XVII.—*Sketch of the Surveying Voyages of his Majesty's Ships Adventure and Beagle*, 1825—1836. Commanded by Captains P. P. King, P. Stokes, and R. Fitz-Roy, Royal Navy. Communicated by Sir John Barrow, Bart.

The best charts of the South American coasts, which had been made by Spain, or by Portugal, were very inadequate to the wants of a rapidly growing intercourse when France and England undertook to explore and survey those shores for the benefit of the world. The French examined the coasts of Brazil; the English those of Patagonia, Tierra del Fuego, Chile, and Peru. In 1825, two vessels, the Adventure, 330 tons, and the Beagle, 235 tons, were ordered to be prepared. Captain Philip P. King was appointed to the former, and charged with the direction of the expedition. Captain Pringle Stokes commanded the latter. They sailed from England in May, 1826.

Part of Eastern Patagonia, the greater portion of the Strait of Magellan, and a considerable extent of the western shores of Patagonia, had been examined, when the death of Captain Stokes caused a suspension of operations. Lieutenant Skyring, whose life has since been sacrificed, was temporarily appointed to the Beagle by Captain King, but soon afterwards superseded by the commander-in-chief on the station; who placed the writer of this sketch in the vacancy. During 1829 and 1830 the two vessels continued the survey, assisted by a tender, whose commander was Lieutenant Thomas Graves. In the latter part of 1830 they returned to England, having added charts of the south-western and southern shores of Tierra del Fuego, besides those of a multitude of interior sounds and passages, to the acquirements above mentioned. Information of other kinds, interesting to men of science, and to most people, was also acquired, and will be made accessible without more delay than is absolutely necessary. A paper on this subject, written by Captain King, was read before the Royal Geographical Society of London, in May, 1831. In the autumn the Beagle was again prepared for a surveying voyage. Every care and assistance was given in her equipment. She wanted nothing that her size would allow to be taken on board. At the end of that year (1831) she sailed from Plymouth. One particular object being the measurement of meridian distances, by a large number of chronometers, the Beagle was ordered to make her voyages by the shortest steps, touching land frequently, for the purpose of obtaining observations and ascertaining the rates of the chronometers. Until the vessel arrived in the River Plata, her chief occupations were, measuring meridian distances, and slightly adding to our knowledge of the Abrolhos shoals, on the coast of Brazil.

While the officers of the Beagle were employed in their usual duties afloat, Mr. Charles Darwin, a zealous volunteer, examined the shores. He will make known the results of his five years' voluntary seclusion and disinterested exertions in the cause of science. Geology has been his principal pursuit.

Beginning with the right or southern bank of the wide river Plata, every mile of the coast thence to Cape Horn was closely surveyed and laid down on a large scale. Each harbour and anchorage was planned;—thirty miles of the River Negro, and two hundred of the Santa Cruz, were examined and laid down, and a chart was made of the Falkland Islands. These earlier productions of the Beagle's voyage are now in the engraver's hands.

Before going westward of Cape Horn it should be remarked, that the detailed survey of so much coast in a short time was accomplished by the constant exertions of Lieutenant John C. Wickham, Mr. J. L. Stokes, and Mr. A. B. Usborne; who ran every risk, and worked by night as well as *every* day, in two small decked boats, during the first year, and afterwards in a tender. The Beagle took portions of coast towards the south, while her detached party were at work between Port Desire and Blanco Bay, and afterwards at the Falkland Islands.

Westward of Cape Horn, as far as the parallel of forty-seven south, little has been added to the results of the Beagle's first voyage, because nearly enough was then done for the wants of vessels employed in, or passing through, those dreary regions; and because there were so many other demands upon the surveyors which were of more consequence. Between forty-seven south latitude and the River Guayaquil, the whole coasts of Chile and Peru have been surveyed; no port or roadstead has been omitted.

Of the Chonos Archipelago, no chart existed. Of Chiloe, the Spanish charts were twenty-five miles in error, in *latitude*. Of the other coasts, a mixture of bad and good description alternately plagued or assisted. Wherever the eyes of Malaspina, Espinosa, or Bauza, reached, in the expedition of the Atrevida and Descubierta, there the old charts are correct; but the intermediate details are not to be compared with those resulting from *their* labours, nor with those in the vicinity of Lima, executed by the students at the Nautical School, under the direction of Don Eduardo Carrasco and his predecessors. Half the coast of Chile was surveyed *in detail*, by Lieutenant B. I. Sulivan, in a small schooner, *lent* for the purpose by Don Antonio José Vascuñan, of Coquimbo; and all the coast of Peru was afterwards closely examined and laid down, by Mr. A. B. Usborne, in the same vessel, then purchased from her public-spirited owner, and fitted out by the Beagle. Mr. Usborne's survey was carried on while

the Beagle was examining the Galapagos* islands, traversing the Pacific Ocean, and returning to England by the way of the Cape of Good Hope.

Traced copies of the charts of coasts adjacent to Buenos Ayres, of the *whole* coast of Chile, and of the greater part of the shores of Peru, were given to the respective governments of those countries before our vessels left their territories,—and long before the original documents could reach England.

Four years having elapsed since the Beagle left England, and having yet three-quarters of the globe to traverse, the little vessel left South America and hastened to that classical spot, Otaheite. Her route was through the Dangerous Archipelago, in which two, if not three, new islands were discovered. Krusenstern's charts and directions were there the only ones of any use. At Otaheite (or Tahiti), a manuscript chart of that really dangerous labyrinth and some useful information were obtained from an intelligent Englishman, who had passed several years in trading with the natives of those numerous low coral islands.

Meridian distances being now the principal object, all haste was made from place to place, and without more delay at any one spot than was absolutely necessary for making observations. Nearly a week, on an average, was passed at each of the following places :—Tahiti, New Zealand (Bay of Islands), Port Jackson (Sydney), Van Diemen's Land (Hobart Town), King George's Sound, the Keeling Islands, Mauritius, Cape of Good Hope, St. Helena, Ascension, Bahia (in Brazil), Pernambuco, Cape Verd Islands, and Azores. At Falmouth the Beagle arrived in the beginning of October; thence she went to Plymouth, Portsmouth, and Greenwich. Directly the rates of her chronometers are ascertained she will go to Woolwich, and there be paid off.

Mr. Usborne has returned from Peru by the way of Cape Horn. His little vessel, of only thirty-five tons burthen, was sold at Paita, when done with, for more than her first cost.

Having thus attempted to give a general idea of the means employed, and course pursued, during these voyages, a few sketches of those places less known, or more interesting than others, will be added.

Those almost boundless plains southward and westward of Buenos Ayres have been too often and too well described to require another word. As pasture land they are excellent, except in the summer, when all is parched. There is a rich tract of country between Buenos Ayres and Cape Corrientes, where the soil is rich and water plentiful. In that tract there are ranges of low hills, running nearly east and west.

* Pronounced Gălăpăgŏs.

From Blanco Bay to the river Negro is a dangerous place. The land is every where low; there are many and extensive shoals and strong tides. Yet with a pilot, or correct chart, excellent harbours may there be reached—in which navies might rest in safety.

In Blanco Bay (the best of these harbours) there are from eight to twelve feet rise of tide. If *large* ships ever frequent that part of the coast, there must be their asylum. But there are material objections to the surrounding country. Water is extremely scarce; wood is not to be procured, except at a great distance.

Unfortunately the fine river Colorado, which rises near Mendoza and brings down a great quantity of water throughout the year, does not run into any of the numerous ports near its opening. A canal might join it to Union Bay, without much difficulty; but does the river remain in one place many years? Do not high tides, floods, and gales of wind alter it annually?

Low, level land extends southward to the river Negro, and westward *gradually* rising towards the Cordillera of the Andes. Villarino, in his Diary, describes the Negro;* it cannot be safely used by vessels drawing more than ten feet water, because there is a dangerous shifting bar at the entrance. South of this river the country and coast change their character; ranges of stony hills, extensive barren plains, and steep cliffs, extend hence to the Strait of Magellan. Only here and there, close to the little river Chupat, or in an occasional oasis, does a tree or green herbage appear. Mixtures of brown, yellow, and light red tire the eye.

One naturally asks why Eastern Patagonia should be condemned to perpetual sterility—while the western side of the same country, in the same parallel of latitude, is injured by too much rain? The prevailing westerly winds, and the Andes, are the causes. The winds bring much moisture from the Pacific, but they leave it all (condensed) on the west side of the mountains. After passing the Cordillera, those same winds are very dry. Easterly winds are very rare upon the east coast: they are the only ones which carry rain to the almost deserts of Patagonia. *Westward* of the Andes, an *east* wind is *dry* and free from clouds. All this country is exposed to severe cold in winter, and to excessive heat in summer; great and sudden changes of temperature take place when, after very hot weather, cold winds rush northwards with the fury of a hurricane. Even the wandering Indians avoid this region, and only cross it to get salt, or visit their burying-places.

In a twenty days' excursion up the river Santa Cruz, we passed through a similar country, without variety, until extensive beds of lava were found overlying the whole country. These Mr. Darwin

* Inserted at p. 136 of this volume.

has already described. We reached nearly to the eastern flank of the Andes, but for want of provisions could go no farther. The river was then, at 200 miles from its mouth, almost as large and quite as rapid as at twenty miles from the sea. Perhaps it runs, for a great distance, along the base of the Andes, and so collects a great body of water; or it may run from a lake into which streams pour. Its water is not muddy. The current runs six knots; none of our boats could pull against it anywhere. We tracked them (pulled them along by a rope). Its *average* width is 200 yards, and mean depth ten feet; perhaps more.

The Gallegos is another rapid torrent; but its size and length do not nearly equal those of the Santa Cruz.

On the coasts adjacent to these rivers the tide rises very much, not less than forty feet at spring tides.

The aboriginal natives of Patagonia are a tall and extremely stout race of men. Their bodies are bulky; their heads and features large; but their hands and feet are small. Their limbs are neither so muscular nor so large-boned as their height and apparent bulk would induce one to suppose: they are rounder and smoother than those of white men. Their colour is a rich reddish brown, rather darker than that of copper, yet not so dark as good mahogany.

Nothing is worn upon the head except their rough, lank, and coarse black hair, which is tied above the temples by a fillet of plaited or twisted sinews. A large mantle, made of skins sewed together, loosely gathered about them, hanging from the shoulders to their ankles, adds so much to the bulkiness of their appearance, that one ought not to wonder at their having been called gigantic.

I am not aware that any Patagonian has appeared during late years whose height exceeded six feet and some inches; but I see no reason to disbelieve the Jesuit Falkner's account of the Cacique Cangapol, whose height, he says, was seven feet and some inches. When Falkner stood on tiptoe he could not reach the top of Cangapol's head. It is rather curious that Byron could only just touch the top of the tallest man's head whom he saw. Ever restless and wandering as were the Tehuel-het, of which tribe he was cacique, might not Byron have measured Cangapol?* Who disbelieves that the Roman Emperor Maximinus, by birth a Thracian, was more than eight feet high?—yet who, in consequence, expects all Thracians to be giants?

Among 200 or 300 natives of Patagonia, scarcely half-a-dozen men are seen whose height is under five feet nine or ten inches: the women are proportionably tall.

I have nowhere seen an assemblage of men and women whose *average* height and *apparent* bulk equalled that of the Patago-

* Dates agree sufficiently.

nians. Tall and athletic as are many of the South Sea islanders, there are also many among their number who are slight, and of lower stature.

The Patagonians seem to be high-shouldered, owing, perhaps, to their habit of folding their arms (across the chest) in their mantles, and thus increasing their apparent height and bulk, because the mantles hang loosely, and almost touch the ground. Until actually measured, it is difficult to believe that they are not much taller than is the case.

But little hair grows on their faces or bodies: from the former it is studiously removed by two shells, or some kind of pincers.

Although they do not try to improve their coarse features by piercing either nose or lips, they disfigure themselves not a little by red, black, or white paint, with which they make grotesque ornaments; such as circles around their eyes, or great marks across their faces. Upon particular occasions all the upper part of their body is queerly decorated by daubs of paint.

On their feet and legs are boots made out of the skins of horses' hind-legs. Wooden (if they cannot get iron) spurs, sets of balls,* a long, tapering lance, and a knife (if one can be procured), complete their equipment.

The women are dressed and booted like the men, with the addition of a half-petticoat. They clean their hair, and plait it into two tails. Ornaments of brass, beads, bits of coloured glass, or such trifles, are prized by them.

Mounted upon horses of a middle size, under fifteen hands high, and rather well bred, the Patagonians seem to be carried no better than dragoons who ride eighteen stone upon horses able to carry ten; yet they go at full speed in chase of ostriches or guanacoes. When hunting, or making long journeys, they often change horses.

The huts of these wanderers are somewhat like gipsy tents. Poles are stuck in the ground, to which others are fixed. Over them are thrown the skins of animals. An irregular, tilt-like hut is thus formed.

The north-eastern part of Tierra del Fuego is like Patagonia. The natives, also, are like those above mentioned, but they have no horses. Balls, bows and arrows, and clubs are their arms and hunting weapons. Seal, guanacoes, and birds are their principal subsistence.

The eastern portion of Tierra del Fuego is a better country than any south of forty-five. The wooded mountains of the west there sink into hills, and those again into level land, partially wooded. The climate is a mean between that of Eastern Patagonia and Western Tierra del Fuego.

* *Bolas*, Spanish. Two or three balls connected by a thong of hide, which they throw at animals or men, to entangle and disable them.

Whenever a settlement is made in those regions, St. Sebastian Bay will be found to possess several advantages.

The southern and western part of Tierra del Fuego may be briefly described by saying that deep but narrow arms of the sea intersect high, mountainous islands, whose summits are covered with snow; while their steep and rocky shores are more than partially covered with evergreen woods.

Throughout the year, cloudy weather, rain, and much wind prevail. Fine days are rare. Frost and snow are constant on the mountains; but near the level of that great climate agent, the ocean, whose temperature is there never below forty-five degrees of Fahrenheit, neither one nor the other are nearly so troublesome as one might expect in so high a southern latitude, among snow-covered mountains, whose sight is enough to make one shiver.

The wretched natives of Southern and Western Tierra del Fuego are low in stature, ill-looking, and ill-proportioned. (I speak of them *generally* in their savage state.)

Their colour is darker than that of copper; it is like old mahogany, or rusty iron. The trunk of their body is large in proportion to their cramped and rather crooked limbs. Rough, coarse, and extremely dirty black hair, half hides, yet heightens, a villainous expression of ugly features.

Sometimes these outcasts wear a piece of seal, otter, or guanaco skin upon their backs; and perhaps the skin of a penguin, or some such covering, is used in front; but often nothing is worn except a scrap of hide, which is tied to their waist. Even this is only for a pocket in which they may carry pebbles for their slings.

Passing so much time in low wigwams, or cramped in small canoes, injures their limbs and movements. In height they vary from four feet ten to five feet six inches; yet the size of their bodies equals that of our largest men. Of course they look clumsy and ill-proportioned. Women usually wear more covering, perhaps a whole skin of a seal. The women comb their hair with the jaw of a porpoise. Both sexes oil themselves, or rub their bodies with grease. They paint, or rather daub their faces and bodies with red, white, or black.

Perhaps Freycinet, and those with him, saw some of these people painted black, as Bory St. Vincent quotes their authority for the natives of Tierra del Fuego being *black*, like the natives of Van Diemen's Land.—See article "Homme" in the *Dictionnaire Classique*.

As a Fuegian is seldom out of sight of his canoe, or a wigwam, a slight idea of those, his only constructions, should be given.

The canoe is made of several large pieces of bark sewed together. Its shape is nearly that which would be taken by the strong bark of a tree (twelve to twenty feet in length, and eighteen inches, or

two feet in diameter), separated from the solid wood in one piece, joined at the ends, but kept open by sticks in the middle. It is ballasted by clay, and always carries a small fire.

There are two kinds of wigwams: one is made with a number of small straight trees, whose upper ends are united, while the lower form a circle; and another which is formed by branches stuck in the ground, bent together at the top, and slightly covered by skins, bark, grass, or leafy twigs. A small entrance is left open: smoke goes out as easily as rain enters.

Western Patagonia is like the worst part of Tierra del Fuego. It is the upper part of a great range of mountains, whose bases are immersed in the ocean. The mountain-tops form multitudes of islands, barren to seaward, but impenetrably wooded towards the main-land; and always drenched with the waters of incessant rain, *never* dried up by evaporation. Every foot of earth, every tree, and shrub, on those islands, is *always* thoroughly wet. Of course the country is uninhabitable, except by savages. Clouds, wind, and rain only cease their annoyance during the very few days on which the wind is easterly, or perhaps southerly. Probably there are not ten days in twelve months, on which rain (or snow) does not fall; and not thirty on which it does not blow strongly. But it is mild, and the temperature is surprisingly uniform throughout the year.

The Chonos Archipelago is very little better than the country just mentioned. It is almost uninhabitable. Indeed, on the west coast of South America, southward of Chiloe, there are very few acres of land capable of cultivation, and no place which is fit for the permanent abode of civilized man. That inhospitable region should be avoided by ships; though really full of harbours, it is so dangerous to run to leeward, and so difficult to make out the land, obscured as it is generally by rain or clouds, that most of them must ever be nearly useless. A heavy swell always sets towards the shore; and, although there are no sand-banks, there are numbers of outlying, dangerous rocks.

Steam navigation may render the numerous interior passages useful. From the north end of Chiloe to the eastern entrance of Magellan's Strait a steamer may go without being exposed to the swell of the Pacific, except at one place, Cape Tres Montes. In that interval she may get fuel (wood) on either hand, wherever she chooses. On the main-land, opposite to Chiloe, are the southernmost volcanoes of whose modern activity we have any certain account. There are four in sight of the inhabitants of Chiloe. Each one, even when tranquil, is a magnificent object.

None of the mountains in this part of the Andes, or to the southward, which have been measured, exceed 9000 feet in height.

Chiloe, though a fertile island, is exposed to an excessive amount of wind and rain. It is the southernmost inhabited part of the west coast.

About Valdivia the climate is similar, and must always be an obstacle to cultivation. Northward of Valdivia, towards Concepcion, is one of the finest countries in the world, in a very healthy climate. There the Araucanians are still unconquered owners of their native land. All the efforts of the Spaniards, all exertions of their descendants in Chile, have failed in expelling that heroic race from the birthplace of their ancestors.

That they should now make head against the Chilenos, is not surprising; but that they should formerly have withstood the power of Spain, and the enthusiasm of their invaders, excites astonishment.

Gold is often supposed to have been the principal temptation of the early conquerors of the New World: but there was another motive for energetic exertion, one which affected many minds far more than the desire of wealth. An enthusiastically religious feeling urged them to persevere under every trial and disappointment. It helps much in accounting for the wonderful hardiness and constancy shown in discovering, exploring, and conquering all but Araucania.

A high sentiment of religion, urging them to conquer, in order to convert to Christianity, and to honour God, by honouring their king, was a powerfully impelling motive in the minds of those leaders who first opened the roads which crowds of inferior men afterwards followed.

While the Beagle was at Valdivia, the great earthquake of the 20th of February, 1835, took place.

Concepcion, February 20th.—At ten in the morning very large flights of sea-fowl were noticed passing over the city of Concepcion, from the sea-coast towards the interior. In the minds of old inhabitants, well acquainted with the climate of Concepcion, some surprise was excited by so unusual and so simultaneous a change in the habits of those birds,* no signs of an approaching storm being visible, nor any expected at that season. About eleven the southerly breeze† freshened up as usual; the sky was clear, and almost cloudless. At forty minutes after eleven ‡ a shock of an earthquake was felt, slightly at first, but increasing rapidly.§ During the first half minute many persons remained in their houses; but then the convulsive movements became so strong, that the alarm was general, and all rushed into the open spaces for safety.

* Chiefly gulls.

† Sea-breeze.

‡ Mean time.—Equation, 14′ subtractive from mean time.

§ No noise preceded the *great* shock.

The horrid motion increased; people could hardly stand; buildings waved and tottered; suddenly an awful overpowering shock caused universal destruction. In less than six seconds the city was in ruins. The stunning noise of falling houses; the horrible cracking of the earth, which opened and shut rapidly and repeatedly in numerous places;* the desperate, heart-rending outcries of the people; the stifling heat; the blinding, smothering clouds of dust; the utter helplessness and confusion, and the extreme horror and alarm, can neither be described nor fully imagined.

This fatal convulsion took place about a minute and a half, or two minutes, after the first shock; and it lasted equally violent during nearly two minutes. During this time no one could stand unsupported: people clung to each other, to trees, or to posts. Some threw themselves on the ground; but there the motion was so violent, that they were obliged to stretch out their arms on each side, to prevent being tossed over and over. Horses, and all animals, were greatly frightened, standing with their legs spread out, and their heads down, trembling violently. Birds flew about wildly.

After the violent shock had ceased, the clouds of dust, which had been raised by the falling buildings, began to disperse. People breathed more freely, and began to look around them. Ghastly and sepulchral was their appearance: had the graves opened and given up their dead, the sight would have been scarcely less shocking. Pale and trembling, covered with dust and perspiration, they ran from place to place, calling for their relations and friends. Many seemed to be quite bereft of reason.

Considerable shocks continued at short intervals, harassing and alarming. The earth was never long quiet during that or the next day; nor, indeed, during the three days following the great shock.

For many hours after the ruin the earth was tremulous, and the shocks were very frequent, though not severe. Many shocks, but not all, were preceded by a rumbling, subterranean noise, like distant thunder: some compared the sound to the distant discharge of many pieces of artillery. These sounds came from the south-west quarter, and preceded the shock by one or two seconds. Sometimes, but not often, the sound was heard unaccompanied by any shock.

It was the general opinion that the motion was from south-west to north-east. Some whole walls, whose direction was south-east and north-west, were laid flat; the bricks still maintaining their relative position, though endwise, without being *scattered* upon the ground. These walls fell, without exception, to the north-east.†

* The direction of these cracks was not uniform, though *generally* south-east and north-west.

† The streets of Concepcion lie north-east and south-west,—north-west and south-east.

Other walls were scattered as they fell; but the greatest masses of brick-work were thrown towards the north-east. Walls standing in the opposite direction, north-east and south-west, suffered far less. Fragments were shaken, or torn off; and some of the walls very much cracked;* but others had suffered little.

Roofs fell in everywhere: houses built of *adobes*† fell into a confused heap. The cathedral, whose walls are four feet in thickness, supported by great buttresses, and built of good brick and mortar,‡ suffered *more* than other buildings. Adhering to the remains of the walls were left the lower parts of some buttresses, theupper parts of others; while in one place a buttress stood on its own foundation, separated entirely from the wall.

The city of Concepcion stands upon a plain very little higher than the level of the river Bio-Bio: the soil is loose and alluvial. To the eastward and northward are rocky, irregular hills, of tertiary § formation. From the foot of these hills the loose earth was everywhere parted by the great convulsion, great cracks being left from an inch to a foot in width. It seemed as if the low land had been separated from the hills, having been more disturbed by the shock.

Women washing in the river near Concepcion were startled by the sudden rise of the water from their ankles to their knees, and at the same moment felt the beginning of the convulsion. It was said that the dogs avoided the ruin by running out of the way before the shock. This, though certainly known to have been the case at Talcahuano, wants confirmation with respect to Concepcion. Of nine men who were repairing the inside of a church, seven were killed, and two severely hurt. One of these poor fellows lay half buried in the ruins during five days, with a dead body lying across him, through which it was necessary to cut for his release. A mother escaping with her children saw one fall into a hole: a wall close to her was tottering; she pushed a piece of wood across the hole, and ran. The wall fell, and covered the hole with masses of brick-work. Next day the child was taken out unhurt. Another woman missed a child; saw that a high wall was tottering, but ran for her son, and brought him out. As she crossed the street the wall fell; but they were safe. When the tremendous crash came, the whole street, which she had just crossed, was filled up with part of the ruins of the cathedral. Besides a waving or undulatory movement, vertical, horizontal, and circular or twisting motions were felt. An angular stone pinnacle was particularly noticed, which had been turned half round without being thrown down, or leaving its base.

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* Vertically,—as if by the undulatory movement of the earth's surface,—in the direction of their length.

† Large unbaked bricks. ‡ Both bricks and mortar were excellent.

§ Not quite certain.

Persons riding at the time of the great shock were stopped short,—some, with their horses, were thrown to the ground, others dismounted, but could not stand. So little was the ground at rest after the great ruin, that between the 20th of February and the 4th of March more than 300 shocks were counted. Much misery was alleviated by the good conduct and extreme hospitality of the inhabitants of Concepcion. Mutual assistance was everywhere rendered, and theft was almost unknown. The higher classes immediately set people to work to build straw-covered huts, and temporary houses of boards, living meanwhile in the open air under trees. Those who soonest obtained or contrived shelter collected all about them whom they could assist, and in a few days had a temporary shelter, under which they tried to laugh at their misfortunes, and the shifts to which they were reduced.

Talcahuano, Feb. 20th, 1835.—At Talcahuano the great earthquake was felt as severely as in the city. It took place at the same time and in a precisely similar manner. Three houses only, upon a rocky foundation, escaped the fate of all those standing upon the loose sandy soil which lies between the sea-beach and the hills. Nearly all the inhabitants escaped uninjured, but they had scarcely recovered from the sensations of the ruinous shocks, when alarm was given that the sea was retiring! Penco* was not forgotten: apprehensive of an overwhelming wave, all hurried to the hills as fast as possible.

About half an hour after the shock, when the greater part of the population had reached the heights, and the sea had retired so much that all the vessels at anchor, even those which had been lying in seven fathoms water, were aground; and all the rocks and shoals in the bay were visible;—an enormous wave was seen forcing its way through the western passage which separates Quiriquina Island from the main land. This immense wave passed rapidly along the western side of the bay of Concepcion, sweeping the steep shores of every thing movable within thirty feet (vertically) from high-water mark. It broke over, dashed along, and whirled about the shipping as if they had been light boats, overflowed the greater part of the town, and then rushed back with such a torrent, that almost every movable, which the earthquake had not buried under heaps of ruins, was carried out to sea. In a few minutes the vessels were again aground, and a second great wave was seen approaching, with more noise and impetuosity than the first. Though this wave was more powerful, its effects were not so considerable, simply because there was less to destroy. Again the sea fell, dragging away quantities of wood-work, and the lighter materials of houses, and leaving the shipping aground.

After some minutes of awful suspense, a third enormous swell

* Penco, the former capital of the province of Concepcion, was overwhelmed by the sea.

was seen, between Quiriquina and the main land, apparently larger than either of the former waves. Roaring, as it dashed against every obstacle, with irresistible force it rushed along the shore, destroying and overwhelming. Quickly retiring, as if spurned by the foot of the hills, the retreating wave dragged away such quantities of household effects, fences, furniture and other movables, that, after the tumultuous rush was over, the sea appeared covered with wreck. Exhaustion appeared to follow these efforts. Earth and water trembled. Numbers of the inhabitants now hastened to the ruins, anxious to ascertain the extent of their losses, and to save some money, or a few valuable articles, which, having escaped the sweep of the sea, were exposed to depredators.*

During the remainder of the day and the following night, the earth was not quiet many minutes at a time. Frequent, almost incessant tremors, occasional shocks, more or less severe, and distant subterranean noises, kept every one in anxious suspense. Some thought the crisis had not arrived, and would not descend from the hills into the ruined town. Others, searching among the ruins, started at every shock, however slight, and almost doubted that the sea was not actually rushing in again to overwhelm them. Nearly all the inhabitants, excepting a few who went on board vessels in the harbour, passed the night upon the hills without shelter.

Next day they began to raise sheds and huts upon the high grounds, still dreading the sea. Without explanation, it appears astonishing how the shipping escaped destruction. Three large whale ships, a bark, two brigs, and a schooner, were lying very near the town in from four to seven fathoms water. They were lying at single anchor,† with a good scope of cable.‡ With the southerly breeze, which was rather fresh at the time of the earthquake, the vessels were lying to seaward§ of their anchors, with their sterns towards the sea. They were left aground in this position. The captain of the port, Captain Delano, was on board one of the whale ships at the time; whose hatches were battened down and dead-lights shipped. All hands took to the rigging for safety. The first great wave came in an unbroken swell to the stern of the vessel, broke over and lifted her along without doing any material harm more than sweeping her decks. Dragging the slack chain over the mud checked her gradually, as the first impetus of the wave diminished. Whirling her round, the

* Thieves were numerous in Talcahuano. Directly after the ruin these scoundrels set to work,—crying 'Misericordia!' and with one hand beating their breasts, with the other they stole most industriously.

† Or steadied by a light anchor and hawser, which would bear no strain.

‡ Chain. The holding ground is excellent; a soft tenacious mud.

§ About half a cable's length, or from sixty to one hundred yards.

water rushed out to seaward again, leaving the vessel aground nearly in her former position. From two fathoms, when aground, the depth alongside increased to ten when the water rose highest, during the last wave. The two latter waves approached, and affected the shipping similarly to the former. All held on; though some of the anchors started a few fathoms. Some of the vessels were thrown violently against others; and whirled around as if they had been in the vortex of a whirlpool. Previous to the rush of waters, the Paulina and Orion, two merchantmen, were lying a full cable's length apart. Afterwards they were lying side by side, with three round turns in their cables. Each vessel had therefore gone round the other with each wave. The bow of one was stove in. To the other little damage was done. A small vessel* was on the stocks, almost ready for launching; she was carried by the sea two hundred yards in shore, and left there unhurt. A small schooner, at anchor before the town, slipped her cable, and ran out in the offing as the water fell. She met the wave unbroken, and rose over it as an ordinary swell. The Colocolo† was under sail near the eastern entrance of the bay. She likewise met the wave as a large swell, without inconvenience.

Many boats‡ put off from the shore before the sea retired. Some met the advancing waves before they broke, and rose safely over them; others, half swamped, struggled through the breakers. The fate of one little boy was extraordinary. A servant woman had taken refuge with him in a boat: the boat was dashed against an anchor lying on the shore, and divided. The woman was drowned, but the half of the boat containing the child § was carried out into the bay. It floated, and the child held firmly. He was picked up afterwards, sitting upright, holding steadily with both hands; wet and cold, but unhurt. The boy's name is Hodges. His father is an Englishman, well known at Talcahuano; he was an officer in the British navy.

Four days afterwards the sea was strewed with wreck, not only in the bay of Concepcion, but outside in the offing. The shores of Quiriquina Island were covered with broken furniture and woodwork of all kinds; so much so, that for weeks afterwards parties were constantly at work collecting and bringing back property. During three days succeeding the day of the ruin the sea ebbed and flowed irregularly, and very frequently. For some hours after the shock it rose and fell two or three times in an hour.

Eastward of the island of Quiriquina, the swell was neither so large nor so powerful as that which swept over Talcahuano. Having more room to expend its strength in the wider and deeper part of the bay, may perhaps have been the reason why the sea swelled

* About thirty tons.
† Chilian schooner-of-war.
‡ Chiefly, if not all, whale boats.
§ Only four years old.

rapidly, without breaking, near Lirquen, in the south-east part of the bay, and why it broke over Tomé* with violence, though not so furiously as over Talcahuano. The great waves coming from the sea appear to have been divided, at the entrance of Concepcion Bay, by the island of Quiriquina, and turned aside both ways; one part taking its course along the Tumbez or western shore, towards Talcahuano, the other *across* the eastern opening, towards Tomé.

While the bay of Concepcion was agitated by the great waves, it was noticed by Captain Walford (from his house at Lirquen) that the Colocolo was swept to and fro remarkably. She was under sail near the eastern entrance of the bay. Two explosions, or eruptions, were seen while the waves were coming in: one beyond the island of Quiriquina, in the offing, was seen by Mr. Henry Burdon and his family, who were then embarked in a large boat near Tomé; it appeared to be a dark column of smoke, in shape like a tower. Another rose in the middle of the bay of San Vicente, like the blowing of an immense imaginary whale. Its disappearance was followed by a whirlpool, which lasted some minutes. It was hollow, and tended to a point in the middle, as if the sea was pouring into a cavity of the earth. At the time of the ruin, and until after the great waves, the water in the bay appeared to be every where boiling; bubbles of air, or gas, were rapidly escaping. The water also became black, and exhaled a most disagreeable sulphureous smell. Dead fish were also thrown ashore in quantities; they seemed to have been poisoned, or suffocated. For several days afterwards the shores of the bay were covered with fine corvinos, and numerous small fish. Black stinking water burst up from the ground in several places. In Mr. Evans's yard at Talcahuano the ground swelled like a large bubble, and then bursting poured forth black fetid sulphureous water. Near Concepcion similar outbursts of water were seen and similarly described.

It was said, and generally considered certain, that every dog had left the town before the shock which ruined the buildings was felt. By a marked part of the wall of Captain Delano's house, it was ascertained that the body of water reached twenty-five feet above the usual level of high water. It penetrated into the Altos,† and left sea-weed hanging to the remains of roofs, or to the tops of broken walls. But this must not be taken as the general height of the wave. A body of water, rushing upon a sloping beach with such force, would naturally preserve its impetus for some time, and run up an inclined plane to a great height. Those who

* Tomé is near the eastern entrance of the bay, where the wave would meet with more interruption than near Lirquen, though considerably less than in the *western* passage.

† First-floor rooms.

watched the waves coming in considered them, while beyond the shipping, about as high as the upper part of the hull of a frigate, or from sixteen to twenty feet above the level of the rest of the water in the bay. Only those parts of the wave broke which encountered opposition, until within half a mile of the beach, when the roar became appalling.

Persons, who were standing on the heights overlooking both bays, saw the sea come swelling into San Vicente, at the same time that it advanced upon Talcahuano. The explosion in San Vicente, and the sea advancing from both sides, made them think that the peninsula of Tumbez was about to be separated from the main land, and many ran higher up the hills until they had reached the very highest point.

Strange extremes of injury and harmlessness were among the effects of these overwhelming waves. Buildings were levelled, heavy twenty-four pound guns were moved some yards and upset; yet a child was carried to sea uninjured, and window-frames with the glass in them were thrown ashore upon the island of Quiriquina without a pane being broken!

According to a register kept by Captain Delano, it appeared that his barometer fell four or five tenths of an inch between the 17th and 18th of February, and was still falling on the morning of the 18th, after which it rose again.* So great and sudden a fall, not followed by bad weather, *may* have been connected with the cause of the earthquake; but some doubt hangs over these observations. The barometers on board the Beagle, at that time in Valdivia, did not indicate any change. Still, at so great a distance, it does not follow that the mercury should move similarly.

In a river near Lirquen, a woman was washing clothes at the time of the great shock. The water rose instantaneously from her feet half way up her legs, and then subsided gradually to its usual level. It became very muddy at the same time.

On the sea beach the water swelled up to high-water mark at the time of the shock, without having previously retired. It then began to retire, and continued falling about half an hour, when the great wave was seen approaching.

For some days after the ruin the sea did not rise to the usual marks, by four or five feet vertically. Some thought the land had been elevated, but the common and prevailing idea was, that the sea had retired. This difference gradually diminished, till, in the middle of April, there was a difference of only two feet between the existing and former high-water marks.

The proof that the *land* had been raised exists in the fact, tha

* In Concepcion a fall of two or three tenths indicates bad weather; four or five tenths, a gale of wind with much rain.

the island of Santa Maria was upheaved nine feet; but of this presently.

In passing through the narrow passage which separates Quiriquina from Tumbez, the great waves had swept the steep shores to a height of thirty feet (vertically) above high-water mark; but this elevation was attained, in all probability, only at the sides of the passage, where the water met with more obstruction, and therefore washed up higher. The passage appears to be nearly one mile in width, and has ten fathoms water in the middle, but the rocks on the western side diminish its navigable width to half a mile.

Wherever the invading waves found low land the destruction was great, those low lands being in general well cultivated, and the site of many houses. The low grounds lying at the bottom of Concepcion bay, particularly those of the island De los Reyes, were overflowed and injured irreparably. Quantities of cattle, horses, and sheep were lost. Similar effects, in an equal or less degree, were felt on the coasts between the river Itala and Cape Rumena. Large masses of earth and stone, many thousand tons in weight, were detached from the cliffs and precipitous sides of the hills. It was dangerous to go near the edge of a cliff, for numerous chasms and cracks in every direction showed how doubtful was the support. When walking on the shore, even at high water, beds of dead mussels, numerous chitons and limpets, withered seaweed still adhering, though lifeless, to the rocks where they had lived, every where met the eye; the effects of the upheaval of the land.

I. Santa Maria.—Besides suffering from the effects of the earthquake, and three invading waves which, coming from the west round both points of the island, united to overflow the low ground near the village, Santa Maria was upheaved nine feet. It appeared that the southern extreme of the island had been raised eight feet, the middle nine, and the northern end upwards of ten feet.

The Beagle visited this island twice, at the end of March, and in the beginning of April. At her first visit it was concluded, from the visible evidence of dead shell-fish, water-marks, and soundings, and from the verbal testimony of the inhabitants, that the land had been raised about eight feet. However, on returning to Concepcion, doubts were raised; and to settle the matter beyond dispute, or the possibility of mistake, the owner of the island, M. Salvador Palma, accompanied us. An intelligent Hanoverian, whose occupation upon the island was sealing, and who had lived two years there, and knew its shores thoroughly, was also a passenger in the Beagle.

When we landed, the Hanoverian, whose name was Antonio

Vogelberg, showed me a spot from which he used formerly to gather choros* by diving for them at low water.

At dead low water, standing upon that bed of choros, and holding his hands up above his head, he could not reach the surface of the water. His height is six feet; on that spot, when I was there, the choros were barely covered at high spring tide.

Riding round the island afterwards, with Mr. Palma and Vogelborg, many measures were taken in places, where no mistake could be made.

On large steep-sided rocks, where vertical measures could be correctly taken, beds of dead mussels were found ten feet above the present high-water mark.

A few inches only above what was taken as spring tide, high-water mark, were putrid shell-fish and seaweed, which evidently had not been wetted since the upheaval of the land.

One foot lower than the highest bed of mussels, a few limpets and chitons were adhering to the rock, where they had grown.

Two feet lower than the same mussels, chitons and limpets were abundant.

An extensive rocky flat lies around the northern parts of Santa Maria. Before the earthquake, this flat was covered by the sea, some projecting rocks only showing themselves. Now, the whole flat is exposed. Square acres (or many quadras) of this rocky flat were covered with dead shell-fish, and the stench arising from them was abominable.

By this elevation of the land, the southern port of Santa Maria has been almost destroyed. There remains but little shelter: and very bad landing. The soundings have diminished a fathom and a half every where around the island.

Tubul.—At Tubul, to the south-east of Santa Maria, the land has been raised six feet.

The waves did not enter that river's mouth until about one o'clock; and then in greater number, but with less force. Six or seven waves were counted. Might not this be owing to the meeting of the divisions of that great wave which passed around the island of Santa Maria?

I. Mocha.—At the island of Mocha the shock of the earthquake was so strong that people could not stand. The sea washed over the rocks at the end of the island, higher than it had ever reached in a heavy gale of wind.

Antonio Vogelborg was on one of those rocks, or rather on an islet at the south end of Mocha, at the time. A party were with him, sealing. Their boat was hauled up upon the top of the rocky islet. They expected to be washed off, and held by the boat, in readiness. The boat was lying nearly east and west.

* A large kind of mussel.

During the earthquake, some water in her bottom ran quickly from one end of the boat to the other, as if some one were quickly lifting one end off the ground, and letting it down again. It did not wash from side to side at any time. Two forked sticks were stuck in the ground, about three yards apart, another lay across them for hanging things to dry: these sticks also were nearly east and west of one another. During the shock they waved to and fro till the forks touched, and the cross stick fell. Strong shocks were felt by vessels under sail near Mocha. Between Mocha and Concepcion shocks were felt by several vessels, not only on the 20th, but during the following days.

At anchor off Mocha, on the 24th, a slight shock was felt which resembled the sudden dragging of the anchor over rocks.

Under way on the 2d of March, it was thought that the chain cable was running out at the hawse.

In one vessel, they thought she had run ashore; on board of another, that the ship had passed over a whale. Vogelborg thinks the land has been upheaved about two feet. From his accuracy in other matters, I am inclined to trust to his opinion.

Valdivia.—At Valdivia, the shock began gently, increased gradually during two minutes, was at its strongest about one minute, and then diminished.

The motion was undulating and regular, like waves rolling from west to east, but strong; it lasted nearly ten minutes. There was no difficulty in standing or walking, but the houses waved and cracked.

The stone church tottered, but was not injured; its roof is very light. All the dwelling-houses, being strongly built of wood, withstood the shock.

Some thought the motion was from south-west to north-east, but Mr. Darwin, and a person with him at the time, thought the reverse. The river swelled, or rose, at the same time, and quickly fell again to its former height. In the port the sea swelled suddenly upon the shore, to high-water mark, though it was then nearly the time of low-water, and quickly fell again. Both sea and river rose and fell frequently, during the remainder of the day. The river never fell below its usual height, neither did the sea retire beyond its proper place, at that time of tide; but each swelled from time to time, and again sunk down. This happened once or twice in an hour. After the great convulsion, other slighter shocks were felt, at intervals of a few minutes, during an hour.

In the afternoon, at about five, a smart shock was felt, which made the people run out of their houses.* One man and one

* Although built of wood.

woman were drowned by the sudden rise of the sea, near Fort Niebla; it was supposed that they were upon the rocks, gathering shell-fish. Excepting in this instance, no injury was done at Valdivia.

No noise preceded or accompanied any of the shocks at Valdivia.

I. Chiloe.—This great earthquake extended to the island of Chiloe, and probably still farther to the southward. The shock was there slight, but lasted during six or eight minutes; it was neither preceded nor followed by any subterranean noise. About thirty-four minutes after eleven,* the beginning of the shock was felt: the motion was undulating, and not strong. The swell of the sea was felt there, but I know not at what time. A man was going to leave the shore † in his boat; he went a short distance to fetch something, and returning found the boat aground and immoveable. Puzzled and vexed, he went away; but had not gone many yards before his son called to him that the boat was afloat.

Northward of Concepcion, Coliumo.—In the little port of Coliumo, close to the northward of Concepcion Bay, the waves rose about as high as at Tomé, nearly fourteen feet, before they reached the shore. The little village of Dichato shared the general calamity; but standing rather higher, and more distant from the sea than Talcahuano, it escaped the ravages of the sea.

Maule.—The force and height of the waves must have been considerably diminished at the mouth of the Maule. No particular effect had been noticed at the time, nor were there any marks upon the shore by which the height of the wave could be afterwards ascertained.

That the sea should not there have occupied attention is not surprising, when one considers the locality of "La Constitucion," as the town and port are called. On level low land, at the south side of the river, is the town. Between the town and the sea is high land, and a distance of about a mile. The river winds round the northern promontory of the high land, and then fights its way to sea over a bar on which there are always breakers.

Without going half a mile, and up the hill, the sea cannot be seen. There are no houses on the sea-shore. Naturally, then, for some time after the town was ruined by the earthquake, the inhabitants would be engaged in saving and sheltering their property, rather than looking at the sea. I could not ascertain whether the river had risen or not. A vessel lying close under the promontory mentioned above, was obliged to move as quickly as possible when the shocks began, so serious was the shower of

* Mean time. † Sandy Point, San Carlos.

stones which rattled down the hill, and fell about and on board of her. I was assured by the governor, by the chief pilot, and by other residents, that instead of the land having been elevated at all, they considered that it had sunk about two feet. The pilot said that he had found two feet more water on the bar, since the great shock; and that he was certain the banks of the river were lower, though he could not say exactly how much. A rush of water might have shifted the loose sands of the bar. Whether the land had sunk, seemed to me very doubtful. Certainly, however, it had not risen.

Having previously heard that the waves had been very powerful at the mouth of the Maule, I was a good deal surprised to find they had been almost unnoticed. All attention had been engrossed with the earthquake.

Juan Fernandez.—The island of Juan Fernandez was affected very much. Near Bacalao Head, an eruption burst through the sea in a place about a mile from the land, where the depth is from fifty to eighty fathoms. Smoke and water were thrown out during the greater part of the day: flames were seen at night. Great waves swept the shores of the island, after the sea had retired so much that old anchors were seen at the bottom of the anchorage.

This earthquake was felt at all places between Chiloe and Copiapo; between Juan Fernandez and Mendoza. On the sea-coast within those limits, the retiring and swelling of the ocean was everywhere felt. At Mendoza, the motion was evenly gentle. Copiapo, Huasco, and Coquimbo felt similar, although rather more forcible, undulations. On the continent, towns and houses which lay between the parallels of thirty-five and thirty-eight, suffered extremely; nearly all were ruined. Northward and southward of those parallels, slight injury was done to any building.

In the parallel of thirty-three and a half, Juan Fernandez suffered; yet Valparaiso, opposite, escaped uninjured.

As to the state of neighbouring volcanoes, so various and indistinct were the accounts of their action, after and before the earthquake, that as yet I have had no means of ascertaining the truth.

On Mocha island, formerly well peopled by Indians, there are now no aboriginal inhabitants. A few natives of Concepcion, or Valdivia, live there, for the sake of sealing on the rocks. Mocha is high, with deep water around it; but straggling, dangerous rocks lie near, towards the south-west.

All the west coast of South America, with but few exceptions, is similar in character. High, steep, rocky shores, with deep water near them, are almost everywhere found.

Northern Chile and Peru are well known, but I have not met with an explanation of the fact, that no rain falls in Lower Peru.

Is not the south-east trade-wind deprived of its moisture, and partly checked, by the Andes, before it reaches the low regions at their western base? That wind is perennial.

The Galapagos Islands are all volcanic, of comparatively recent formation. Their lavas seem to be very durable. Vegetation makes small progress. On five islands there are fertile spots; at one of which, Charles Island, a small colony has lately been established by the government of Guayaquil.

There are six principal and seven small islands. The largest is sixty miles in length, and about fifteen broad. The highest part is 4000 feet above the sea. At first landing upon their shores, black, dismal-looking heaps of broken lava everywhere meet the eye. Innumerable crabs, hideous iguanas (or rather large lizards), and great elephant tortoises startle and surprise. These two latter reptiles are peculiar to the Galapagos. The name itself is Spanish for land tortoises. These animals grow to a great size, —to several hundred pounds in weight. Their feet are then like those of a small elephant. Few reptiles are uglier than those black lizards. They are about three feet in length. Their great mouth has a pouch hanging under it. A spiny sort of mane is on the neck and back. They have long claws and tail, and are of a dirty black colour. They swim with ease and swiftness, using their tails only.

A little way inland, on the windward side of the island, there is much underwood and some crooked trees nearly two feet in diameter. How they are able to penetrate, or derive nourishment from, the hard lava, is perplexing.

A shell is common on these shores, which reminds one of the purple murex. The fish emits a strong dyeing liquid of a similar colour.

The little colony is established on Charles Island, in a plain about 1000 feet above the sea. To go there, we ascended gradually from the shore till we reached the edge of the rocky height which limited our view. Surprisingly sudden was then the change. Heated and tired by a dusty up-hill walk, through sun-dried trees and over rugged lava, our bodies were at once refreshed by a cool breeze, while our eyes enjoyed an unexpected view of a fertile and cultivated plain. Surrounded by tropical vegetation, by bananas, sugar-canes, sweet potatoes, and Indian corn, all luxuriantly flourishing, it was hard to believe that land so sterile, and apparently so useless as that we had just passed, could be so close to such rich fertility.

In a small cave near the top of this island an old sailor lived many years. He had been unfortunate, and was tired of the

world. Terrapin (or land-tortoises) and sweet potatoes were his food. An old friend, the master of a whaler, recognized him, and carried him away by force, for so strongly was the old man attached to his cave, that no motive was sufficient inducement for a willing departure.

Besides affording a wholesome and palatable food, the terrapin yield an excellent oil. But it is a pity to kill them for this purpose; they are so useful to the crews of whale ships.

The little colony can now supply shipping with vegetables, fowls, and pigs. Very soon they will have cattle, sheep, and goats. Water for shipping can only be procured at the south side of Chatham Island.

The particular names of these islands were given by the old Buccaneers, and by Colnett.

More instances of the manner in which high land deprives wind of its moisture may be seen at each of the Galapagos. Situated in a perennial wind, only those sides which are exposed to it are covered with verdure and have water. All else is dry and barren.

Passing a projecting headland, we were all struck by the wildness and grandeur of the scene which opened to us, as the ship sailed round. Immense craters, suddenly rising from the sea—enormous masses of black lava—and a multitude of fumeroles, scattered in every direction—gave one the idea of an immense Cyclopian iron foundry. In many places the lava cliffs are very high, while close to them the water is so deep that a ship cannot anchor, even in a calm. From this situation dismal indeed was the view, yet interesting. To see such an extent of country overwhelmed by lava, and to think of the possible effects of seven dormant volcanoes then in sight, was impressive.

Remarkable currents are found about the Galapagos. In some places they run three, four, or even five miles an hour, generally, but not always, to the north-west. On one side of an island the temperature of the sea is sometimes found to be near eighty, while on the other the water is at less than sixty degrees (Fahrenheit). These striking differences may be owing to the cool current, which comes from the southward along the coast of Chile and Peru, meeting a far warmer stream from the neighbourhood of the bay of Panama. The manner in which these great ocean streams preserve their temperature has been remarked: they must have much effect upon the climates of those countries near the sea along whose shores they

The Dangerous Archipelago is deserving of such a name. Numerous coral islets, only a few feet above water, obstruct navigation; while currents and strong squalls add to the risk. Singular interruptions to the trade-wind are caused by these low lagoon islands; not only does the trade often fail among them, but heavy

squalls come from the opposite direction, and more frequently by night than by day. Clouds are said to be attracted, if not partly caused, by land or by trees. As the low islands of this archipelago have no hill or height of any kind about which the clouds attracted by them can gather and discharge their contents, whether electrical or fluid, perhaps those clouds wanting a conductor discharge themselves irregularly and in squalls. Where high land acts as a conductor between the upper regions of the air and the earth, there may be a continual though unperceived electrical action.

Otaheite, or Tahiti, as it is more correctly called, is indeed beautiful. We saw it early in the morning, and were at first disappointed. Clouds hung over the land; but as the sun rose higher the clouds shrunk away, vanishing as they rolled off the grandly formed mountains. High, sharp, irregular peaks, and huge masses of rock appeared between the clouds, and again were hidden. Deep valleys, or glens, showed darkly; and as the shadows passed, seemed to be denied the light of day. Strikingly different in appearance were the lower hills, and the richly wooded land at the sea-side. There the bright sunshine heightened the vivid and ever-varying tints of a rich verdure. Every kind of green, a beautiful alternation of light and shade, each moment changing as the light clouds passed; the groves of graceful palm trees, and the dazzling white foam of the breakers on the coral reefs, contrasted by the deep blue of the sea, combined to form a most enchanting view.

But few days were passed at this delightful island. What little we saw of the missionaries, and what we heard of their labour, and its effects, highly gratified us. But we were yet more gratified by hearing of the number of native missionaries who had gone into other distant islands (having been educated at Tahiti), and of the beneficial effects produced by them. Wherever the missionary succeeds in obtaining even a slight influence, there the seaman may go in safety. He should not be ungrateful. He should not be among the first to seek for faults. What man, what human institution is blameless?

In the Gambier Islands there is now a Roman Catholic mission. It is said to be well supported.

What a fine fertile country is the northern island of New Zealand; and how fast the character of that land and its inhabitants is changing! An Englishman may now walk alone, and unmolested about any part of the northern island, where, ten years ago, such an attempt would have been a rash braving of the club and the oven.

English and American houses are scattered near the Bay of Islands; and settlers are rapidly increasing. All this is chiefly due to the Church Missionary Society.

Nothing could be more gratifying than the view of a flourishing

agricultural settlement, with good farm-houses, barns, water-mill, mechanics' shops, and large gardens, in the interior of the northern island. I was astonished at what I saw; and when a New Zealander came out of the mill, powdered with flour, and carrying a sack of corn upon his back, I could hardly believe my own eyes. This effect has been caused by the missionaries. But I must hasten to a conclusion.

Sydney and Hobart Town are known well; yet I do not think every one is aware of the great difficulty of bringing up a family well in those countries, owing to the demoralizing influence of convict servants, to which children must more or less be exposed. Nor is every one aware of the extent of that rancorous feeling which is caused by the total separation of the descendants of convicts, as well as the emancipists, from free settlers and their families, as well as from all who are officially employed.

At King George's Sound they are not doing much, but are very sanguine.

Swan River, notwithstanding its untoward exposure to the most frequent winds, is flourishing.

An English family has settled upon the Keeling Islands, where they make cocoa-nut oil, and catch abundance of turtle. Every creature upon those islands seemed to live principally upon cocoa-nuts. Pigs, ducks, fowls, and even large crabs are dependent upon them.

The Keelings, or Cocos, are a cluster of low coral islands, almost surrounding a lagoon. Within half a mile of them I found no bottom with more than 1000 fathoms of line, (1600 were out.) We were surprised to see that some of the fish lived upon coral branches, for which kind of grazing they are furnished with strong front teeth.

Before a hurricane at the Mauritius, the water rises considerably, and is agitated. In other parts of the world the sea rises before a storm some feet above its usual level. At the same time mercury in a barometer falls. Is not this rising of the waters caused by diminished pressure of the atmosphere at those places, while at other more distant parts there is an increased pressure?

Returning homeward by St. Helena, Ascension, and the Cape de Verd Islands, I had opportunities of proving that the rollers, which sometimes set heavily upon their shores, are caused by distant gales of wind. Those at Ascension and St. Helena, for instance, by Pamperos, and those at the Cape de Verds, by the severe, though generally short gales met with between the Tropics in the time of the line westerly Monsoon. These latter gales may also send rollers towards the north-west side of Ascension.

The heavy rollers which sometimes set in upon the coasts of

Chile and Peru led me to seek for proofs of the causes being such as I then suspected. But there is at times another kind of "rollers," which are perhaps caused by an earthquake.

Tides, dip, intensity and variation, temperature of air and water, pressure of the atmosphere, and some other matters, have been regularly observed; but time will not allow of my now making an abstract of the results.

It may appear presumption in a plain sailor attempting to offer an idea or two on the difficult subject of "Tides;" yet, with the utmost deference to those who *are* competent to reason upon the subject, I will venture to ask whether the supposition of Atlantic tides being principally caused by a great tide-wave coming from the Southern Ocean, is not a little difficult to reconcile with the facts that there is very little tide upon the coasts of Brazil, Ascension, and Guinea, and that, in the mouth of the great river Plata, there is little or no tide?

Can each ocean have its own tides, though affecting, and being affected by, the neighbouring waters?

Can the *mass* of an ocean have a tendency to move westward as well as upward, after and towards the moon as she passes? If so, after the moon has passed, will not the mass of that ocean have an easterly inclination, to regain that equilibrium (with respect to the earth alone) from which the moon disturbed it? (Sun's action not here considered.)

In regaining its equilibrium, would not its own momentum carry it too far eastward? and would not the moon's action be again approaching?

Can one part of an ocean have a westward tendency, while another part, which is wider or narrower from east to west, has an eastward libration? If so, many difficulties would vanish: among them, those which were first mentioned, and those perplexing anomalies on the south coast of New Holland.

This sketch has been very hastily written, since the Beagle's arrival in England, and is therefore far inferior to the writer's wishes.

Annexed, are a few positions, of which the longitudes are supposed to be relatively right, and some notes, showing upon what the chronometric measurements depend.

Coast.	Name of Place.	Name of Particular Spot.	Latitude.	Longitude in Time.	Variation.
			North.	West.	
			° ′ ″	h. m. s.	° ′
England	Devonport	Baths	50 22 00	0 16 40	25 18 W.
	Falmouth	Pendennis Castle	50 08 33	0 20 11	
Western Islands.	Terceira	Mount Brazil	38 38 35	1 48 52	24 18
	St. Michael's	St. Braz Castle	37 43 58	1 42 41	
C. Verd Isl.	Quail Island	Gun Point	14 54 02	1 34 00	16 30
			South.		
Brazil.	Pernambuco	Fort Picao	8 03 35	2 19 26	5 54
,,	Bahia	Fort San Pedro	12 59 20	2 34 03	4 18
Abrolhos.	St. Barbara Island	East Summit	17 57 42	2 34 46	2 00 W.
Brazil.	Rio Janeiro	Villegagnon Island	22 54 50	2 52 35	2 00 E.
Riv. Plate.	Monte Video	Rat Island	34 53 20	3 44 53	12 00
	Blanco Bay	Wells	38 57 00	4 07 54	15 00
East Coast of Patagonia.	River Negro	Pilot's House at the entrance	41 00 42	4 11 05	17 42
	,,	Town	40 48 18	4 11 52	
	River Chupat	South-entrance Point.	43 20 25	4 19 34	18 06
	Port Desire	Ruins	47 44 56	4 23 40	20 12
	Port St. Julian	Lieut. Sholl's Monument	49 15 20	4 30 48	21 00
Tierra del Fuego.	River Santa Cruz	Keel Point	50 06 45	4 33 34	20 54
	Good Success Bay	Watering Place	54 48 00	4 16 56	22 54
	Cape Horn	South Summit	55 58 41	4 29 04	24 00
	Port Famine	Observatory on West Side	53 38 15	4 43 51	23 00
Falk. Isl.	Berkeley Sound	Port Louis Settlement	51 32 15	3 52 29	19 00
Chile.	Midship Bay	East Side of Centre Island	45 18 30	4 58 25	20 48
	Port Lowe	Observation Inlet	43 48 30	4 56 09	19 48
	Huafo Island	Peak on N.W. end	43 35 30	4 59 10	
	S. E. extreme of Chiloe	Port San Pedro	43 19 30	4 54 59	
	Port San Carlos	Sandy Point	41 51 20	4 55 44	18 0
	Valdivia	Observation Spot near Fort Corral	39 52 53	4 53 56	
	,,	Town	39 49 20	4 53 15	
	Mocha Island	E. Side near N. Point	38 19 35	4 55 59	
	St. Mary's Island	Observation Spot near rivulet	37 02 48	4 54 12	
Concepcion	Talcahuano	Fort Galvez	36 42 00	4 52 40	16 48
Chile.	River Maule	Church Rock	35 19 40	4 49 55	16 24
	Valparaiso	Fort San Antonio	33 01 53	4 46 45	15 18
	Papudo	Landing Place	32 30 09	4 46 03	15 12
	Pichidanque	S.E. Point of Island	32 07 55	4 46 20	15 24
	Coquimbo	S.W. Corner of Herradura Bay	29 58 41	4 45 43	14 24
	,, Town	Mr. Edward's House	29 54 10	4 45 15	
	Tortoralillo	South-entrance Point	29 29 15	4 45 35	
	Huasco	Capt. of Port's House	28 27 15	4 45 16	13 37
	Herradura de Carrisal	Landing Place	28 05 45	4 45 03	13 23
	Pajonal	S.E. Corner	27 43 30	4 44 28	13 28
	Copiapo	Landing Place	27 20 00	4 44 08	13 32
	English Harbour	Sandy beach in S.W. Corner	27 05 20	4 43 44	13 30
	Flamenco	S.E. Corner of Bay	26 34 30	4 43 16	13 46
	Lavata	Cove near S.W. Point	25 39 30	4 43 09	

Coast.	Name of Place.	Name of Particular Spot.	Latitude.	Longitude in Time.	Variation.
			South.	West.	East.
			° ′ ″	h. m. s.	° ′
Galapagos Islands, Peru.	Copiapo	Landing Place	27 20 00	4 44 05	13 36
	Iquique	Centre of Island	20 12 30	4 40 58	12 18
	Callao	Flag Staff in Arsenal	12 04 00	5 08 54	10 36
	Chatham Island	S. W. Point of Stephen's Bay	0 50 00	5 58 27	9 30
	Charles's Island	Post-office Bay, S. E. corner	0 15 25	6 02 06	
	Albemarle Island, near S. W. end	Iguana Cove	0 59 00	6 06 09	
	Albemarle Island	Tagus Cove	0 15 55	6 05 47	9 30
	Otaheite	Point Venus	17 29 15	9 58 18	7 54

Carrying the Chronometric Chain one Place farther Westward, gives for the position of

New Zealand.	Bay of Islands	Paihia Islet	35 16 30	11 37 12	

Measuring Eastward from Bahia gives the following results:—

			South.	West.	
Brazil.	Bahia	Fort San Pedro	12 59 20	2 34 03	4 18 E.
	Ascension	Barrack Square	7 55 33	0 57 37	13 30 W.
	St. Helena	Close to high-water mark in the merid. of the Observatory	15 55 15	0 22 51	18 00
				East.	
Cape	Simon's Bay	East end of Dock Yard	34 11 24	1 13 43	28 30
	Cape Town	Observatory		1 13 54	
Mauritius	Port Louis	Observatory	20 09 25	3 50 06	11 18
Keeling Is.	Direction Island	South Point	12 05 22	6 27 39	1 12
Australia.	King George's Sd.	Princess Royal Harbour, Government new buildings	35 02 11	7 51 46	5 36
	Hobart Town	Fort Mulgrave	42 53 30	9 49 37	11 06
	Sydney	Fort Macquarie	33 51 30	10 05 08	10 24
	Paramatta	Observatory		10 04 16	
N. Zeald.	Bay of Islands	Paihia Islet	35 16 30	11 36 39	14 00
Pacific.	Otaheite	Point Venus	17 29 15	9 57 45	7 54

By the Beagle's chronometers the meridian distances between Falmouth and Greenwich are nearly as follows:—

	h. m. s.
Portsmouth Observatory, from Greenwich	0 04 24,5
Devonport (Government House) from Portsmouth	0 12 15,3
Pendennis Castle, Falmouth, from Devonport	0 03 31,1
Falmouth, west of Greenwich	0 20 10,9

Results of a few of the Observations made by the Officers of the Beagle's Tender, 1834 *and* 1836.

1834.	Name of Place.	Name of particular Spot.	Latitude.	Long. W. of Green.	Variation.
Coast.			South.	h. m. s.	East.
Falkland Islands.	Ship Harbour	S.W. end of Ship Isl.	51 43 10	4 05 09	20 3
	Port Louis	Settlement Creek	51 32 15	3 52 29	19 0
	Choiseul Bay	S. side of Mare Harb.	51 54 15	3 54 01	19 2
	Long Isl. Sound	W. part of Long Isl.	52 12 15	3 56 19	
	Port Porpoise	Head of Creek	52 20 45	3 57 23	19 7
	Speedwell Island	Harbour on E. side	52 13 00	3 58 46	
	Port Edgar	W. arm on N. side	52 03 15	4 01 06	20 0
	Port Stephens	E. end of harbour	52 11 35	4 02 44	20 4
	Ship Harbour	S.W. end of Ship Isl.	51 43 10	4 05 09	20 3
	Hope Harbour	Fish cove	51 20 45	4 02 42	
	Port Egmont	Ruins of Settlement	51 21 30	4 00 17	19 5
	White Rock Harb.	W. extreme of cliff	51 26 00	3 57 08	
	Port St. Salvador	First inlet on W. side	51 27 00	3 53 21	

1836.	Name of Place.	Name of particular Spot.	Latitude.	Longitude E. or W. of Valparaiso.	Variation.
Coast.			South.	East.	East.
Peru.	Paposa	Whitehead		h. m. s.	
	Constitucion Hbr.	Shingle Pt. on Island	23 29 10	0 04 04	12 8
	Cobija	Flagstaff	22 34 00		
	Iquique	Centre of Island	20 12 30	0 05 49	12 0
	Arica	Mole	18 28 05	0 05 11	11 0
				West.	
	Islay	Custom-house	17 00 00	0 01 55	11 0
	Atico	East Cove	16 13 30	0 08 15	11 2
	Lomas	Flagstaff on Pt.	15 33 15	0 12 53	10 3
	San Juan	Needle Hummock	15 21 00	0 14 07	10 3
	Bay of Yndependencia	S. Pt. of Santa Rosa Island	14 18 15	0 18 03	
	Pisco	W. Pt. of Paracas bay	13 48 00	0 18 43	10 0
	Callao	Arsenal Flagstaff	12 04 00	0 22 08	10 0
	Supé	W. end of village	10 49 15	0 24 22	9 8
	Guarmey	W. end of sandy beach	10 06 15	0 26 06	9 5
	Samanco	Cross Point	9 15 30	0 27 25	9 5
	Malabrigo	Bay rocks	7 42 40	0 31 97	
	Lobos de Afuera Island	Fisherman's cove on the east side	6 56 45	0 36 10	9 5
	Payta	New end of town	5 05 30	0 37 47	9 0
	Island of Puna	Consul's house on Pt. Española	2 47 30	0 33 05	
	Guayaquil	South end of city	2 13 00	0 32 48	

Remarks on the Beagle's Chronometric Measurements.

Before attaching any value to the results shown in the accompanying paper, many questions will probably be asked. Some of those questions I will endeavour to anticipate by the following short detail.

The chronometers, twenty-two in number,* were taken on board a month before the Beagle finally sailed from Plymouth. Their boxes were placed in sawdust, divided and retained by partitions secured upon two wide shelves. All were in one small cabin, into which no person could enter, except to compare or wind the watches, and in which nothing else was kept. The greater number have never been moved from their places since they were first put into them.

The chronometers have been wound daily at nine, and compared at noon. Both comparing and winding have been performed most accurately and regularly by one person only, Mr. G. J. Stebbing, of Portsmouth.

Time has invariably been obtained by series of equal or corresponding altitudes of the sun; observed by one person, with the same sextant; and the same artificial horizon, with its roof placed in the same manner, both before and after noon.

A very good pocket chronometer, carried by hand in a small box, has been always used for taking time. In every instance it has been compared with the standards immediately before the observations, and immediately afterwards. This watch (Parkinson and Frodsham, No. 1041) was so well constructed, that the intervals shown by it between morning and afternoon observations always agreed with those shown by the standard chronometers (allowing for the respective rates).

Generally speaking, seven altitudes of one limb have been taken, and then the same seven altitudes of the other limb, for one set. Three sets have been usually taken at short intervals, and the mean result used, unless a marked difference occurred, in which case the result of each pair of sights was computed, and the erroneous ones rejected. Those few were considered wrong which differed from the majority. Generally, however, there has been a close agreement between the results of single pairs of sights, as well as of entire sets.

When clouds intervened, the series was unavoidably irregular; but the pairs of equal altitudes were always numerous.

In a very few instances the chronometers have been rated by the

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* Twenty-two chronometers were embarked on board the Beagle when she sailed from England. Some failed during the voyage; but none of the measurements depend upon the results of fewer than twelve.

results of absolute or independent altitudes, taken with every precaution at similar times of day. Those rates were obtained by comparing together the times obtained by morning observations, or those deduced from afternoon sights; not by morning and afternoon, or afternoon and morning observations, on different days. But the time, considered *correct*, has invariably been deduced from equal altitudes. At Paramatta and at the Cape of Good Hope, it was ascertained that our time, thus obtained, did not differ from that of the astronomer.

The sextant, used for obtaining time, is a particularly good instrument, made by Worthington and Allan. Its index error has never varied, nor has it ever been out of adjustment. It has been used almost solely for this purpose. Between corresponding altitudes it was more than usually guarded, and on no account handled, or exposed to an unusual change of temperature.

During the first three years of the voyage all observations for time were made by me. During the last two years Mr. J. L. Stokes, assistant surveyor, has made nearly the whole. Latterly my own have been only a few for the sake of comparison. I found that Mr. Stokes was a better, and more attentive observer than myself, and willingly gave way to him, especially as the first and last days at a place,—when good series of observations were so desirable,—have been usually those on which my mind was the most occupied with a variety of details, insignificant perhaps, except in their consequence, and in their being inevitable. Here let me quietly protest against the attempted union of petty astronomer, experiment maker, and captain of a man-of-war in one individual.

Latitudes have been obtained by a variety of methods, and by several officers. The near agreement of their results, when many observations have been made in the same place, induces me to place confidence in those made only by the two best of various instruments.

The computations were made by me, and by some one or two of the officers (for the sake of comparison and proof) during the first three years: since then they have been made by Mr. Stokes and Lieut. B. Sulivan, but inspected, compared, and often proved by myself. Each of those officers is a better computer than I am.

In the list of resulting meridian distances, I have noticed a few remarkable agreements with the determinations of other persons. The accordance of different measurements made by the Beagle, between any two places, is very satisfactory. Yet there hangs a cloud over the synoptic view which I am as yet unable to dissipate, and for which I cannot account in any satisfactory manner. Instead of the length of the whole chain of distances equalling twenty-four hours exactly, it is equal to twenty-four hours and thirty-three seconds. The positions of the Cape of Good

Hope and Cape Horn appear to be ascertained to less than three seconds of time. Those of Valparaiso and Callao agree with the results of the best observations, calculated by Professor Oltmanns. That of Otaheite (or Tahiti) accords with the position assigned by Captain Cook and Mr. Wales. Our longitude of New Zealand agrees exactly with that of M. Duperrey, of the Coquille.

From Sydney to King George's Sound the Beagle corroborates the determination of Flinders; and from the Mauritius to the Cape of Good Hope, the astronomical difference of longitude, and Captain Owen's meridian distance, are in exact accordance with our measurements. How, and where, has an error of thirty-three seconds been caused? The computations have all been examined and verified, again and again. The usual rates of the chronometers, and their daily comparisons, would detect any sudden error or change.

Remarks on Chronometers.

During eight years' observation of the movements of a large number of chronometers, I have become gradually convinced that the ordinary motions of a ship, such as pitching and rolling moderately, do not affect tolerably good chronometers which are fixed in one place, and are defended from vibration and concussion.

Frequently employing chronometers in boats and in very small vessels has strengthened my conviction that temperature is the chief, if not the only, cause (*generally* speaking) of marked changes of rate.

The balances of but few watches are so well compensated as to be proof against a *long* continuance of higher or lower temperature.

It often happens that the air in port, or near the land, is at a temperature very different from that over the open sea in the vicinity. Hence the difference sometimes found between harbour and sea rates.

The change so frequently noticed to take place in the rates of chronometers moved from the shore to the ship, and the reverse, are well known to be partly caused by change of temperature and partly by change of situation.

I have never found chronometers go better than when the boxes were bedded in sawdust, and the watches moving freely in well-oiled jimbals.

Suspending them in cots not only alters their rate, but makes them go less regularly.

When fixed to a solid substance, they feel the vibrations caused by people running on the decks, by shocks, or by chain-cables running out.

A cushion, wool, hair, or any such substance, is preferable to a solid bed; but I can think of nothing better than plain dry sawdust.

Many chronometric measurements have caused errors, and great consequent perplexity, in the following manner:—

The chronometers were rated in air whose average temperature was (let us suppose) 70°.

They were then carried through air either considerably hotter or considerably colder, and again rated in a temperature nearly equal to that specified.

The rates did not differ much, and it was supposed that the chronometers had been going extremely well: in truth, the rates of most of the watches *had* differed *extremely* from those found in port during the voyage; but they had *returned* nearly to the *old* rates upon reaching nearly equal temperature.

This has happened more or less to every ship carrying chronometers across the equator, especially when going to Rio de Janeiro with the sun to the northward of the line.

Magnetism is supposed by some persons to affect the rates of chronometers. It is difficult to detect.

XVIII.—*Notice of a Visit to the Himmáleh Mountains and the Valley of Kashmír, in* 1835. Communicated by Baron Charles Hügel.

[Baron Hügel, of Vienna, well known as an eminent naturalist, having just returned to this country, after an absence from Europe of six years, chiefly spent in India, has communicated the following account of a journey from the river Sutlej at Belaspúr, through the lower range of the Himmáleh to Kashmír, from thence to the highest part of the Tibet Panjáhl, then to the Attock and back through the Panjáb to Lud'yana, recrossing the Sutlej; accompanied by a letter, tracing his route during his five years' travels, from which a slight extract is subjoined.]

"I left Toulon in May, 1831, visited parts of Greece, Cyprus, Latakia, Syria, and Baalbek; Alexandria, Cairo, and Egpyt, to the confines of Nubia; descended the Nile to Ghineh; crossed to Cosseir, and embarked in the steamer for Bombay, where I arrived in the spring of 1832. In India I visited Puna, Aurungabad, Ellora, Sattara, Bijapúr, Belgám, Goa, Darwar, Bellari, Bangalore, Seringapatam, the Nilgheries, Kochin, Cape Komorin, Palamcotta, and by Ramiseram to Manár in Ceylon. In this Island I visited both the east and west coasts; the highest point Pedradallegalla, near Nur Ellia, and