BEAGLE LETTERS

EXTRACTS FROM LETTERS

ADDRESSED TO

PROFESSOR HENSLOW

BY

C. DARWIN, ESQ.

READ AT A MEETING OF THE
CAMBRIDGE PHILOSOPHICAL SOCIETY
16 NOVEMBER, 1835

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PREFACE

This reprint of the first writing of Charles Darwin ever to be published has been undertaken by the President and Council of the Cambridge Philosophical Society to mark the 100th anniversary of the publication of the Origin of Species *on 26 November 1859. The pamphlet, originally issued by the Society, has become scarce. It has, however, a great value for the reader today since it shows the quality and spontaneity of the young naturalist (he was twenty-six years old in 1835), writing as he did away from any adequate reference library under the cramped and difficult conditions of a surveying voyage. The range of competence shown by Charles Darwin in these letters would be considered noteworthy in one trained into the more exacting specialisms of the present day. Much comment is now made on the apparently casual education in matters of Geology and Natural History that Darwin received at Edinburgh and Cambridge. Even a few hours' conversation with people as gifted as Grant, Henslow, Sedgwick and Whewell, to say nothing of the friendship of such field naturalists as his cousin Fox, and Jenyns, would have a profound effect on the developing capacity of the young Darwin. How apt a pupil he was this pamphlet enables the reader to judge today.*

The circumstance of the original publication can be reconstructed from the records of the Society. The minutes of a meeting held on 16 November 1835, with the President, the

Rev. Dr Clark in the chair, record that the following communications were made: 'A memoir was read by the Rev. R. Murphy "On the resolution of Equations of Finite Differences". Extracts of letters were read from Sir J. Herschel on meteorological observations made and collected by him at the Cape of Good Hope. Extracts were read of letters from C. Darwin Esq. of Christ's College containing accounts of the Geology of certain parts of the Andes and S. America. Observations by Prof. Sedgwick and Henslow.'

The first item of the minutes of the next succeeding Council held on 30 November 1835 reads: 'The printing of certain extracts from M^r^ Darwin's correspondence be submitted to M^r^ Whewell, M^r^ Peacock & Prof. Henslow.' The pamphlet was presumably issued to the Fellows shortly after this date. It was distributed when the Beagle *had just completed its visit to the Galapagos Islands. The threads of the transmutation theory were already in Charles' hands, but the pattern by which they could be woven into an enduring fabric was not discerned until his return to England on 2 October 1836. Several events contributed to the maturing of Darwin's ideas: he saw much of Charles Lyell and was stimulated by his company, and he spent the remaining months of 1836 and the early part of 1837 unpacking and sorting his collections and collating the items with his field notes whilst in residence in Fitzwilliam Street, Cambridge. His personal Journal reads '1837 Jan. Cambridge, time spent in arranging general collection, examining minerals, reading & writing little Journal in the evening. Paid two short visits to London & Read paper on elevation of Coast*

of Chile.' He left Cambridge on 6 March and on the 13th of that month his journal reads 'entered my lodgings in 36. Gt. Marlborough Str.'

This address occurs in the transmutation notebooks, the first of which was opened in July 1837. Darwin's note in his private journal proceeds: 'Had been greatly struck from about the month of previous March on character of South American fossils and species on Galapagos Archipelago. These facts (especially latter) origin of all my views.'

SYDNEY SMITH
Biological Secretary

CAMBRIDGE PHILOSOPHICAL SOCIETY

FOR PRIVATE DISTRIBUTION.

THE following pages contain Extracts from LETTERS addressed to Professor HENSLOW by C. DARWIN, Esq. They are printed for distribution among the Members of the Cambridge Philosophical Society, in consequence of the interest which has been excited by some of the Geological notices which they contain, and which were read at a Meeting of the Society on the 16th of November 1835.

The opinions here expressed must be viewed in no other light than as the first thoughts which occur to a traveller respecting what he sees, before he has had time to collate his Notes, and examine his Collections, with the attention necessary for scientific accuracy.

CAMBRIDGE,
Dec. 1, 1835.

EXTRACTS,

&c.

RIO DE JANEIRO, *May* 18, 1832.

WE started from Plymouth on the 27th December 1831—At St Jago (Cape de Verd Islands) we spent three weeks. The geology was pre-eminently interesting, and I believe quite new: there are some facts on a large scale, of upraised coast that would interest Mr Lyell. . . . . .

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St Jago is singularly barren, and produces few plants or insects; so that my hammer was my usual companion. . . . . .

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On the coast I collected many marine animals, chiefly gasteropodous mollusca (I think some new). I examined pretty accurately a Caryophyllia, and, if my eyes were not bewitched, former descriptions have

not the slightest resemblance to the animal. I took several specimens of an Octopus, which possessed a most marvellous power of changing its colours; equalling any chamelion, and evidently accommodating the changes to the colour of the ground which it passed over. . . . . .

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We then sailed for Bahia, and touched at the rock of St Paul. This is a serpentine formation. . .

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After touching at the Abrothos, we arrived here on April 4th. . . . . .

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A few days after arriving, I started on an expedition of one hundred and fifty miles to Rio Macao, which lasted eighteen days. . . . . .

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I am now collecting fresh water and land animals: if what was told me in London is true, viz. that there are no small insects in the collections from the Tropics, I tell entomologists to look out and have their pens ready for describing. I have taken as minute (if not more so) as in England, Hydropori, Hygroti, Hydrobii, Pselaphi, Staphylini, Curculiones, Bembidia, &c. &c. It is exceedingly interesting to observe the difference of genera and species from those which I know; it is however much less than I had expected. . . . . .

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I have just returned from a walk, and as a specimen how little the insects are known, Noterus, according to Dic. Class. consists solely of three European species. I, in one haul of my net, took five distinct species.

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At Bahia, the pegmatite and gneiss in beds had the same direction as was observed by Humboldt to prevail over Columbia, distant thirteen hundred miles.

MONTE VIDEO, *Aug.* 15, 1832.

MY collection of plants from the Abrothos is interesting, as I suspect it contains nearly the whole flowering vegetation. . . . . .

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I made an enormous collection of Arachnidæ at Rio. Also a good many small beetles in pill-boxes: but it is not the best time of year for the latter. .

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Amongst the lower animals, nothing has so much interested me as finding two species of elegantly coloured planariæ(?) inhabiting the dry forest! The false relation they bear to snails is the most extraordinary thing of the kind I have ever seen. In the same genus (or more truly, family) some of the marine species possess an organization so mar-

vellous, that I can scarcely credit my eyesight. Every one has heard of the discoloured streaks of water in the equatorial regions. One I examined was owing to the presence of such minute Oscillatoria, that in each square inch of surface there must have been at least one hundred thousand present. . . . .

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I might collect a far greater number of specimens of invertebrate animals if I took up less time over each: but I have come to the conclusion, that two animals with their original colour and shape noted down, will be more valuable to naturalists than six with only dates and place. . . . .

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At this present minute we are at anchor in the mouth of the river: and such a strange scene it is. Every thing is in flames—the sky with lightning—the water with luminous particles—and even the very masts are pointed with a blue flame.

MONTE VIDEO, *Nov.* 24, 1832.

WE arrived here on the 24th of October, after our first cruize on the coast of Patagonia, north of the Rio Negro. . . . . .

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I had hoped for the credit of dame Nature, no such country as this last existed; in sad reality we coasted along two hundred and forty miles of sand hillocks; I never knew before, what a horrid ugly object a sand hillock is: the famed country of the Rio Plata in my opinion is not much better; an enormous brackish river bounded by an interminable green plain, is enough to make any naturalist groan.

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I have been very lucky with fossil bones; I have fragments of at least six distinct animals; as many of these are teeth, shattered and rolled as they have been, I trust they will be recognized. I have paid all the attention I am capable of, to their geological site; but of course it is too long a story for a letter. 1st. the tarsi and meta-tarsi, very perfect, of a cavia; 2d. the upper jaw and head of some very large animal, with four square hollow molars, and the head greatly produced in front. I at first thought it belonged either to the megalonyx or megatherium. In confirmation of this, in the same formation I found a large surface of the osseous polygonal plates, which "late observations" (what are they?) have shewn to belong to the megatherium. Immediately I saw them I thought they must belong to an enormous armadillo, living species of which genus are so abundant here. 3d. The lower jaw of some large animal, which, from the molar teeth I should think belonged to the edentata; 4th. large molar teeth, which in some

respects would seem to belong to some enormous species of rodentia; 5th. also some smaller teeth belonging to the same order, &c. &c.—They are mingled with marine shells, which appear to me identical with existing species. But since they were deposited in their beds, several geological changes have taken place in the country. . . . . .

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There is a poor specimen of a bird, which to my unornithological eyes, appears to be a happy mixture of a lark, pigeon, and snipe. Mr Mac Leay himself never imagined such an inosculating creature. . . . . .

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I have taken some interesting amphibia; a fine bipes; a new Trigonocephalus, in its habits beautifully connecting Crotalus and Viperus: and plenty of new (as far as my knowledge goes) saurians. As for one little toad, I hope it may be new, that it may be christened "diabolicus." Milton must allude to this very individual, when he talks of "squat like a toad."

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Amongst the pelagic crustaceæ, some new and curious genera. Among Zoophites some interesting animals. As for one Flustra, if I had not the specimen to back me, nobody would believe in its most anomalous structure. But as for novelty, all this is nothing to a family of pelagic animals, which at first sight appear like Medusa, but are really highly organized.

I have examined them repeatedly, and certainly from their structure it would be impossible to place them in any existing order. Perhaps Salpa is the nearest animal; although the transparency of the body is almost the only character they have in common.

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We have been at Buenos Ayres for a week. It is a fine large city; but such a country; every thing is mud; you can go no where, you can do nothing for mud. In the city I obtained much information about the banks of the Uruguay. I hear of limestone with shells, and beds of shells in every direction.

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I purchased fragments of some enormous bones, which I was assured belonged to the former giants!!

April 11, 1833.

We are now running up from the Falkland Islands to the Rio Negro (or Colorado.) . .

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It is now some months since we have been at a civilized port; nearly all this time has been spent in the most southern part of Tierra del Fuego. It is a detestable place; gales succeed gales at such short intervals, that it is difficult to do any thing. We were twenty-three days off Cape Horn, and could

by no means get to the westward.—We at last ran into harbour, and in the boats got to the west of the inland channels.—With two boats we went about three hundred miles; and thus I had an excellent opportunity of geologizing and seeing much of the savages. The Fuegians are in a more miserable state of barbarism than I had expected ever to have seen a human being. In this inclement country they are absolutely naked, and their temporary houses are like those which children make in summer with boughs of trees. . . .

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The climate in some respects is a curious mixture of severity and mildness; as far as regards the animal kingdom the former character prevails; I have in consequence not added much to my collections. The geology of this part of Tierra del Fuego was to me very interesting. The country is non-fossiliferous, and a common-place succession of granitic rocks and slates: attempting to make out the relation of cleavage, strata, &c. &c. was my chief amusement.

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The Southern ocean is nearly as sterile as the continent it washes. Crustaceæ have afforded me most work. . . . . .

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I found a Zoea, of most curious form, its body being only one-sixth the length of the two spears. I am convinced, from its structure and other reasons, it is

a young Erichthus. I must mention part of the structure of a Decapod, it is so very anomalous: the last pair of legs are small and dorsal, but instead of being terminated by a claw, as in all others, it has three curved bristle-like appendages; these are finely serrated and furnished with cups, somewhat resembling those of the Cephalopods. The animal being pelagic, this beautiful structure enables it to hold on to light floating objects. I have found out something about the propagation of that ambiguous tribe the Corallines. . . . .

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After leaving Tierra del Fuego, we sailed to the Falklands. . . . . .

I had here the high good fortune to find amongst the most primitive looking rocks, a bed of micaceous sandstone, abounding with Terebratula and its subgenera, and Entrochites. As this is so remote a locality from Europe, I think the comparison of these impressions with those of the oldest fossiliferous rocks of Europe will be pre-eminently interesting. Of course they are only models and casts; but many of them are very perfect.

Rio de la Plata, *July* 18, 1833.

The greater part of the winter has been passed in this river at Meldonado. . . . .

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We have got almost every bird in this neighbourhood, (Meldonado) about eighty in number, and nearly twenty quadrupeds. . . . . .

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In a few days we go to the Rio Negro to survey some banks. . . . . .

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The geology must be very interesting. It is near the junction of the Megatherium and Patagonian cliffs. From what I saw of the latter, in one half hour, in St Joseph's bay, they would be well worth a long examination. Above the great oyster-bed there is one of gravel, which fills up inequalities in its interior; and above this, and therefore high out of the water, is one of such modern shells that they retain their colour and emit a bad smell when burnt. Patagonia must clearly have lately risen from the water.

MONTE VIDEO, *November* 12, 1833.

I LEFT the Beagle at the Rio Negro, and crossed by land to Buenos Ayres. There is now carrying on a bloody war of extermination against the Indians, by which I was able to make this passage. But at the best it is sufficiently dangerous, and till now very rarely travelled. It is the most wild, dreary plain imaginable, without settled inhabitant or head of

cattle. There are military "postas" at wide intervals, by which means I travelled. We lived for many days on deer and ostriches, and had to sleep in the open camp. . . . . .

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I had the satisfaction of ascending the Tierra de la Ventana, a chain of mountains between three and four thousand feet high, the very existence of which is scarcely known beyond the Rio Plata. After resting a week at Buenos Ayres, I started for St Fé. On the road the geology was interesting. I found two great groups of immense bones, but so very soft as to render it impossible to remove them. I think, from a fragment of one of the teeth, they belonged to the Mastodon. In the Rio Carcarana, I got a tooth which puzzles even my conjectures. It looks like an enormous gnawing one. At St Fé, not being well, I embarked and had a fine sail of three hundred miles down that princely river the Parana. When I returned to Buenos Ayres, I found the country upside down with revolutions, which caused me much trouble. I at last got away and joined the Beagle.

E. FALKLAND ISLAND, *March* 1834.

I HAVE been alarmed by your expression "cleaning all the bones," as I am afraid the printed numbers will be lost: the reason I am so anxious they should

not be, is, that a part were found in a gravel with recent shells, but others in a very different bed. Now with these latter there were bones of an Agouti, a genus of animals, I believe, peculiar to America, and it would be curious to prove that some one of the same genus coexisted with the megatherium; such, and many other points entirely depend on the numbers being carefully preserved. . . .

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I collected all the plants which were in flower on the coast of Patagonia, at Port Desire, and St Julian; also on the eastern parts of Tierra del Fuego, where the climate and features of Tierra del Fuego and Patagonia are united. . . . . .

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The soil of Patagonia is very dry, gravelly, and light. In East Tierra, it is gravelly, peaty, and damp. Since leaving the Rio Plata I have had some opportunities of examining the great southern Patagonian formation. I have a good many shells; from the little I know of the subject, it must be a tertiary formation, for some of the shells (and corallines) now exist in the sea. Others, I believe, do not. This bed, which is chiefly characterized by a great oyster, is covered by a very curious bed of porphyry pebbles, which I have traced for more than seven hundred miles. But the most curious fact is, that the whole of the east coast of the southern part of South America has been elevated from the ocean, since a period during which

muscles have not lost their blue colour. At Port St Julian I found some very perfect bones of some large animal, I fancy a Mastodon: the bones of one hind extremity are very perfect and solid. This is interesting, as the latitude is between 49° and 50°, and the site far removed from the great Pampas, where bones of the narrow toothed Mastodon are so frequently found. By the way this Mastodon and the Megatherium, I have no doubt, were fellow brethren in the ancient plains. Relics of the Megatherium I have found at a distance of nearly six hundred miles in a north and south line. In Tierra del Fuego I have been interested in finding some sort of ammonite (also I believe found by Capt. King) in the slate near Port Famine; and on the eastern coast there are some curious alluvial plains, by which the existence of certain quadrupeds in the islands can clearly be accounted for. There is a sandstone with the impression of leaves like the common beech tree; also modern shells, &c., and on the surface of the table land there are, as usual, muscles with their blue colour, &c. . . . . .

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I have chiefly been employed in preparing myself for the South Sea, and examining the polypi of the smaller corallines in these latitudes. Many in themselves are very curious, and I think undescribed: there was one appalling one, allied to a Flustra, which I dare say I mentioned having found to the northward, where

the cells have a moveable organ (like a vulture's head, with a dilatable beak), fixed on the edge. But what is of more general interest, is the unquestionable (as it appears to me) existence of another species of ostrich besides the Struthio ostrea. All the Gauchos and Indians state it is the case: and I place the greatest faith in their observations. I have the head, neck, piece of skin, feathers, and legs of one. The differences are chiefly in the colour of the feathers and scales; in the legs being feathered below the knees; also in its nidification, and geographical distribution.

VALPARAISO, *July* 24, 1834.

AFTER leaving the Falklands, we proceeded to the Rio Santa Cruz; followed up the river till within twenty miles of the Cordilleras: unfortunately want of provisions compelled us to return. This expedition was most important to me, as it was a transverse section of the great Patagonian formation. I conjecture (an accurate examination of the fossils may possibly determine the point) that the main bed is somewhere about the meiocene period (using Mr Lyell's expression); judging from what I have seen of the present shells of Patagonia. This bed contains an *enormous* mass of lava. This is of some

interest, as being a rude approximation to the age of the volcanic part of the great range of the Andes. Long before this it existed as a slate and porphyritic line of hills. I have collected a tolerable quantity of information respecting the various periods and forms of elevations of these plains. I think these will be interesting to Mr Lyell. I had deferred reading his third volume till my return; you may guess how much pleasure it gave me; some of his wood-cuts came so exactly into play, that I have only to refer to them, instead of redrawing similar ones. .

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The valley of Santa Cruz appears to me a very curious one; at first it quite baffled me. I believe I can shew good reasons for supposing it to have been once a northern strait, like that of Magellan. . .

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In Tierra del Fuego I collected and examined some corallines: I have observed one fact which quite startled me. It is, that in the genus Sertularia (taken in its most restricted form as by Lamouroux), and in two species which, excluding comparative expressions, I should find much difficulty in describing as different, the polypi quite and essentially differed in all their most important and evident parts of structure. I have already seen enough to be convinced that the present families of corallines, as arranged by Lamarck, Cuvier, &c. are highly artificial. It appears to me, that they are in the same

state in which shells were, when Linnæus left them for Cuvier to re-arrange. . . . . .

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It is most extraordinary I can no where see in my books a single description of the polypus of any one coral (excepting Lobularia (Alcyonium) of Savigny). I found a curious little stony Cellaria (a new genus), each cell provided with a long toothed bristle capable of various and rapid motions. This motion is often simultaneous, and can be produced by irritation. This fact, as far as I see, is quite isolated in the history (excepting of the Flustra, with an organ like a vulture's head) of Zoophites. It points out a much more intimate relation between the polypi, than Lamarck is willing to allow. I forget whether I mentioned having seen something of the manner of propagation in that most ambiguous family, the corallines: I feel pretty well convinced that if they are not plants, they are not Zoophites: the "gemmule" of a Halimeda contains several articulations united, ready to burst their envelope and become attached to some basis. I believe that in Zoophites universally, the gemmule produces a single polypus, which afterwards or at the same time grows with its cell, or single articulation. The Beagle left the strait of Magellan in the middle of winter: she found her road out by a wild unfrequented channel; well might Sir J. Nasborough call the west coast South Desolation, "because it is so desolate a land

to behold." We were driven into Chiloe, by some very bad weather. An Englishman gave me three specimens of that very fine lucanoidal insect, which is described in the Cambridge Philosophical Transactions, two males and one female. I find Chiloe is composed of lava and recent deposits. The lavas are curious, from abounding with or rather being composed of pitchstone. . . . . .

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We arrived here the day before yesterday; the views of the distant mountains are most sublime and the climate delightful: after our long cruise in the damp gloomy climates of the South, to breathe a clear dry air, and feel honest warm sunshine, and eat good fresh roast beef, must be the summum bonum of human life. I do not like the looks of the rocks half so much as the beef, there is too much of those rather insipid ingredients mica, quartz, and feldspar.

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Shortly after arriving here I set out on a geological excursion, and had a very pleasant ramble about the base of the Andes. The whole country appears composed of breccias, (and I imagine slates) which universally have been modified, and often completely altered by the action of fire; the varieties of porphyry thus produced are endless, but no where have I yet met with rocks which have flowed in a stream; dykes of greenstone are very numerous. Modern volcanic action is entirely shut up in the

very central parts (which cannot now be reached on account of the snow) of the Cordilleras. To the south of the Rio Maypo, I examined the tertiary plains already partially described by M. Gay. The fossil shells appear to me to differ more widely from the recent ones, than in the great Patagonian formation; it will be curious if an eocene and meiocene formation (recent there is abundance of) could be proved to exist in South America as well as in Europe. I have been much interested by finding abundance of recent shells at an elevation of thirteen hundred feet; the country in many places is scattered over with shells, but these are all *littoral* ones! So that I suppose the thirteen hundred feet elevation must be owing to a succession of small elevations, such as in 1822. With these certain proofs of the recent residence of the ocean over all the lower parts of Chili, the outline of every view and the form of each valley possesses a high interest. Has the action of running water or the sea formed this ravine? was a question which often arose in my mind, and was generally answered by my finding a bed of recent shells at the bottom. I have not sufficient arguments, but I do not believe that more than a small fraction of the height of the Andes has been formed within the tertiary period.

VALPARAISO, *March* 1835.

WE are now lying becalmed off Valparaiso, and I will take the opportunity of writing a few lines to you. The termination of our voyage is at last decided on. We leave the coast of America in the beginning of September, and hope to reach England in the same month of 1836. . .

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You will have heard an account of the dreadful earthquake of the 20th of February. I wish some of the geologists, who think the earthquakes of these times are trifling, could see the way in which the solid rock is shivered. In the town there is not one house habitable; the ruins remind me of the drawings of the desolated eastern cities. We were at Valdivia at the time, and felt the shock very severely. The sensation was like that of skating over very thin ice; that is, distinct undulations were perceptible. The whole scene of Concepcion and Talcuana is one of the most interesting spectacles we have beheld since leaving England. Since leaving Valparaiso, during this cruise, I have done little excepting in geology. In the modern tertiary strata I have examined four bands of disturbance, which reminded me on a small scale of the famous tract in the Isle of Wight. In one spot there were beautiful examples of three different forms of upheaval. In two cases I think I can show that the inclination is owing to the presence

of a system of parallel dykes traversing the inferior mica slate. The whole of the coast from Chiloe to the south extreme of the Peninsula of Tres Montes is composed of the latter rock; it is traversed by very numerous dykes, the mineralogical nature of which will, I suspect, turn out very curious. I examined one grand transverse chain of granite, which has clearly burst up through the overlying slate. At the Peninsula of Tres Montes there has been an old volcanic focus, which corresponds to another in the north part of Chiloe. I was much pleased at Chiloe by finding a thick bed of recent oyster-shells, &c. capping the tertiary plain, out of which grew large forest trees. I can now prove that both sides of the Andes have risen in this recent period to a considerable height. Here the shells were three hundred and fifty feet above the sea. In Zoology I have done but very little; excepting a large collection of minute diptera and hymenoptera from Chiloe. I took in one day, Pselaphus, Anaspis, Latridius, Leiodes, Cercyon, and Elmis, and two beautiful true Carabi; I might almost have fancied myself collecting in England. A new and pretty genus of nudibranch mollusca which cannot crawl on a flat surface, and a genus in the family of balanidæ, which has not a true case, but lives in minute cavities in the shells of the concholapas, are nearly the only two novelties.

VALPARAISO, *April* 18, 1835.

I HAVE just returned from Mendoza, having crossed the Cordilleras by two passes. This trip has added much to my knowledge of the geology of the country. . . . . .

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I will give a very short sketch of the structure of these huge mountains. In the Portillo pass (the more southern one) travellers have described the Cordilleras to consist of a double chain of nearly equal altitude, separated by a considerable interval. This is the case: and the same structure extends northward to Uspellata. The little elevation of the eastern line (here not more than six thousand or seven thousand feet) has caused it almost to be overlooked. To begin with the western and principal chain, where the sections are best seen; we have an enormous mass of a porphyritic conglomerate resting on granite. This latter rock seems to form the nucleus of the whole mass, and is seen in the deep lateral valleys, injected amongst, upheaving, overturning in the most extraordinary manner, the overlying strata. On the bare sides of the mountains, the complicated dykes and wedges of variously coloured rocks, are seen traversing in every possible form and shape the same formations, which, by their intersections, prove a succession of violences. The stratification in all the mountains is beautifully distinct, and owing to a variety in their colouring, can be seen at great

distances. I cannot imagine any part of the world presenting a more extraordinary scene of the breaking up of the crust of the globe, than these central peaks of the Andes. The upheaval has taken place by a great number of (nearly) north and south lines*; which in most cases has formed as many anticlinal and synclinal ravines. The strata in the highest pinnacles are almost universally inclined at an angle from 70° to 80°. I cannot tell you how much I enjoyed some of these views; it is worth coming from England, once to feel such intense delight. At an elevation of from ten to twelve thousand feet, there is a transparency in the air, and a confusion of distances, and a sort of stillness, which give the sensation of being in another world; and when to this is joined the picture so plainly drawn of the great epochs of violence, it causes in the mind a most strange assemblage of ideas. The formation which I call porphyritic conglomerates, is the most important and most developed in Chili. From a great number of sections, I find it to be a true coarse conglomerate or breccia, which passes by every step, in slow gradation, into a fine clay-stone porphyry; the pebbles and cement becoming porphyritic, till at last all is blended in one compact rock. The porphyries are excessively abundant in this chain, and I feel sure that at least four-fifths of them have been thus

* Of dykes?

produced from sedimentary beds in situ. There are also porphyries which have been injected from below amongst the strata, and others ejected which have flowed in streams: and I could shew specimens of this rock, produced in these three methods, which cannot be distinguished. It is a great mistake to consider the Cordilleras (here) as composed only of rocks which have flowed in streams. In this range I nowhere saw a fragment which I believe to have thus originated, although the road passes at no great distance from the active volcanos. The porphyries, conglomerates, sandstone, quartzone-sandstone, and limestones alternate and pass into each other many times (overlying clay-slate, when not broken through by the granite.) In the upper parts the sandstone begins to alternate with gypsum, till at last we have this substance of a stupendous thickness. I really think the formation is in some places (it varies much) nearly two thousand feet thick. It occurs often with a green (Epidote?) siliceous sandstone and snow-white marble: and resembles that found in the Alps, from containing large concretions of a crystalline marble of a blackish-gray colour. The upper beds, which form some of the higher pinnacles, consist of layers of snow-white gypsum and red compact sandstone, from the thickness of paper to a few feet, alternating in an endless round. The rock has a most curiously painted appearance. At the pass of the Puquenas in this formation, where a black rock (like clay-slate,

without many laminæ) and pale limestone have replaced the red sandstone, I found abundant impressions of shells. The elevation must be between twelve thousand and thirteen thousand feet. A shell which I believe is a Gryphæa is the most abundant. There is also an Ostrea, Turritella, Ammonites, small bivalve, Terebratula (?) Perhaps some good conchologist will be able to give a guess to what grand division of the continents of Europe these organic remains bear most resemblance. They are exceedingly imperfect and few; the Gryphites are most perfect. It was late in the season, and the situation particularly dangerous, from snow-storms. I did not dare to delay, otherwise a good harvest might have been reaped. So much for the western line. In the Portillo pass, proceeding eastward, I met with an immense mass of a conglomerate, dipping to the west 45°, which rests on micaceous sandstone, &c. upheaved, converted into quartz rock, penetrated by dykes, from a very grand mass of *protogene* (large crystals of quartz, red feldspar, and a little chlorite.) Now this conglomerate, which reposes on and dips from the protogene at an angle of 45°, consists of the peculiar rocks of the first described chain, *pebbles* of the black rock with shells, green sandstone, &c. &c. It is here manifest also that the upheaval (and deposition at least of part) of the grand eastern chain is entirely posterior to the western. To the north, in the Uspellata pass, we have also a fact of the same

class. Bear this in mind; it will help to make you believe what follows. I have said the Uspellata range is geologically, although only six thousand or seven thousand feet, a continuation of the grand eastern chain. It has its nucleus of granite, consisting of grand beds of various crystalline rocks, which I can feel no doubt are subaqueous lavas alternating with sandstone, conglomerates, and white aluminous beds (like decomposed feldspar) with many other curious varieties of sedimentary deposits. These lavas and sandstones alternate very many times, and are quite conformable one to the other. During two days of careful examination I said to myself at least fifty times, how exactly like, only rather harder, these beds are to those of the upper tertiary strata of Patagonia, Chiloe, and Concepcion, without the possibility of their identity ever having occurred to me. At last there was no resisting the conclusion. I could not expect shells, for they never occur in this formation; but lignite or carbonaceous shale ought to be found. I had previously been exceedingly puzzled by meeting in the sandstone with thin layers (a few inches to some feet thick) of a brecciated pitchstone. I now strongly suspect that the underlying granite has altered such beds into this pitchstone. The silicified wood (particularly characteristic of the formation) was yet absent; but the conviction that I was on the tertiary strata was so strong in my mind by this time, that on the third day, in the midst of lavas, and heaps of

granite, I began an apparently forlorn hunt in search of it. How do you think I succeeded? In an escarpement of compact greenish sandstone I found a small wood of petrified trees in a vertical position, or rather the strata were inclined about 20° or 30° to one point, and the trees 70° to the opposite; that is, they were before the tilt truly vertical. The sandstone consists of many horizontal layers, and is marked by the concentric lines of the bark (I have a specimen). Eleven are perfectly silicified, and resemble the dicotyledonous wood which I found at Chiloe and Concepcion: the others, thirty to thirty-four in number, I only know to be trees from the analogy of form and position; they consist of snow-white columns (like Lot's wife) of coarsely crystalized carbonate of lime. The largest shaft is seven feet. They are all close together, within one hundred yards, and about the same level; no where else could I find any. It cannot be doubted that the layers of fine sandstone have quietly been deposited between a clump of trees, which were fixed by their roots. The sandstone rests on lava, is covered by a great bed, apparently about one thousand feet thick, of black augitic lava, and over this there are at least five grand alternations of such rocks and aqueous sedimentary deposits; amounting in thickness to several thousand feet. I am quite afraid of the only conclusion which I can draw from this fact, namely, that there must have been a depression in the surface of the land to that amount. But

neglecting this consideration, it was a most satisfactory support of my presumption of the tertiary age of this eastern chain. (I mean by tertiary, that the shells of the period were closely allied to, and some identical with, those which now lie in the lower beds of Patagonia.) A great part of the proof must remain upon my ipse dixit of a mineralogical resemblance to those beds whose age is known. According to this view granite, which forms peaks of a height probably of fourteen thousand feet, has been fluid in the tertiary period: strata of that period have been altered by its heat, and are traversed by dykes from the mass: are now inclined at high angles, and form regular or complicated anticlinal lines. To complete this climax, these same sedimentary strata and lavas are traversed by very numerous true metallic veins of iron, copper, arsenic, silver, and gold, and these can be traced to the underlying granite. A gold mine has been worked close to the clump of silicified trees. When you see my specimens, sections, and account, you will think there is pretty strong presumptive evidence of the above facts. They appear very important; for the structure and size of this chain will bear comparison with any in the world: and that all this should have been produced in so very recent a period is indeed remarkable. In my own mind I am quite convinced of it. I can any how most conscientiously say, that no previously formed conjecture warped my judgment. As I have described, so did I actually

observe the facts. . . . . .

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On some of the large patches of perpetual snow, I found the famous red snow of the arctic regions. I send with this letter my observations and a piece of paper on which I tried to dry some specimens.

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I also send a small bottle with two Lizards: one of them is viviparous, as you will see by the accompanying notice. M. Gay, a French naturalist, has already published in one of the newspapers of this country a similar statement, and probably has forwarded to Paris some account*. . . .

* The following is an Extract from the Newspaper referred to by Mr DARWIN:

"Besides these labours I employed myself during the great rains in dissecting various reptiles. It must be interesting to know the influence of the climate of Valdivia on the animals of this family. In the greater part of those which I have been able to submit to my scalpel, I have found a truly extraordinary fact, that they were viviparous. Not only the innocent Snake of Valdivia has offered to my notice this singular phenomenon, but also a beautiful and new kind of Iguana which approaches very near to the *Liposoma* of Spix, and to which, on account of its beautiful colours, he has given the name of *Chrysosaurus*. All the species, even those which lay eggs in Santiago, here produce their young alive; and the same thing happens with some *Batrachians*, and particularly with a genus near to the *Rhinella* of Fitzingen, of which the numerous species have the skin pleasingly spotted with green, yellow, and black. I need not dwell on the importance of this last example, in reference to comparative anatomy: an importance which appeared to me still greater when, on analyzing a Tadpole not yet transformed, I satisfied myself that nature has not varied

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In the box there are two bags of seeds, one ticketed "valleys of Cordilleras five thousand to ten thousand feet high": the soil and climate exceedingly dry; soil light and strong; extremes in temperature: the other "chiefly from the dry sandy traversia of Mendoza, three thousand feet, more or less." If some of the bushes should grow, but not be healthy, try a slight sprinkling of salt and saltpetre. The plain is saliferous.

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In the Mendoza bag, there are the seeds or berries of what appears to be a small potatoe plant with a whitish flower. They grow many leagues from where any habitation could ever have existed, owing to the absence of water. Amongst the Chonos dried plants, you will see a fine specimen of the wild potatoe, growing under a most opposite climate, and unquestionably a true wild potatoe. It must be a distinct species from that of the lower Cordilleras.

her plan of organization. In these, as in the Tadpoles which live in water, the intestines were of a length very disproportioned to the body: now if this length was necessary to the latter, which live upon vegetable substances, it was altogether useless to those which are to undergo their metamorphosis in the belly of the mother: and thus nature has followed the march prescribed to her by a uniformity of construction, and without deviating from it, has admitted a simple exception, a real hiatus, well worthy the attention of the philosophical naturalist."