

THE  
RAMBLES OF A NATURALIST  
ON THE  
COASTS OF FRANCE, SPAIN, AND SICILY.

BY  
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AT THE JARDIN DES PLANTES,  
ETC. ETC.

TRANSLATED  
*(with the Author's sanction and co-operation)*

BY  
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IN TWO VOLUMES.

VOL. I.

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TO  
SIR DAVID BREWSTER, K.H.

D.C.L., F.R.S.

ONE OF THE EIGHT ASSOCIATES OF THE IMPERIAL INSTITUTE OF FRANCE,  
CHEVALIER OF THE PRUSSIAN ORDER OF MERIT OF  
FREDERICK THE GREAT,  
PRINCIPAL OF THE UNITED COLLEGES OF ST. SALVATOR AND  
ST. LEONARD'S, ST. ANDREWS,  
ETC. ETC. ETC.

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DEAR SIR DAVID,

I VENTURE to associate your name with the present volumes on the double ground that the learned Author is one of the most active members of the time-honoured Institute of France, which, by electing you one of its Eight Foreign Associates, has conferred upon you the highest honour that can be attained in the world of Science; and that M. de Quatrefages, like yourself, combines the faculty of abstruse research with the felicitous gift of popularising science in a spirit at once earnest and genial.

Hoping that you may be spared for many years to continue your important labours in those fields of science in which you have already reaped so rich a harvest,

I remain,

Dear Sir David,

Yours very truly,

E. C. OTTÉ.

ST. ANDREWS:

October 1857.

## CHAP. V.

## THE COASTS OF SICILY.

## TRAPANI. — THE ISLANDS OF FAVIGNANA.

Journey to Trapani. — The ancient splendour of that city. — The doves of Venus Erycina; the women of San-Juliano.—Departure for the Islands of Favignana. — Cordial reception. — Geological structure of the islands. — Cultivation of the land and sources of industry. — Tunny fishery. — Researches on the circulation. — Independence of functions.—Progressive perfection of organisms. —Phlebenterism.— The labours of M. Edwards, and my own researches. — The opposition which these labours at first experienced.—Applications.— General consequences.

THE rain, cold, and wind, which had met the *Santa Rosalia* on her arrival at Santo-Vito, still continued. We found it almost impossible to pursue our labours in our windowless rooms; and our explorations among the rocks, which were incessantly washed by the waves, became every day more difficult and less successful. We therefore found it necessary at once to seek new quarters. This time we determined to proceed by land; and whilst our boat was contending, under the able command of Perone, against the rough gales that continued to blow from the west, we, in the prosecution of our land journey, were following a mule track which, winding along the extreme edge of the rugged mountain side, never deviated far from the sea, excepting when the over-

hanging rocks made it necessary to traverse the barren heath which skirted along the beach. A few hours' march enabled us to reach the sandy tongue of land at the extreme point of which rises Trapani; but the rough gait of our mules and the uncouth apparatus which served us in the place of a saddle seemed to double the distance. The feeling of intense enjoyment with which we took possession of the not over-soft beds of the Albergo di Napoli will be readily understood by every one who, like ourselves, had been shaken all day long on the back of a Sicilian mule, or had slept, as we had done, for a month past, between a plank and a sailor's cape.

Placed at the extreme western point of Sicily, and possessing a tolerably good harbour, Trapani, with its 30,000 inhabitants, still enjoys a certain degree of importance. One may easily see that this town has known better days. Here, as in all the cities of the western part of Sicily which we had already visited, there still remained mournful vestiges of former splendour which had long since given place to misery. Grass grew abundantly in the broad straight streets; on every side were palaces now in ruins, scarcely able to afford shelter to the few beggars who had appropriated them. Trapani is rich in such contrasts between the past and the present. We were especially struck by the remains of a palace which had been erected by William de Porcelels, the only one of all the French nobles whose life was spared in the massacre of the Sicilian Vespers.\* The walls are covered, from the base-

\* William de Porcelels was lord of Calatafimi and governor

ment to the cornices, with sculpture; everywhere trophies and statues are interspersed amid the armorial bearings of this proud family, whose cognisance was a boar and an eagle. The only part of this once princely residence which is still occupied is the ground floor, now used as a stable.

Built upon the site of the ancient Drepanum Trapani has not preserved any remains of Greek, Carthaginian, or even Roman architecture; the Temple of Venus, which was situated at about three miles from the town, on the summit of Mount Eryx, has been successively replaced by a Saracenic fortress, and by the convent of San-Juliano; but if the works of man have disappeared from this corner of the earth, where once the most powerful nations of bygone times were brought in contact with one another, nature has ever remained the same. Facing the harbour, we still behold the same rock described by Virgil, which served as the goal for the boat-race which formed part of the funereal games celebrated in honour of Anchises. This rock is called *la Colombara*, and, as in the time of Venus Erycina, it still serves as a meeting-place for the doves of the region at the periods of their annual migrations.

of the town and castle of Pouzzoles at the time of the massacre. He owed his safety to the justice and loyalty with which he had always treated the conquered Sicilians. These virtues, as well as courage, were, moreover, hereditary among the Porcelets, for the grandfather of William had saved the life of Richard Cœur de Lion, and had inspired the Saracens with so much confidence, that they refused to treat with the crusading princes until they had received his guarantee of good faith, and we find in history frequent other references to the chivalric character of this family.



These birds, which the zeal of the Christian Neophytes vainly attempted to banish from the country, have maintained their old habitats, and defying in the present day the shot of the sportsman, as in the middle ages they defied the thunders of excommunication, they still come year by year to build their nests among the grottoes and the rocky recesses which abound along the shore.

For the rest it would almost seem, as if to spite the saint who had thrown down her altars, the Goddess of Beauty still continued to shed her favours over the land which had once been consecrated to her worship. The women of the village of San-Juliano, which is built on the ancient Mount Eryx, have the reputation of being the most beautiful in the land of Sicily. Admitting that such is the fact, we might perhaps discover a natural explanation of this circumstance in that transmission of generic characteristics, to which man is no less subjected than the lower animals. The priestesses of the Erycinean Venus, who were no vestals, were selected with much care from amongst the loveliest maidens of Greece, Sicily, and Italy. This choice source of origin would, most probably, in the course of ages, diffuse some of its elements of beauty among the neighbouring tribes; and this circumstance can hardly have failed to influence their physical development. We are therefore probably not wrong in conjecturing, that the superior charms of the women of San-Juliano still afford evidence of this origin, by an impress of beauty which has defied the action of time.

We were doomed to experience at Trapani the same disappointment which we had already felt at Castellamare. A single glance sufficed to show us that we had nothing to hope from the bare and rugged rocks which bounded the town to the north; and still less, perhaps, from the immense salt marshes situated to the south, which were then being worked with extreme industry. We at once determined to try our luck elsewhere. The ancient *Ægades*, now known as the Islands of Favignana, were situated at about nine miles distant; and, owing to the transparency of the atmosphere, we were actually enabled with the naked eye to trace the rocks and the deep indentations of the coast line which were indicated on our charts. This little archipelago promised to afford us all the conditions which were most favourable to the prosecution of our researches. A cursory examination confirmed these conjectures; and, as soon as the *Santa Rosalia* joined us, we lost no time in embarking, hopeful of better success in this new station.

Lying altogether out of the ordinary routes, and possessing scarcely any sources of commerce, the Islands of Favignana have very rarely been visited by foreigners. From time to time they had been visited by some Englishman who was engaged in buying up Sicilian wines, but no Frenchman had landed upon any of the islands within the memory of the oldest inhabitant. It may, therefore, be easily understood what an immense sensation was produced on the arrival of letters from the Dukes of Serra di Falco and of Cacamo, which announced the

speedy coming of three French naturalists, who were specially recommended to the good offices of those in authority. Even on the occasion of the short excursion which I had made to the islands in order to reconnoitre the locality, I had been received with marked attention. Signor Gaspardo, chief of the Quarantine, had come with great ceremony to receive me. His father, Signor Bartholini, one of the principal people on the island, had entertained us most liberally at his house; while Signor Georgio, the Commander of Fort St. Catharine, had freely placed his country house at the disposal of the *scienziati francesi*, to whom it would naturally form a most convenient abode, owing to its being situated close to the sea side, at about three miles' distance from the village.

We landed in a small bay facing our future residence, where we found a crowd of workmen busily employed in rendering it worthy of its expected occupants. Some were rubbing down the walls, whilst others were whitewashing the three apartments which were destined for our use. The wife of the Commander of the Fort, surrounded by three or four maid-servants, was actually herself engaged in the labour of pouring buckets-full of water over the cracked bricks, which formed the flooring of the rooms; whilst her handmaidens were scrubbing away with all their might. Our sudden arrival produced very much the same effect that one might suppose would follow on throwing a stone into an ant-hill; there was a perfect confusion of cries, exclamations, and interjections, ending in a torrent



of excuses for not being ready to receive us on our arrival. The signora left her pails in haste and rode away upon a donkey, which, after an absence of two hours, returned laden with mattresses, blankets, and pillows. A set of kitchen utensils and a ready-cooked dinner also arrived by the same mode of conveyance, and were, as may easily be conceived, not the least welcome part of the supplies. We, in the meanwhile, had not been idle; for we had spent this two hours' interval in landing our instruments and other apparatus. As a large piece of enclosed land lay between us and the beach, we had to make a considerable *détour* before we could reach our boat. The Commander of the Fort at once perceived the great inconvenience to which this exposed us, and without a moment's delay he gave orders for knocking down a portion of a wall, and thus opened to us a direct passage across his vineyard. I am bound to admit that the wall consisted only of a heap of dry stones, which were generally adjusted every evening; still we may question whether many proprietors in our own country would have been equally ready to take measures for saving a guest from any inconvenience of this kind.

It must not be supposed, however, that this liberal and magnificent way of treating strangers was wholly disinterested. The Sicilians with whom we were thus brought in contact, while they placed themselves unreservedly at our disposal, *per l'onore*, as they themselves would express it, do nevertheless count a little upon the *complimento* which they may receive in return. In these districts, in which no

traces of the usages of modern civilisation seem as yet to have penetrated, and where one does not even meet with anything like the *posadas* of Spain, the stranger receives, it is true, the hospitality of an ancient form of manners, but it is with the understanding that it shall be acknowledged by some equivalent or other. He who entertains looks for a return for his hospitality, and he is apt to take it in very bad part if his guest should in this particular deviate from the ordinary usage. We had occasion to appreciate this condition of things on our departure from Favignana. Having set forth with the idea that travelling in Sicily would be very much the same thing as travelling in France, we had neglected to provide ourselves with such articles as might appropriately be offered as parting gifts. At Torre dell' Isola and at Castellamare we had managed very well in acquitting ourselves of all obligation through the simple payment of money, which had been received without the slightest scruple both by Padre Antonino and by Artese's friend, but we dared not attempt a similar mode of acknowledgment in the case of the Signori of Favignana. We left them, therefore, with purely verbal thanks; and, at the moment at which we were bidding him adieu, the Signor Georgio found it impossible to conceal the vexation he felt in perceiving that our gratitude was expressed in mere words. We took care, however, on a future occasion to prove to him that his guests had neither been forgetful nor ungrateful recipients of his attentions.

The obliging hospitality of our Favignana friends

speedily enabled us to commence our researches in the little archipelago of the *Ægades*, which had never yet been visited by any naturalist. The field which was thus opened to our explorations consisted of some naked rocks, forming so many islets, and three principal islands, Favignana, Levanzo, and Maritimo. We thought it would be of no use to extend our excursions as far as the two latter of these; for Maritimo was too far distant, and Levanzo was entirely formed of calcareous rock, which rose in abrupt mountains, and was so completely devoid of all vegetation that it could not support many terrestrial species. We were, moreover, well acquainted with the nature of this rock; for we had always found it associated with *Caryophyllia*, the presence of which, as I have already remarked, invariably indicates great poverty, when considered from a zoological point of view. We did not, therefore, waste any time in examining the coasts of either of these islands; one of which is entirely deserted, while the other has no inhabitants beyond the few men who garrison the small fort, and work the telegraph which is situated on the island.

Favignana, moreover, was in itself sufficient to occupy the whole of our time. Larger than either of its sister islands (for it measures about twenty miles in circuit), it also presented a much greater variety in its geological constitution. Its central part is entirely occupied by a range of mountains, similar to those of Levanzo, and about 1000 or 1200 feet in height. The highest point of the range is occupied by Fort St. Catharine, a state prison, which

during the different revolutions of Naples has acquired a mournful celebrity. To the east and west of the island, the calcareous rock underlies a stone of a very different character and known to geologists as Palermo limestone. This stone, which is soft and friable, is almost entirely composed of the fossil remains of the lower animals. On making an examination with a microscope, or even with the naked eye, we discover an incredible variety of zoophytes, an infinite number of sponges, and many different kinds of Polyparies. A cubic foot of this stone would in itself afford materials for an entire collection, and if the sea with its living population had not absorbed all our time, we should certainly have possessed ourselves of many highly interesting samples of this rock. In the midst of these fossil remains, which are very small and sometimes even microscopical, belonging, as they do, to the lowest representatives of animality, we find scattered here and there the remains of sea-urchins and of star-fishes, and the shells of oysters and pectens; but these animals, which were at once more elevated in the scale of being and of much more considerable dimensions, constitute only a very small part of the materials which enter into the composition of the rock. In this respect the limestone of Favignana affords another proof of a very general but most remarkable fact. When we examine the animal remains buried within the strata of the earth's crust, in the hope of tracing the history of the past, we cannot fail to recognise the important part which has been played in the geology of our globe by animals, whose significance in this respect



seems to bear an inverse proportion to their size and the degree of development manifested in their organisation. The higher animals, or, in other words, those in which the animal machine had arrived at its highest degree of perfection, have left but feeble traces of their existence. We know of only three or four cases in which osseous debris have been found to contain the remains of the Monkey tribe, while in the case of Mastodons\*, Elephants, and even gigantic Reptiles†, very few perfect skeletons have been found; and science has therefore gratefully treasured the isolated fragments of their remains which from time to time have been brought to light. The inferior animals, on the contrary, have contributed most materially in forming the solid crust which we inhabit. In the case of certain mountains, more than half their structure consists of shells, whilst some entire strata are exclusively composed of infusoria, which are so infinitely small that hundreds of their carapaces crumble into dust beneath the point of a needle. The study of these inferior beings, which is so important to the phy-

\* [A note on the Fossil Remains of the Mastodon is transferred to the Appendix, Note XIV.]

† The Reptiles preceded the Mammals on the surface of the globe, and they were present in a highly developed state during the secondary period. Among the species then existing, several possessed very strange forms; amongst others we may instance the Plesiosaurs, which lived in the water, and had the body of a lizard, with a serpent's head on a very long neck; and the Pterodactyli, which flew like bats, by means of a membrane, supported by one of the digits of their anterior members, &c. Many of these species were of very large size; some of them being, according to Cuvier, upwards of fifty feet in length.



siologist and the zoologist, is not the less suggestive to the geologist of the gravest subjects of meditation.

The loose and porous structure of the Palermo limestone permits rain-water to accumulate within it, as in a sort of sponge, and thus provides the thin stratum of earth covering the rock with the humidity necessary to counteract the effect of the longest droughts. These waters, the further course of which is stopped by the more dense limestone whose strata form the basis of the whole island, combine to form subterranean reservoirs, which feed a large number of wells and inexhaustible springs. On this account the cultivation of the island is concentrated upon the points occupied by this beneficent rock, which alone prevents Favignana from becoming, like Levanzo, a dreary and uninhabitable desert.

The capital of Favignana is situated nearly in the centre of the island, on the side of a small harbour, which penetrates far inland. It contains from 300 to 400 tolerably well-built houses, and numbers about 3000 inhabitants, who appeared to us to enjoy a degree of general prosperity unknown in the villages of the coast. But although a state of general competency seemed to prevail amongst this isolated population, it appeared to us to be very deficient in other respects; and we observed amongst the inhabitants, various customs which showed significantly enough that they were still in the infancy of civilisation. One instance will suffice by way of illustration. There is no public clock at Favignana, and it seems that no

better method had suggested itself for supplying this deficiency than to charge a man with the accomplishment of its functions. This person, who took up his abode in the keep of one of the fortresses which defend the village, warned his fellow-citizens of the march of time by striking the hours with a hammer on a bell. A sand hour-glass served him by way of indicator. As may readily be conceived, this animal machine was very easily put out of order, and we had more than one opportunity of convincing ourselves that, in point of regularity, the man-clock of Favignana was very inferior to one of Breguet's chronometers.

The number of the population is almost doubled by that of the garrisons of the three forts, by that of the officials of the custom house and quarantine, and above all by that of the convicts who are incarcerated within the prisons of Fort St. John — those terrible dungeons, which, together with the cells of the ordinary prisoners, are deep excavations hollowed out of the rock, and from which escape is almost impossible. The greater number of the unfortunate beings confined here were expiating the crimes of murder, or of theft accompanied by violence; their number during our stay amounted to nearly 2000.

The products of Favignana are very limited, and quite inadequate for the maintenance of the inhabitants. The land immediately round the town is more fertile than in any other part of the island, and is generally enclosed in gardens, in which grow excellent vegetables, together with magnificent

orange, lemon, and pomegranate trees.\* In the eastern part of the island we met with a few corn-fields, but with that exception the soil seemed to be abandoned to vineyards and some plantations of cactus, a plant which may be said to mark the limits of vegetation. There are only a very few horned cattle to be seen on the island, and hence Favignana is obliged to supply her population with meat, oil, and cereals from abroad, in exchange for which she gives her wines. Being entirely without manufactures, she is obliged to obtain from foreigners, not only articles of luxury, but even many of the necessaries of life. To judge by the samples which fell under our notice, France and England would seem to share in the office of provisioning this remote corner of the globe, where the two countries are to a certain extent represented by their productions. Everything that relates to the material wants of life is of English origin; knives, forks, dinner-services, all bear, with few exceptions, the name of London. Everything akin to elegance, everything that can call up an idea, has come to Favignana from the provinces of France, if not from Paris. The chimney-pieces were adorned with our porcelain vases, the walls were hung with our papers, and

\* The pomegranate tree (*Punica granatum*) is a native of Mauritania, from whence it was imported by the Romans at the time of their wars with Carthage. This tree was cultivated by them with much care; and while we are only acquainted with three varieties, the Romans at the time of Pliny possessed as many as six, one of which called *Apyrenum*, bore fruits containing seeds without pips.

everywhere our eyes encountered engravings of the Rue Saint-Jacques, of Napoleon, his marshals and his battles.

The inhabitants of Favignana are not the proprietors of the lands which they cultivate; for the entire archipelago is the property of a noble Genoese family, the Palavicini, who rarely visit this maritime fief, which they govern through the agency of a steward. I do not know what the rents may be which are derived from the cultivation of the soil; but they cannot be very considerable, and the proprietor, no doubt, derives the greatest part of his revenues from the produce of the sea. The lords of Favignana have the exclusive right of fishing over a very large tract of water; while, of course, they have the entire monopoly of the produce of the archipelago, and these rights derive great value from the vast shoals of the tunny which frequent these seas. It is well known that this fish appears every year in immense numbers in the neighbourhood of Gibraltar, where they separate into two columns, one following the shores of Africa, whilst the other makes its way along the coasts of Europe. The successive appearance of these shoals in different localities, and their inexplicable disappearance on the approach of cold weather, led for a long time to the belief that they made actual migrations, similar to those of birds. In this respect the tunny resembled the herring and the mackerel, which had at all times been regarded as migratory fish; but M. Valenciennes having confirmed by personal observation the doubts which had already been ad-



vanced in reference to this point by Lacépède and Noel de la Moriniere, showed that these pretended voyages had really no existence. Neither the tunny nor the herring leaves its native country. The fact is, however, that during winter, they seek shelter from the cold at a depth to which no net can reach, and when the sun has warmed the surface of the sea and their season of reproduction has arrived, they leave those abysses of the deep, and approach the neighbouring shores, in order to deposit their eggs in warm and shallow waters.

At all events the tunny is undoubtedly a source of wealth to the shores which it frequents. Either fresh, salted, or smoked, it is an object of commerce, which annually leads to the circulation of thousands of thousands, and hence this fish has at all times been the object of remorseless pursuit. Aristotle, Pliny, Athenæus, and Oppian, have all transmitted to us details of the different methods employed by the ancients for its capture. Since then, every age and every people seem to have furnished their contingent of murderous inventions. The most formidable means devised for capturing this unfortunate fish is undoubtedly the *madraque*, which is said to have been first employed by the inhabitants of Martigues. This apparatus is not merely the *libouret* of the Bayonnese or the *grand couple* of the Basque fishermen, which are gigantic lines carrying many hundred baited hooks, and which are worked by a boat's crew of eight or ten men; nor is it like the *courantille* of the Provence fishermen, for this contrivance is merely a kind of *seine* from 1500 to 2000



feet in length, which is often thrown over a space measuring more than six or eight miles across. The *madraque* is an actual park, with its walks and alleys all terminating in a vast labyrinth, composed of chambers, which open into one another, and all of which lead to the chamber of death, or the *corpou*, which is situated at the extremity of the structure. This vast enclosure, the walls of which sometimes extend upwards of three miles, is both secured and raised by means of immense lines and nets weighted with stones, supported by cork buoys, and secured with anchors in such a manner as to resist the most violent storms to which it would be exposed during the usual fishing season. It may easily be conceived that the materials constituting an apparatus of this kind, are of enormous size and bulk; on this account a steam-boat is chartered every year to convey the entire apparatus from Palermo to Favignana. The arm of the sea which lies between this island and Levanzo is peculiarly well adapted for the establishment of a *tonnara*, as the Sicilians call it, and the right of fishing in this locality alone is valued at 60,000 francs.

When first we arrived at Torre dell' Isola, we saw this steamer on her way to Favignana, and from that time, till we landed on the island, men had been continually at work in fixing the *madraque*; it was now completed, and some tunnies had already been seen within the first compartments of the apparatus. We had a great desire to witness one of these fishings, of which Joseph Vernet's picture gives a tolerably good idea. The reports of our

own sailors, whose eyes sparkled at the very mention of the word *tonnara*, had increased our anxiety to be present on one of these occasions, which are regarded by the inhabitants of the Sicilian islands in the light of festivals. Signor Bartholini kindly undertook to inform us of the time at which we were to hold ourselves in readiness to join the other boats engaged in the fishing, and we lost no time in obeying his directions. One morning on looking out, we saw that flags had been raised on every elevated point of the island to serve as signals for calling together the fishermen of the neighbourhood to take part in the *tonnara*. Scarcely any, I believe, failed to appear at the common rendezvous. Every bark between Trapani and Mazara had hoisted her sails, and by the break of day, far as the eye could reach, the sea seemed to be covered with a moving fleet of sailing boats, whose hundred broad lateen sails, converging to one and the same point, presented the most picturesque appearance. The Santa Rosalia was soon in the midst of this numerous flotilla; and by the energetic efforts of our sailors, whose strength and activity seemed to be doubled for the occasion, we reached the *madraque* in good time to follow all the scenes of the sanguinary drama which was about to be enacted.

If any of our readers should deem these expressions exaggerated, we would beg them to come and judge for themselves, and embark with us on board one of those large boats which, in the midst of the sea, have combined to enclose a space of about one hundred square feet. Between 500 and 600 tunnies,

impelled from chamber to chamber by the valves which close behind them, have at length reached the last compartment, or the *chamber of death*. This enclosure is provided with a movable floor formed of netting, which can be raised from the bottom to the surface of the water by means of ropes. All night long men have been labouring to lift the huge apparatus, little by little, and now each of its margins rests upon one of the sides formed by the boats. Facing us is the proprietor of the fishery, surrounded by his staff and by a charming group of ladies, who have come from Palermo to witness the spectacle which is about to be exhibited. To the right and to the left are stationed the two principal boats, which convey the band of fishermen. These boats, which are entirely empty, lie ready to receive their cargo, the only thing that breaks the even line of their decks being a long beam, which passes from one extremity to the other, and leaves a narrow sort of gangway on the edge of the boat, where stand at least two hundred fishermen, who have come, in some cases, from a distance of more than fifty miles to take part in this exciting sport. Half naked, with deeply-bronzed limbs, these athletic men stand side by side, all awaiting, with the same eager impatience, for the moment of action. Their eyes are sparkling beneath their scarlet Phrygian caps; their hands are grasping the instruments of death—broad, sharp, and cutting hooks, which are either inserted into a long pole, or fitted to the end of a short, massive handle, which is deeply cut to enable the hand to obtain a firmer hold of the weapon. In the midst of the

enclosure, a little black rowing boat manned by two oarsmen contains the master-fisherman, from whom emanate all orders, and who is ever at hand to encourage and lead on the workmen, or to carry reinforcements from side to side, as they may be needed.

During all this time the capstans, which are fixed at the extremities of the net, have never ceased turning; and as the moving floor of the *corpou* gradually rises, the tunnies begin to appear, and on looking through the transparent water we see the fish darting uneasily from one side to the other of the vast enclosure in which they are imprisoned. Some of them rise to the surface or even spring out of the water; but woe be to those who rise near one of the boats, for no sooner does the fish appear than hands of iron are stretched forth to bury their sharpened points in its sides. Even though they may be wounded, the fish generally escape from the first attack; for being full of life and strength, and in the enjoyment of entire liberty of motion within the large basin that encloses them, they tear themselves from the hands of their enemies, leaving only a few bleeding shreds of flesh attached to the hooks; but still the capstan turns remorselessly to the modulated songs of the sailors, and the net rises higher and higher. The master-fisherman is always at hand in his little boat to drive the tunnies towards the edges of the net; wounds are now dealt on every side; and soon some fish, more deeply struck than his companions, slackens his course, showing from time to time his broad silvery sides, along which the black blood is streaming forth. At every new stroke his



resistance diminishes, and soon the victim pauses for an instant; but that instant is enough; a dozen hooks are at once buried in his flesh, a dozen arms are bent to lift him to the surface of the water. In vain the skin has given way; each hook that loses its hold is raised on high only to be buried still deeper in the quivering flesh, and soon the unfortunate animal is drawn to the side of the boat; in another moment he is seized by two men, who each grasping one of his large pectoral fins lift him to the beam which is placed behind them, and throw him into the hold.

But the net is always remorselessly rising, and now the entire shoal of tunnies is exposed to view. Pressed close to one another, these monster fishes are throwing themselves in despair against the flexible walls of the *corpou*, at one moment showing their black yellow-spotted backs, at another moment cleaving the surface of the water with their large crescent-shaped fins. Here and there a few sword-fish with their long pointed snouts may be seen interspersed among the tunnies. Animated by the sight of the victims which lie exposed to their attack, the sailors strike with redoubled force, and the fishing becomes a massacre. One can no longer individualise the separate actors in this drama; the serried crowd seems to be composed of nothing but violently moving heads, bleeding arms, which rise and fall, and harpoons which flash and cross one another as they are hurled against the victims. All eyes are sparkling, all lips are uttering cries of triumph, clamour, and encouragement. The waters of the *corpou* are tinged with blood, and every moment



another fish has been hurled across the beam; the dead and the dying lie heaped together in such vast multitudes, that the hulls of the boats are almost hidden beneath the load of their half-living cargoes.

After two hours of carnage symptoms of exhaustion begin to appear, the tunnies come but rarely to the surface, and at length their enemies begin to lose patience. A boat is then loosened from either side of the enclosure, and the two principal barks are brought within half their former distance of one another. The capstans are now again brought into play, the impatient fishermen all lend a hand, and now the hooks are inserted in the meshes of the net; but these efforts, which are somewhat irregular, do not at first produce any great results. Soon, however, the master-fisherman's whistle is heard: at once the men break into a song of measured rhythm, their movements become more regular, and pulling in unison with the words which they sing, the net is made to rise higher and higher. Soon it is almost on a level with the surface of the water, and now it is time to resume the labour in good earnest. The master-fisherman's boat now, for the first time, takes an active part in the labours of the day. Its crew of picked men pursue the tunnies within the narrow limits to which they are now circumscribed, and, striking them with long harpoons, urge them forward against the hooks which are projected from the boats, and which speedily secure them.

I must confess that this spectacle, which we had so anxiously desired to witness, left us melancholy and discontented, for we had been most painfully

affected by the exhibition of such wholesale butchery. Perhaps the impression produced on our minds would have been different if the fishermen had had a shadow of danger to encounter, or if the tunnies had been able to offer the slightest resistance in their struggles for freedom; and it seemed to us impossible to avoid feeling the deepest emotion in witnessing so unequal a strife, and in observing the mute anguish in which the convulsive movements of the victims were the only indications of the agony which was so wantonly inflicted upon them. It was quite different with our sailors, who were perfectly radiant with delight. As fishermen, they could only see and judge of things after the fashion of their calling, and the fishing had been superb. In three hours 554 fish had been harpooned, weighing on an average 176 lbs. Besides this, the chambers of the *madrague* still contained about 400 captives; the proprietor might therefore count, at the very beginning of the season, upon having caught about seventy tons of the tunny fish, which would, at the least, be equivalent to the sum of 43,000 francs (1720*l.*) Here then, in one fishing, nearly enough had been gained to pay the whole expenses of the *tonnara*.

A small island, in which every inch of productive ground has to be wrested from the naked rock, is necessarily not well adapted for the multiplication of independent animal species. For this reason, Favignana possesses hardly any animals beyond those which have been subjugated to the use of man, or which live at his expense, or which, from their in-

significance, are not made the objects of his pursuit. Here, as everywhere else, the dog and the cat share his dwelling, which, at the same time, affords shelter to the rat and the mouse. The ox, the horse, and the ass, aid him in his labours, but beyond these there are no mammals to be found on the island. Some of the slender-billed *Passerinæ* (*Motacilla* \*), and a few little birds living upon grain, were hovering about the fields and amongst the orange groves; whilst magnificent falcons, which were formerly in great request for the noble sport of falconry, soared incessantly above the peaks of the most inaccessible rocks. Lizards, skinks, and the black snake, are the representatives of the class of reptiles, and lie concealed beneath the stones upon the beach. Insects buzz among the hedges or burrow round the roots of shrubs; but there are not many different species to be met with, and M. Blanchard very soon collected numerous representatives of each of them.

But while the air and the land were so deficient in animals worthy of interest, the sea afforded us ample compensation. In this respect Favignana more than answered our expectations, for no place could be better adapted for zoological investigations. In several parts of the island the two kinds of rocks of which we have already spoken, lay in juxtaposition to one another, within a few inches below the level of the sea, which, wearing away the limestone rock, had laid bare a more compact stone, the inequalities of which formed many recesses and small basins,

\* [This family includes most of our smaller singing birds.]

which almost looked as if they had been hollowed out by the hand of man. Besides this, the waves, which had penetrated between the interstices of the two ranges of rock, too hard to be entirely broken through, opened a channel inland and gradually formed small grottos, which were sometimes partially vaulted over, and at other times wholly exposed and uncovered. Many of these cavities gave a miniature representation of the well-known phenomenon observed in the grotto of Capri. When our boat, lying at the entrance of one of these caves, intercepted the direct rays of light, they passed below our keel, and, being refracted in the crystal liquid, gave rise to the same effect as that produced by a prism, and bathed the rocks and the foam-crested waves in the richest azure tints.

We found at Favignana almost all the animals of which we had lost sight ever since we left Torre dell' Isola. The Medusæ and their kindred allies were, however, of much rarer occurrence, probably in consequence of having been carried away by some opposing currents. We met with only a few Alcinoës\*, some large Beroïdæ, and an infinite number of Pelasgiæ. The recesses and the basins to which I have already referred were, however, unusually rich in all littoral species. The annelids especially presented numerous varieties. It was at Favignana that M. Milne Edwards found his Myriana, which bears a chaplet of six individuals united end to end in such a manner that the last of all has no other nourishment but the food which

\* The genus Alcinoë belongs to the family of the Beroïdæ, of which I have already spoken.



has been previously digested by its parent, and its five brothers or sisters. It was also here that this naturalist entered upon a series of observations on the development of the annelids, to which we shall refer in the sequel. M. Blanchard continued his researches on the nervous system of the Mollusca, and the result of each day's labour seemed to reveal to him some new and unexpected complications. I, in my department, was fortunate in obtaining a profusion of Nemertes and of Phleboterous Molluscs. We had therefore ample materials for work, and so thoroughly did we avail ourselves of our opportunities, that almost the only occasions in which our labours were interrupted, were when we chanced to receive a visit from some one or other of the islanders, who were desirous of verifying by their own eyes the accuracy of the reports which had been spread in reference to the marvellous powers of our instruments.

The researches on the circulation of the Mollusca which M. Milne Edwards began at Favignana, and continued during all the rest of our voyage, and the observations which I had been led to make on the same subject during my renewed investigations relative to the Phleboterata, gave rise to very keen discussions, the report of which has even penetrated beyond the precincts of our academic circles. The facts under consideration touched upon such general questions and militated against such long-received opinions, that we could not expect they would be easily accepted. M. Milne Edwards in the introductory remarks at the head of the exposition of his



views, showed how certain results which at first sight seemed to be inexplicable, become easy of comprehension when they are judged by that principle of the *division of labour* of which we have elsewhere spoken.\* I have also considered in many memoirs the questions which refer to this order of ideas. Numerous investigations were soon entered upon, and pursued in the same direction, both in France and in other countries, and the results which have been arrived at seem daily to confirm more and more the principles, or, to speak more accurately, the *tendencies* of this school of physiological zoology, which at its dawn met with so violent an opposition. We will endeavour to give a general and comprehensive idea of the facts established by it, and the consequences to which they lead.

We know that one of the principal differences which separates inorganic bodies from living beings, consists in the necessity for nutrition in the case of the latter. The mineral, when once formed, will, if placed beyond the action of external influences, endure for ever without suffering loss or gain. In the plant and in the animal, an incessant circulation of matter expels from the organism some of the elements which previously had formed a part of it. These elements require to be replaced by others, and to effect this is the end and object of nutrition. Four important functions, which are themselves accomplished by the aid of several secondary functions, concur in the accomplishment of this fundamental

\* See Chapter II. on the Archipelago of Bréhat.

act—viz., digestion, which prepares the food; absorption, which separates the useless parts, isolates the essential principles, and causes them to penetrate into the organism; circulation, which transports these principles to all the points at which their presence is necessary; and, finally, respiration, which restores to the nutrient liquids, after they have been changed by their sojourn in the organs, the vivifying action by which they are characterised.

In the superior animals—that is to say, those in which the organisation acts in the highest degree of perfection—each of these functions is accomplished by the aid of special organs. The first naturalists who endeavoured to penetrate into the mysteries of the mechanism of life, directed their studies only to these complicated organisms, and, being forcibly struck by this fact, they declared that the function was at all times and in all cases *dependent* on the organ. In other words, that where no special instrument was present for the accomplishment of the function, that function could not exist. However rational this principle may appear to be, it is not the less a profound error; for we find that among the lower grades of the animal scale there are no distinct organs, and yet these animals feed and are nourished—that is to say, they *digest, absorb, and respire*, and plastic fluids *circulate* through all their tissues.

We will take, by way of illustration, one of those fresh-water Hydras so common in the neighbourhood of Paris, which were first recognised by Trembley, and to the study of which M. Laurent\* has con-

\* M. Laurent, formerly a Navy surgeon, who died recently

secreted two years of unremitting labour. This animal resembles the finger of a glove with its aperture surrounded by long, hollow, flexible, and contractile prolongations. These organs serve the polype like so many arms, enabling it to seize larvæ and other small aquatic animals, which are rapidly digested after their introduction into the cavity of the body. Let us take the moment in which it has just swallowed one of these larvæ, and, proceeding with caution, let us try to tear it away. Rather than relinquish its prey, the polype will suffer itself to be turned inside out like the finger of a glove, to which we have already compared it, when that which formed the exterior skin will become a membrane clothing the digestive cavity, and *vice versâ*. Yet the animal is none the worse for this; it will remain on the watch, seize and digest its prey precisely as it did before. Let us go still farther; let us cut this Hydra into twenty or thirty pieces, and still each of these fragments will continue to be nourished. They will soon begin to grow, and in the course of a few days we shall have twenty or thirty complete Hydras obtained by this apparently barbarous process.

With these incontestable facts before us we must admit, that in these simple beings the function is *independent* of the organ—that is to say, that each part of the body is equally adapted simultaneously to perform all the physiological acts; but it is at the

at Paris, devoted himself with much perseverance to the study of the lower fresh-water animals. We are also indebted to him for several curious observations on the embryology of some of the terrestrial molluscs.

same time evident that these different acts, being all accomplished at the same point, cannot be executed with the same degree of perfection as if each of them resulted from the action of a special instrument. We can, therefore, fully comprehend the full value of the principle which was developed more than twenty years ago by M. Milne Edwards, and which may be summed up in the following terms:—the successive degrees of perfection attained by the different organisms in the animal kingdom depend upon the extent to which functional labour \* is divided.

An attentive study of the circulation, when considered in all its bearings, is well adapted to demonstrate the very suggestive nature of this principle; while at the same time it shows how it leads to the coordination of facts, which at first sight appear to be incongruous or even in direct antagonism. This function is effected in the higher animals by the aid of a very complicated apparatus, the principal parts of which have received the names of *heart*, *arteries*, *veins*, *lymphatics*, and *lacteals*. The heart sends the blood through the arteries towards every part of the body, from which this fluid is returned to it through the veins. The lymphatics convey to the same circulatory centre the *lymph*, which is a transparent liquid, exuding, if we may use the expression, from all the organs. The lacteals transport to the same centre the *chyle*, which is the immediate product of digestive absorption. These different liquids, which are enclosed in veritable tubes, follow with admirable

\* I have already referred to these views in Chapter II., on the Archipelago of Bréhat.



regularity one invariable and determinate direction, during the whole life of the animal. It is not the same with the lower animals. Here, as we have seen in the instance of the Hydra, the circulation is often confounded with the other functions of nutrition. Between these two extremes, however, there must necessarily be many intermediate connecting links.

Even the class of Polypes presents some instances of progressive development. Let us open one of those animals which, connected by hundreds upon a sort of common stem, of which they represent the flowers, produce the substance known as *coral*. In these animals the mouth terminates in a sort of pouch or bag, suspended in the cavity of the body, and constituting an actual stomach, into which the food penetrates. After the latter has been sufficiently digested, the animal rejects by its mouth the coarser residue, and opening an orifice which is situated at the other extremity of the bag, it only suffers the portions of food adapted for its maintenance to penetrate into the interior. From this special cavity within each animal are given off canals, which, being prolonged into the common part or the polypary, communicate freely with similar canals coming from all the other polypes—an arrangement by which the entire colony profits from the nourishment taken separately by each individual.

Something similar to this exists in the case of some of the Medusæ, while in others the functional labour begins to be more definitely characterised. These animals, as we have already said, resemble an in-

verted bell, the place of the tongue being supplied by the mouth which serves as an entrance to the stomach; in the *Lesueuria* this first cavity is followed by a second, to which the coarser parts of the food do not penetrate. The liquids which enter this cavity are carried towards the circumference by one system of canals, whilst other special vessels carry them back to their starting point. This movement reminds us to a certain degree of that of the blood in the mammals; but here it is the stomach which fulfils the functions of the heart, whilst the same canals serve the part of intestines, arteries, and veins.

These vessels, moreover, do not convey any special liquid meriting the name of *blood*. It is not even *chyle*, properly so called. The water in which the animal lives penetrates—one might almost say accidentally—into its interior. In its passage it takes up the substances which have been digested by the stomach, and conveys them into the cavity of the body which they are to nourish. In passing away again, this same water carries with it, indiscriminately, the remains of these substances, and the elements of which the organism strives to free itself. At the same time it also serves the purposes of respiration, no less than those of digestion and circulation. Here, as we see, all the organs are still confounded; and this very confusion explains the evident imperfection of the animals which we have been considering.

The isolation of these functions by the appearance of organs specially appropriated to each of

them, is in itself a great step in advance; but nature never proceeds by sudden starts, and this perfection is brought about by very gradual steps. When once the digestive cavity is complete, we may assume that there will also be present in the animal some liquid specially designed for the maintenance of the organs. Here, too, a preliminary absorption is necessary to enable the materials furnished by digestion to blend with this kind of blood, but still respiration continues for some time to be effected by the aid of already existing organs, or by the digestive apparatus itself. A very large number of Annelids respire through the skin only, while many Crustaceans have no other branchiæ than their feet. In the larvæ of those large insects known as dragon flies, we observe a still more curious phenomenon. Here the intestine presents a considerable dilatation at its posterior extremity. The water penetrates into this cavity, from which it is propelled at the will of the animal. Here, then, we have the respiratory apparatus. It is easy to ascertain this by holding one of these larvæ out of the water, and then, after a time, restoring it to its native element. We shall find that it will draw in and eject the liquid with the same kind of anxious precipitation that is exhibited by a half-suffocated mammal; but while the latter breathes through a mouth, the larva of the dragon-fly respire through the opposite extremity of its alimentary canal.

The circulation presents an almost infinite variety in the modes of its successive development. Very often it is altogether wanting; in the lower types

of the *Articulata* and *Mollusca*, no trace of vessels can be detected. The general movements of the animal communicate motion to the liquid which is enclosed between the walls of the body and the intestine, and sometimes more or less irregular currents are produced by vibratile cilia, arranged in bands or groups; but there is no heart to give a definite impulse, no arteries to distribute the nutrient fluid to the surface of the body, nor veins to return it to the centre of the organism. In this case there can be no distinction between arterial and venous blood, or between lymph and chyle; and here the liquid, which fills all the organic interstices, receives the products of digestion directly and immediately.

In some cases the intestinal apparatus compensates by a very singular arrangement for this absence of circulatory organs; for we find this apparatus charged with the duty of distributing to all parts of the body the nutrient elements, which it is specially destined to prepare. In these cases, we perceive that it is complicated by the presence of prolongations or appendages which reach the most distant points of the organism. In the *Nymphon* and the *Pycnogonum*—crustaceans which bear considerable resemblance to certain field spiders—the intestine penetrates to the very extremities of the feet and claws, very much in the same way as if, in man, the stomach were to be prolonged across the neck, arms, and legs, to the jaws, wrists, and ancles.

Nature is much less economical of her forces than



we are apt to suppose, and often when two means present themselves for attaining the same object, she employs both at once. The arrangement to which we have referred is to be met with in certain Molluscs, of which some, at any rate, possess a heart. Here, there are indeed no veins, but a more or less complete arterial system conveys successively to all the different parts of the body the liquid enclosed in the general cavity; nevertheless the stomach sends forth prolongations to all the appendages, including even the tentacles on the forepart of the head, which, in the case of the snail, are improperly designated as *horns*. In obedience to the simple laws of physics, the products of digestion contained within these prolongations must necessarily transude and mix with the liquid which fills the body of the animal. These prolongations, therefore, actually play the part of arteries by conveying materials of nutrition to the points where they are to be used. These same prolongations also fulfil the functions of lacteals. The latter never convey directly to the arteries the chyle which they have collected from the surface of the intestine. In order to render this liquid suitable to the maintenance of the organism, it requires to be exposed to the modifying action of the air in the lungs or branchiæ which it reaches in association with the venous blood. In the Molluscs to which we refer there exist no branchiæ which admit of a comparison with those of other animals of the same class; but here their functions are performed by the small richly coloured papillæ which cover the bodies of these

animals. The prolongations of the stomach are all carried into the interior of these small protuberances, and consequently the chyle, on issuing from the intestine, is at once brought into the midst of the respiratory apparatus, where it cannot fail to undergo *immediately* the vivifying influence which it requires. Such are the facts which led me to that theory of *phlebenterism*, which, after being violently attacked by several French naturalists, has met with a much more favourable reception amongst foreigners, and more especially amongst German zoologists. In the detailed examination of the remarkable group which furnished me with my facts, I was necessarily led into some errors; but time and renewed researches have only tended more and more to confirm the essential and general results which I discovered.\*

When considered from this point of view, the class of the Mollusca is indeed very remarkable. Without departing from its limits, we find the circulation exhibiting the most different degrees of complication, and that even in animals often closely allied to one another, and in which we might therefore have been led *à priori* to believe that the organisation was almost identical. Nevertheless, the circulatory system still remains *incomplete*, there being no perfect continuity between the venous and the arterial apparatus. Consequently, the blood which was propelled from the heart cannot return to it until it has been diffused through all the inter-organic spaces or *lacunæ*, and hence it must neces-

\* [An abstract of the discussions on the subject of Phlebenterism is given in the Appendix, Note XV.]

sarily fill the general cavity of the body. Here it bathes the greater part of the viscera, and receives without any intermediate aid the nutrient elements which have been elaborated by the alimentary canal; hence it will be understood that if we must admit the presence of venous and arterial blood in the higher Molluscs, we are yet unable to distinguish either lymph or chyle.

The Articulata furnish precisely similar facts. Several of the results which have been obtained from these animals had already long before been admitted into the science of zoology; but in consequence of not perceiving the relations which connect them with what occurs in other groups, physiologists had been led to regard them merely as strange and characteristic exceptions. Thus, from the time when the researches of MM. Audouin and Milne Edwards received the prize of the French Institute, in 1827, the absence of veins where the heart and arterial system were both present, was looked upon as exclusively characteristic of lobsters, crabs, and other animals belonging to the class of the Crustacea. The absence of any circulatory organ was, they thought, limited to Insects and to a portion of the Arachnida, and they endeavoured to explain this fact, which was the more striking from its peculiar isolation, by the modification which the respiratory apparatus presents in these cases.

Insects, indeed, have neither lungs nor branchiæ; but in them the air passes through a variable number of openings into a system of tubes, called tracheæ, whose singular structure bears the most striking

resemblance to an elastic webbing. These tracheæ ramify over the whole body, and, consequently, as Cuvier remarked, the air seems in insects to go in search of the blood, whilst the contrary is the case in other animals. The explanation was logical, for every movement of this liquid seemed as if it were useless, since it could be incessantly revived on the spot. A more attentive observation has, however, shown that insects possess a true circulation, for a long contractile dorsal vessel here plays the part of a heart. The blood moves freely through the interstices of the organs, yet each one of its portions circulates successively through every part of the organism; but then the circulation is performed almost entirely in *lacunæ*. We may readily observe, under the microscope, the existence and direction of all these currents, which are made apparent by the globules in the liquid. The circulatory circle is therefore incomplete in all the Invertebrata of which we have spoken, and hence it is the more remarkable that the class of the Annelids should possess an uninterrupted circulation. We undoubtedly meet among the lower forms of this group of animals with many totally deficient in an apparatus of circulation, while some species exhibit a mere rude outline of such a system; but the greater number certainly possess a perfectly closed system of sanguiferous vessels. Even in the Nemertes, whose animal machine presents a most remarkable degree of simplification, the blood pursues its course without ever leaving the contractile tubes within which it is contained. In these animals, however,



as in all the Annelids, properly so called, there is no heart; whilst the vessels, which are everywhere of equal calibre, do not give origin to any secondary branches. In respect to the circulation, the lower Articulata present a much greater similarity to the Vertebrata than to Insects or the higher Molluscs, whose organisation is nevertheless very far superior to their own.\*

Even the Vertebrata obey the common law, and in the lower representatives of this type—in the fishes—we still meet with examples of this lacunary circulation. This important fact, which could not have been anticipated a few years ago, was discovered at Paris simultaneously, although independently, by two anatomists, MM. Natalis Guillot† and Robin,

\* This is a very important result, which moreover derives confirmation from the comparative study of several other groups. We still meet with some naturalists, who, guided solely by their pre-conceived ideas, wish to insist that there must be not only necessary physiological relations between each functional apparatus, but they would make it appear that there is an anatomical dependence among them, which is regulated by laws, which exist only in their own imagination. In the eyes of these naturalists, no apparatus can be simplified or degraded without inducing a corresponding simplification and degradation in all the others. In refutation of such views, it is sufficient to refer those who uphold them to the study of the circulation in Insects and in Annelids.

† M. Natalis Guillot, who is physician to several of the Paris hospitals, affords a happy illustration of the manner in which scientific pursuits can be combined with the practice of a laborious profession. His *Exposition Anatomique de l'Organisation des Centres Nerveux*, which gained for him the prize offered by the Brussels Academy of Sciences, will ever remain one of the most trustworthy works on this difficult subject. M. Guillot has published numerous memoirs illustrative of various other points in comparative anatomy and physiology.

who have shown that in the Rays there are certain portions of the body in which the blood-vessels cease all at once, and where the blood flows freely into cavities, whose arrangement recalls to mind that which exists in some of the lowest animals. M. Robin in following his first researches, has extended these results to several species of the family of the Squalidæ. We are convinced that the question will not remain where it now is, and that in the course of a few years we shall undoubtedly meet with facts in the highest Mammals, and even in man himself, which, if not entirely similar, are at least almost analogous. The results at which MM. Dujardin and Natalis Guillot have arrived by the study of the minute structure of the liver, appear to offer a certain guarantee of the success which will attend the investigations undertaken in this direction.

The circulation, therefore, which is at first entirely lacunary, is consequently reduced to a sort of vague agitation, which, as it gradually becomes regulated, assumes a more and more vascular character, in proportion as we rise higher in the animal scale. This is the general fact or tendency which predominates in the progressive development of the circulatory apparatus.

The same tendency is to be met with in organisms in the act of formation, whether we examine the development of a normal germ, or whether we study the manner in which certain accidental tissues are constituted. The *area vasculosa*, in which the embryo of the bird seems to draw the first elements necessary to its evolution, presents at first nothing

more than a sort of membranous disc hollowed out into irregular lacunæ. These may be regarded, according to M. Milne Edwards, as so many small lakes communicating with one another by means of tortuous canals. In proportion as the organisation of the embryo advances, these canals become enlarged, the lakes change into streams, and the canals which had at first been simply hollowed out of the actual substance of the tissues, becoming enclosed, are invested with a tubular membrane, and thus pass into the condition of vessels properly so called. Precisely similar phenomena occur in the false membranes which often supervene on an inflammatory affection of the thoracic organs. Here also the plastic matter becoming organised under the abnormal influence of excessive vitality, gives rise to lacunæ, which becoming converted into vessels, are soon brought into communication with some of the pre-existing branches of the circulating system. In the presence of such an array of facts, derived from wholly different sources, it seems scarcely unreasonable to think that the same order of things may be generally present, and that usually, if not always, a lacuna has preceded a vessel.

Such, indeed, was the conclusion at which M. Milne Edwards arrived in opposition to the cellular theory of Schwann, one of the most distinguished pupils of the celebrated Müller.\* According to the German physiologist, all parts of the animal body have been primarily composed of simple cells. This universal

\* [A sketch of the scientific labours of Professor Müller is given in the Appendix, Note XVI.]

element, by its gradual development and modification, would produce, according to circumstances, either muscular fibres, the parenchyma of the glands, or the matrix of the osseous tissue. According to the same theory, the vessels are in like manner cells, which being at first spherical, become gradually elongated, until, combining together, they constitute by their reunion the thousand vascular ramifications of the body.

This theory numbers amongst its partisans many distinguished physiologists. It is certainly highly attractive from its simplicity, and from the manner in which it enables us to embrace all the phenomena of development, while it establishes the existence of ultimate relations between the two great divisions of organised creation. A similar theory has indeed been long adopted by botanists, who regard it as the expression of all the facts to be observed in plants. We have seen, however, that the case is different with respect to animals, although here we believe that the cellular theory furnishes several useful results. It may be well adapted to guide us in the study of certain animal tissues which present remote relations to those of plants; but when applied to the entire animal kingdom, it can no longer be accepted as true.

We will add another example to those already given. It had long been known that in the *Anodonta*—a species of fresh-water mussel, very common in the neighbourhood of Paris—the heart is traversed by the last portion of the intestine. M. Edwards, moreover, in studying the organisation of the Pa-



tellæ and the Haliotides, has recognised that in these Molluscs, the aorta (or large artery given off directly from the heart) encloses a portion of the buccal apparatus. These curious facts cannot be explained by the cellular theory. Indeed, we cannot understand how a cell, in the course of its development, could enclose, within its interior, organs which had first been situated outside of it; it would rather tend to displace them in proportion as it increased in volume. It is easy, on the contrary, to suppose that these organs which have been formed in the midst of a perfectly free space, must have been surrounded by walls which, being subsequently formed, convert the lacuna into a vessel or a heart.

The general ideas of which we have endeavoured to give a brief abstract, met, as we have already remarked, with a most violent opposition. They were stigmatised with the epithets of incredible, absurd, and ridiculous; whilst many of the facts on which they were based, were regarded as impossible. It was at Paris, we regret to say, that this opposition was most strongly manifested, which would have been worthy of respect if it had always originated in purely scientific and conscientious convictions; but it unfortunately was too often to be attributed to motives of personal rivalry. Foreigners, in a more disinterested spirit, comprehended the value of these results, and promptly recognised and accepted them. The most distinguished physiologists of England, Belgium, Germany, Denmark, and Sweden, gave these questions their most serious attention; and the greater number soon expressed their concurrence

in these newly enounced views. In France, even, the importance of these ideas could not be wholly denied, and they soon forced themselves on the attention of the Faculty of Medicine of Paris, which certainly cannot be accused of any inconsiderate love of scientific innovation. In several of his public lectures, M. Andral developed these new theories, exposed and demonstrated the facts on which they were based, and the important consequences which might result from them by aiding us to arrive at a more exact appreciation of many of the physiological and pathological phenomena which are daily observed in the human subject. We see, therefore, that a careful study of the inferior animals is not to be regarded as purely speculative — a view which is unfortunately still too generally adopted.