eight times a day, of the chronometer No. 72, (which had been originally designed for pendulum observations,) with three other chronometers of Louis Berthoud, and with that of M. Breguet; this comparison would render the observations of value, even if the time-keeper No. 72 should happen to go somewhat irregularly on some occasions.

To be satisfied that the iron tripod which Captain Freycinet took with him, upon which the apparatus was to be fixed during the experiments, was of proper strength; one of these pendulums was successively suspended on this tripod, and on a thick supporter of hammered iron, fixed upon two strong cross-bars of the same metal, carefully soldered into one of the walls of the observatory, and further strengthened by two buttresses. The number of oscillations of the pendulum in the twenty-four hours was exactly the same in both cases. Such persons as have witnessed the curious experiments lately made by our fellow academician M. Breguet, upon the influence which two clocks placed against the same wall exercise upon each other, will not regard the verification of which we have been speaking as superfluous.

The horary angles intended to regulate the movement of the chronometer No. 72, have been sometimes taken with reflecting instruments, but most frequently by an astronomical repeating circle. We shall add finally, that everywhere the temperature has been determined with the same thermometers; and that consequently there could be no uncertainty as to the correctness depending on that, as, before the departure of the expedition, these instruments had been carefully compared with those of the observatory at Paris.

Rio Janeiro is the first place of rendezvous where Captain Freycinet

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remained long enough to set up the pendulum apparatus. In January 1818, he there observed the pendulum No. 1, with the cylindrical copper rod, and the pendulum No. 2, with the flat rod; on his second passage by Rio, in August 1820, he made the whole four pendulums oscillate successively.

At the Cape of Good Hope, where Lacaille had formerly measured the absolute pendulum in 1752, Captain Freycinet determined the number of oscillations of his four invariable pendulums. The calculation which one of us has made of these observations, enables us to say, that they do not confirm the consequence which had been deduced from Lacaille's operations, as to the dissimilarity of the two hemispheres.

The observations on the three copper pendulums made at the Isle of France, and particularly those at Port Jackson, will supply some valuable data on this point. These last, when compared with the observations made at the Cape, almost under the same latitude, but at 134° of difference in longitude, will inform us, as much at least as that sort of observation will allow of, if, in the austral hemisphere, the parallels have a sensible oblateness.

Captain Freycinet's operations would have been incomplete, if he had not determined the number of oscillations of his pendulums exactly on the equator, or at least very near that line. It was at Rawak, (a small island attached to New Guinea, and situated at only 1.′½ of south latitude,) that the observations on the four invariable pendulums were made, with which every analogous observation must be compared in attempting to calculate the extent of the oblateness of the two hemispheres.

This oblateness, whether it is deduced from the different lengths of the absolute pendulum, or from the number of oscillations performed in twenty four hours by one pendulum of invariable length in different places, is ascertained with so much greater precision, in proportion as these places are at a greater distance in latitude. Admitting this observation to be correct, it is difficult to over-rate the value which observations made at Cape Horn, whose southern latitude is 55°. 59′, would have possessed in this investigation. Very unfortunately, as has been seen, a violent storm did not allow the expedition to stop there: the observations at the Malouine Islands might have been a substitute for those at Cape

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Horn; but after a shipwreck, and being cast away on a desert island, obliged to provide by hunting for the support of 120 persons, and occupied in hastily preparing the sloop which was to carry part of the crew to America, in order to obtain prompt succours for the rest; it was not to be expected that our navigators had sufficient time or tranquillity of mind, to count minutely for whole days the oscillations of their pendulums! We should also remark, that during the period the expedition remained at French Bay, it was only at considerable intervals of time, that the horary angles, which were to regulate the movement of the time-keepers could be obtained, the sun having been almost constantly obscured by thick fogs, both morning and evening. Under such a combination of circumstances, we cannot lay great stress on the single series of pendulum observations which Captain Freycinet has brought from the Malouine Islands.

During her long voyage, the Uranie kept almost constantly to the South of the equator; the only places where she rendezvoused in our hemisphere were the Marianne and the Sandwich Islands. At Guam, the principal of the Mariannes, Captain Freycinet observed the whole four pendulums; at Mowhee, No. 1. only.

In concluding this branch of our report, it only remains for us to notice the officers who took part in the pendulum observations. Captain Freycinet constantly gave his personal superintendence to the operations, and with his own hands fixed and regulated the apparatus. We have also great pleasure in remarking that there is not a single series of observations made during the whole of the voyage, in which he had not the greatest part; this affords the most certain guarantee for their accuracy. We must next mention M. Lamarche, *commandant en second*, an officer of great merit; M. Duperrey, who will be honorably mentioned in several subsequent paragraphs of this report; M. Fabré, midshipman; M. Labiche, whom we ought perhaps to refrain from naming, to avoid awakening the regret which his premature death inspired in all his companions; M. Berard, the brother of the able chemist who was crowned for the second time at the last public sitting of the Academy; M. Guerin, midshipman; M. Laborde, the first officer who fell a victim to the fatigues of the voyage; M. Pellion who has enriched the portfolios of the expedition with a number of beautiful drawings; and Messrs. Railliard, Ferrand, and Duband, midshipmen.

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MAGNETISM.

Next to the observations, relative to the determination of the figure of the globe, nothing could be more interesting to natural philosophers, than an investigation of the laws of magnetic phenomena; unfortunately this question appears to be very complicated.

We all know, without having yet been able to ascertain the cause of it, that the inclination or declination of the needle of the compass undergoes in every part of the globe, very considerable annual alterations; to ascertain which, becomes the more important, as, without doing so, it would be impossible to reduce to a common epoch, and to bring into comparison the measurements made in different years. The number of observations collected by this expedition will furnish very valuable data to mathematicians who engaged in such inquiries.

It will be as well, however, to make the distinction here between two different classes of Captain Freycinet's observations; the first will include all those made at the different places of rendezvous, and the second those which were made at sea.

The first, and particularly the very delicate measurements of inclination, appear to us worthy of being placed on a par with the most perfect hitherto published; not merely by navigators but by sedentary natural philosophers, who were able to select the times and situations most favourable to their observations. As a proof of the justice of this assertion, we here transcribe the inclinations measured at the little island of Rawack, with five different needles; it will be seen that the extreme discordances scarcely amount to 7′.

Needle, No. 1, Lenoir, inclination or dip	14°. 23′;
Needle, No. 0, Lenoir, inclination	14°. 30′;
Needle, No. 3, Breguet, inclination	14°. 29′;
Needle, No. 2, Breguet, inclination	14°. 26′;
Needle, Richer, inclination	14°. 29′.

Our navigators have measured on shore, the declination of the needle of the compass with good instruments, and according to the most approved methods. The azimuthal observations, whose object was to ascertain the bearing of the mark, were made at several points with the theodolite, at others with astronomical repeating, or reflecting circles; sometimes with

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all three at once. At Rawack for instance, we find not less than forty-four distinct series of azimuthal observations.

Notwithstanding all this attention, the declinations may be affected by a continual error, arising from the want of parallelism between the optical axis of the telescope, and the line marked North-South on the graduated circle. Captain Freycinet not having (from an oversight of the artist) during the whole of the voyage any means of rectifying this, has since his return, been employed along with one of us, in making the necessary verifications; the result of which is, that all the declinations determined on shore require a trifling correction of 7′.

The observations relative to the intensity of magnetic power, were made at all the points of rendezvous with several needles. Previous to announcing to the Academy what results may be expected from that portion of Captain Freycinet's labours, we deemed it indispensable to compare the quantity of magnetism preserved by the horizontal needles which had been longest and most frequently in use, with that which had been communicated to them four years since, prior to the departure of the expedition. The following are the results:

A needle which had belonged to M. Coulomb performed in the garden of the observatory in 1817, before Captain Freycinet's departure, 100 oscillations in 16′ 53″; it now performs 3 less in the same space of time.

A second steel needle, made by M. Fortin, which performed four years since, 100 oscillations in 17′ 3″, now performs only 98; the loss of magnetic power has therefore been so trifling on these two needles, as to allow us the hope of calculating with sufficient accuracy, the corrections which must be made in the different observations of intensity.

These observations of inclination, and of intensity on land, belong almost wholly to Captain Freycinet himself. The officers by whom he was most frequently assisted were MM. Lamarche, Duperrey, Labiche, Bérard, Pellion, and Fabré.

Mr. John Macdonald published some years since in the Philosophical Transactions, two series of observations on the daily variations of the magnetic needle, which were made in 1794, 1795, and 1796, at Fort Marlborough in Sumatra, and at Saint Helena. It does not appear that since that time, any of the navigators who have visited the equinoctial countries

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have paid any attention to this singular phenomenon. The observations of this kind, brought us by Captain Freycinet, will therefore be a valuable acquisition to science.

Mr. Macdonald's labours led to two important results; the first (and which every philosopher appears to have adopted) is, that the daily variations between the tropics have a sensibly less extent than in Europe; the second (to which less attention has been paid) is, that at the same hours, at which in our climate the Northern extremity of the needle moves towards the west, at Fort Marlborough and Saint Helena, which are situated to the South of the equator, the movement is directly opposite, namely, to the East.

Mr. Macdonald has drawn no general conclusion from his observation; he even supposes that there is a connexion between daily variations and declinations; as a proof of which, he ventures to predict, that in India for example, if the absolute declination is Eastern, the needle from morning to evening will move in a certain direction, and that at the same hours, a directly contrary movement will be perceived, if the absolute declination is western. Captain Freycinet's observations do not appear to confirm these conjectures.

We have found in the journals of the expedition, six series of observations of diurnal variations, which were made at the Isle of France, at Timor, at Rawack, at Guam, at Mowhee,and at Port Jackson. At the Marianne and Sandwich islands, situated in the Northern hemisphere, the North point of the needle moves towards the West, the same as in Europe, from eight o'clock in the morning till one in the afternoon, although the absolute declination of the compass is there Eastern. At the stations at Timor, Rawack, and Port Jackson, situated to the South of the equator, the North point of the needle moved every morning in an opposite direction, or to the East; and we should remark, that at Timor the needle declines towards the West, while at Rawack, and Port Jackson, on the contrary, its deviation relatively to the meridian, is East.

It is evident therefore, that the observations, made North of the line, agree with those of Europe; and that those of the southern hemisphere, present, like those of Mr. Macdonald, a diametrically opposite movement. The Isle of France would be the only exception to this rule; but to get rid of the anomaly, it will be sufficient to admit, that the note which accompanies the observations relates not to the direct position of the mark but to the

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reversed position, as it was seen by the observer looking through a magnetic telescope; this is a still more natural explanation, because the form of the mark at the Isle of France made it easy to mistake. Be that as it may, there will be an end of all doubt on the subject when we have compared the observations of M. Lislet Geoffroy, an old correspondent of the Academy of Sciences, with those of the expedition.

One fact which Captain Freycinet's voyage has put beyond all doubt, is, the small extent of diurnal vibrations between the tropics. This might already be deduced from the observations of Mr. Macdonald; but as the needle which that gentleman made use of was supported by a point, it might be matter of doubt whether a want of mobility was not partly the cause of the smallness of his results; to which we should add, that the magnetic power is sometimes distributed along the whole length of a steel needle, so as to render it almost insensible to daily vibrations; of this we have had frequent examples. These doubts do not apply to the observations of our navigators: their needle was supported by a piece of untwisted silk, in the manner described by Coulomb, and though it remained constantly in the same state during the voyage, it gave, notwithstanding, at different stations, very unequal daily variations. At Timor, in fact, these variations were $6', 5$; at Rawack they were already sensibly weaker and scarcely amounted to $3'$; at the Mariannes there was only one third of a minute more than at Rawack: but at the Sandwich Islands and Port Jackson, the same needle traversed from morning to evening an arc of $9'$.

If the diurnal morning variation is Western to the North of the equator, and Eastern to the South of it, it follows that upon the equator itself there should be none whatever. We have just seen however that at Rawack, the South latitude of which is scarcely one-40th of a degree, the needle vibrates in an arc of $3'$: this result would appear to indicate (particularly when we compare it with the amount of the daily vibration at the Mariannes) that it is not the terrestrial, but the magnetic equator which separates the zone of Western from the zone of Eastern variations; we should therefore obtain in this manner, as is easily seen, a new and very convenient method of determining some points of the magnetic equator; if observations were now made between this equator and the equinoctial line, at Fernambuco for instance, at Cape Comorin, to the south of Ceylon, in the Northern part of Sumatra and

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Borneo, at the Pelew Islands, &c. they would be of the greatest consequence.

We trust the Academy will excuse us for dwelling at such length on this part of Captain Freycinet's labours; good observations contribute to the progress of science, not only by the questions they resolve, but by those of which they suggest the idea.

The expedition would have very imperfectly fulfilled the expectations of Government and of the Academy, if it had brought home no other magnetic observations than those that were made at the different points of rendezvous. The curves along which the declinations are equal; the curves of equal inclination and equal intensity are of such singular forms upon the globe, that it is scarcely possible to determine any points of them by interpolation; the only means we have therefore to arrive at any certain results on this subject, are by the multiplication of observations.

The journals of the expedition contain for every day the sun was seen, from the time of departure from Toulon to its arrival at Havre, a great number of determinations of the declination. The observations of inclination at sea, began later, namely from the rendezvous at Timor; but from that time up to the second rendezvous at Rio Janeiro, a period of two years, they were followed daily with a degree of zeal and perseverance unequalled. One example taken at random from the journals gave us 50 measurements of inclination, performed in one day before and after the reversing of the poles of the needle.

The measurements of inclination brought us by Captain Freycinet, fully establish the singular inflexion of the magnetic equator in the South sea, which had been already deduced from Cook's observations; a minute discussion of all the results will enable us to ascertain if that inflexion has always the same extent, and if it has changed in longitude.

The inaccuracy of the measurements of inclination and declination made at sea is not entirely attributable to the want of stability in the vessel; the quantities of iron used in her construction, the cannon, anchors, ballast, &c. exercise a particular influence over these results, the extent of which is not yet entirely ascertained, in spite of the various and multiplied experiments which have been recently made by different philosophers and navigators.

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Practical methods however have been devised for ascertaining with tolerable correctness, the variations of declination and inclination arising from these causes of local attractions in different azimuths of the keel, relatively to the magnetic meridian; and even the changes which depend on the ship s position on the globe. As to the absolute variations, each vessel would require to make a series of experiments for the purpose of ascertaining the co-efficients of the formulas, and even to repeat them after every change in her stowage. We have the pleasure of observing, that in the experiments made upon different points by Capt. Freycinet, he has afforded every possible element for making that calculation with accuracy.

Capt. Freycinet having entrusted M. Lamarche with the direction of the magnetic observations made at sea, we are indebted to that officer for the greatest number of those observations. When Capt. Freycinet's other occupations allowed him, he very frequently took an active part in the measurements of inclination and intensity. The other observers whose names we have most frequently met with in the journals, are, Messrs. Bérard, Rainliard, Guérin, Fabré, and Dubaud.

IV. GEOGRAPHY.

Determinations of the longitude by a single chronometer can scarcely in general, contribute at present to the progress of geography. The sudden changes which the very best of these instruments will sometimes undergo for several days are the more to be dreaded, because if they happen at sea, and if the chronometer again goes regularly when on land, the observer may be completely unaware of any irregularity having taken place. There is one method of resolving doubts upon this subject, which is not to reckon upon any longitudes, obtained by the time at different places, unless the same result is obtained by several different chronometers.

It is not altogether unexampled, that three or four of these pieces, placed on board the same vessel, have been simultaneously deranged in the same manner and nearly to the same extent; but the case is too rare to justify us in refusing confidence to the determinations that are confirmed by this mutual comparison.

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We have already mentioned that Captain Freycinet had four chronometers with him These instruments were daily compared with each other during the whole of the voyage, after the series of horary angles; the longitude of the coasts where the expedition touched, or in sight of which it passed, might therefore be deduced separately from each chronometer. We thought it desirable to examine the results of this method, relatively to Rio Janeiro, the position of which has recently been the subject of some dispute between geographers. We proceeded for tha tpurpose on the supposition, that Santa-Cruz de Teneriffe, is in 18°. 36′. 0″ of West longitude. In the comparison which we made of the daily rates of the timekeepers at Santa-Cruz and Rio, we ascertained that the Nos. 144 and 150 of Berthoud had varied too much during the passage, to be of any use in the investigation; the other three, on the contrary, went at Brasil, nearly as well as at Teneriffe. The three longitudes which they give for the castle at Rio, are:

No. 72, of Berthoud	45°. 36′. 38″.
No. 158, of ditto	45°. 35′. 49″.
No. 2868, of Breguet	45°. 44′. 10″.

The medium, or 45° 38′. 52″ differs only by one minute of a degree, from the result given in the old *Connaissances des Temps*. The same timepieces indicate the considerable error of 36′½ less than the longitude given by a modern traveller for Cape Frio. That which was obtained by Baron Roussin, in his last hydrographical campaign, is only 2′ less than that of Captain Freycinet.

The bounds to which it is necessary to circumscribe this Report, will not allow us to enter at greater length into the chronometrical determinations of the longitudes. We have thought it our duty however to submit to the Academy, a review of the observations made on shore with the astronomical and reflecting repeating circles, as such observations promise great accuracy; it will also exhibit a fresh proof of the zeal with which all the officers of the expedition were animated, even for objects which were of secondary importance in the voyage.

In following the order of the different places of rendezvous, we find first, seventeen series of distances from the sun to the moon, which will furnish

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another determination of the longitude of Rio Janeiro, and six series of circum meridian altitudes of the sun for the latitude. It is unnecessary here to notice the observations at the Cape, or the Isle of France; the positions of these having been long since settled The longitude of Shark's Bay may be calculated, independently of thetimekeepers, by twenty-four series of distances from the sun to the moon. On shore, at this Bay, only two series of observations of the sun's altitude could be obtained; but the journals contain a great number of observations, made on board the vessel while at anchor, which would if necessary complete the determination of the latitude.

The position of Agagna at the Marianne Islands, has been determined by twenty-three series of circum meridian altitudes of the stars; and by twenty-two series of distances; the latitude of Fort Santa Cruz, in the harbour of St. Louis, may be deduced from nine series of circum-meridian altitudes of the stars; that of Goats' Island, from two series of the sun's.

At Owhyhee, the only one of the Sandwich Islands where Captain Freycinet remained long enough to make any astronomical observations, we find three series of altitudes of the sun for the latitude, and fifty-six series of distances from the sun to the moon.

At Port Jackson in New Holland, our navigators have determined the altitude of the South pole, by ten different stars, and the longitude by ten series of distances of the moon from the sun.

The position of French Bay, at the Malouine Islands, will be ascertained by twelve series of circum-meridian altitudes of the sun, and five series of distances.

Finally, Monte-Video, at the mouth of the River Plate, has been determined by nineteen series of lunar distances, and eleven series of meridian altitudes of the sun.

The observers who participated in the labours of which we have as it were given a catalogue, under the immediate direction of Captain Freycinet, were Messrs. Duperrey, Railliard, Bérard, Fabré, Pellion, Dubaud, Guerin, Lamarche, Labiche and Ferrand. It will be observed here, as in former instances, that the order in which we have placed the names is not the order of their rank, but has been solely directed by their greater or less participation in each class of observation, treated in each paragraph of the Report.

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