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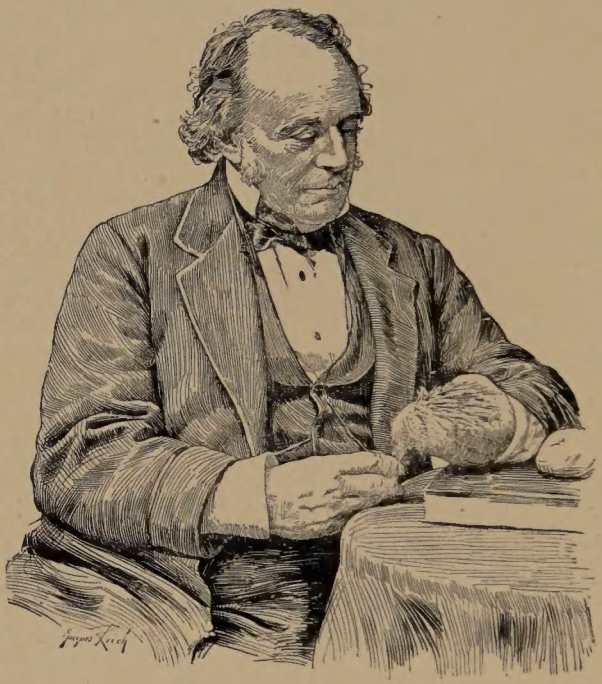

LOUIS AGASSIZ.

Leaders in Science

LOUIS AGASSIZ

HIS LIFE AND WORK

BY

CHARLES FREDERICK HOLDER, LL.D.

AUTHOR OF "THE LIFE OF CHARLES DARWIN," "LIVING LIGHTS," "ELEMENTS OF ZOÖLOGY," "MARVELS OF ANIMAL LIFE," "THE IVORY KING," "ALONG THE FLORIDA REEF," ETC., ETC.

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DEDICATION

In his biographical memoir, read before the National Academy, Arnold Guyot, the life-long friend of Agassiz, said: "Permit me here to allude to one of the providential circumstances of Agassiz's life, which enabled him to perform so large an amount of work, and to do it cheerfully as well as efficiently. I mean his marriage, in 1849, with a distinguished daughter of his adopted country, whom we all know without naming her, and all admire and respect. In this constant and devoted companion of his American life he found a wise and affectionate mother for his children. Her sound and firm judgment, her well-balanced mind, gave him much needed help and encouragement in the midst of sometimes complicated circumstances. Her literary talents, to which we owe the interesting record of his Brazilian journey, the picturesque account of the Florida reefs, and perhaps the final appearance of more than one of his late works, are acknowledged by all. Her deep and absolute devotion, her soothing influence, secured for him the peace of mind and heart so necessary for an undisturbed mental activity. To her also science owes a tribute of gratitude."

TO

ELIZABETH CARY AGASSIZ

THIS VOLUME IS, WITH PERMISSION, RESPECTFULLY

INSCRIBED

PREFACE

THE effect of the teachings and work of Louis Agassiz upon the world has been pronounced and far-reaching, his appearance in America marking the beginning of a new epoch in natural science. Previous to his advent Biology in particular had languished, but from the time of his arrival in Boston a new interest was created. His personality and methods, his reputation as a teacher, investigator, and scientist, took the New World by storm, and without reflecting upon those eminent American scientists who had laboured long in the field, it was his example, his power of teaching, that gave a new and fresh impetus to American science. His indomitable purpose, his industry, his devotion to the dissemination of knowledge, his love for science—which is but another term for truth,—were traits which commended him to all men, and ensured him a lasting place in their affection and appreciation. Agassiz was the greatest teacher of his time, and his place is still unfilled. With Darwin he was the most conspicuous man of his day, rendered still

more notable by his position regarding the origin of man and life. He was the great theistic philosopher of the scientific world in which he lived. He fought with unflagging valour the suggestion that God was not existent in nature; seeing in every animate or inanimate object an evidence of design, in the tracing of every leaf the hand of the Omnipotent. He contested without bigotry the views of Darwin and his school until the very last, and died believing that the advance of time and new discoveries would demonstrate that the mind in nature, which he clearly saw, would be accepted. He was a noble and heroic figure, one of the stepping-stones in the advance of civilization.

In the present volume I have not attempted an elaborate analysis of his life and its effect upon the scientific world, but rather a brief story of its salient features, an impression of the good he accomplished, hoping that younger readers, as well as those of maturer years, may be tempted to emulate the lesson his life presents. In the preparation of the volume I am indebted to Mrs. Louis Agassiz for permission to use certain material contained solely in the *Life* of her husband, which must always remain the authority on this subject; to David Starr Jordan, LL.D., President of Leland Stanford, Jr., University, and to Professor Samuel Garman, of the Museum of Comparative Zoölogy, at Cambridge, for personal incidents in the life of Agassiz, and for suggestions and advice. My thanks are also due the California Academy of Sciences for permission to quote from their memoirs, and to the Boston Natural History

Society for similar favours. I am also indebted to Mr. Darwin, Librarian of the U. S. Geological Survey, for valuable data, and to Mr. Joy Lichtenstein, Assistant Librarian of the Free Library of San Francisco, for the appended bibliographical list.

C. F. H.

PASADENA, CAL., September, 1892.

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AGASSIZ HELPING HIS LITTLE BROTHER ACROSS A CRACK IN THE ICE.

LOUIS AGASSIZ.

CHAPTER I.

THE BOY AGASSIZ.

Birthplace of Agassiz—Boyhood Pastimes—Early Love for Nature—Collections—First Collection of Fishes—The Aquarium—Manly Traits—Inventive and Imitative Faculties—Descendant of a Line of Clergymen—An Ancient Family—Influence of His Mother.

EAN Louis Rudolphe Agassiz was born May 28, 1807, in the little village of Motier by the borders of Lake Morat—a placid sheet of water nestled among the foothills of the Bermese Alps. The locality of his birth was one of sharp contrast: the lake clear and unruffled, the rich green slopes of the hills, the vineyards with their grape-laden vines, gardens of flowers, valleys deep in varied colours, while not far

distant the crests of mighty mountains pierced the sky, gleaming with the snows of eternal winter, telling of the avalanche, *crevasse*, and ancient rivers of ice.

From such a land of varied attractions sprang the ancestry of the greatest science teacher of modern times. "I am Swiss," he once said, "and have been for generations," and it is believed that for three hundred years at least the Agassiz family lived in Switzerland, being originally Burgundian Huguenots, who left France during the acts of injustice and persecution which characterised the reign of Louis XIV.

Louis Rudolphe Agassiz, father of the naturalist, was the sixth clergyman in direct line in his family; a man of strong personality and lovable character. He married Rose Mayor, who lived in the little village of Cudrefin, one of the most attractive places on the borders of Lake Neuchâtel. The Mayors were a sturdy and intellectual race, many being professional men of literary and scholastic tastes. The father of Rose Mayor was a physician, while her brother, Mathias Mayor, was a distinguished surgeon and physician of Lausanne.

The true genius is born, and Louis Agassiz was no exception to the rule. From his very earliest years he evinced a taste for nature and natural objects,—a love that was fostered and encouraged by a devoted mother who, perhaps by intuition, recognised the germ that was to develope and produce such notable results in later years. For the first ten years of his life Agassiz received all his instruction from his parents. His active mind was not overcrowded,

and we find him roaming the fields with his companions, wooing the secrets of nature from the flowers and insects; a merry lad, brave, courageous, earnest and thoughtful. His first collection was a series of fishes representing all the different varieties which he and his companions could find in the vicinity of the village. While other boys collected inanimate objects he showed a strong preference for animal life, and one of his chief delights was the possession of various birds, mice, rabbits, indeed every available creature that he could keep and rear.

As a fisherman he was particularly successful, often disregarding the appliances of his comrades, catching the finny victims in the nooks and corners to which he knew they resorted. In the yard of the Agassiz home a stone basin had been built to receive the water of a spring, and in this the young naturalist placed his finny prizes and watched and studied their habits, taking the first steps in the direction in which in later years he became so justly celebrated.

If any one trait impresses the reader at this period of his life it is his habit of observation, so essential to the successful naturalist. The boy did not confine his investigations to natural history alone, but made incursions into various fields, often displaying remarkable mechanical skill. It was the custom in those days, as it is now in some of the cantons of Switzerland, for the various artisans—tailors, carpenters, coopers and others, to travel about the country, and in the course of the year many stopped at the Agassiz parsonage. Young Agassiz carefully observed their methods of work, and after a visit from

the cobbler astonished his sister by presenting her dolls with carefully-made foot-gear. He made a miniature water-tight barrel after watching the cooper in his father's vineyard, and could have made himself a suit of clothes had it been required, so well did he profit by the stay of the tailor at the homestead.

Such habits did not detract from the manly qualities that constituted a prominent feature in his character. He was, as a boy, bold, fearless, and courageous, as shown on many occasions. His mother cites several instances illustrative of his daring. One day there was to be a fair in the town of Morat, on the opposite side of the lake from Motier, and Louis with his brother Auguste determined to skate over, the lake being about two miles wide at this point. Their mother did not hear of this plan until they had started; then taking her glass to watch them, fearing that the ice was too thin or unsafe, she saw them stop as if puzzled at a wide crack. Louis evidently could cross, but for the younger boy it was too wide. It did not require many moments for the intrepid Louis to solve the problem, and the anxious mother saw him drop upon his knees and reach the other side of the opening, with his hands, thus forming a living bridge over which the younger brother crawled in triumph, after which Louis leaped the fissure and they sped away over the ice, followed, it should be said, by a man-servant, sent by the uneasy parent. Although Agassiz was not sent to school until he was ten years of age, owing to the admirable instruction he had received from both parents, he was well abreast of boys of his age in almost every

AGASSIZ'S FIRST AQUARIUM.

branch of learning, while as for general information few of his companions were his equals. Even at this early age his genius asserted itself in many ways. His young companions recognised the fact that he was different from them, and were in the habit of appealing to him in their games as possibly better able to decide the numerous questions of childhood. In his habits of observation, whether with the collection of fishes in the little aquarium, the insects found down in the vineyard, or the wild flowers on the hillside, he was laying up a store of truths that served him well in later years, and he is said to have referred to the fact that the thoughtfulness with which he made his observations and the tireless labour which he expended upon his work were due to the habits formed in the first decade of his childhood.

These traits were not unnoticed by his elders, and many were the early prophesies regarding the boy, though probably few realised how completely he would fulfil their prophetic sayings. The child's unusual brightness was one reason for his not being sent to school earlier. Having lost two of her boys, his mother was very solicitous for those remaining, and watched their growth with increasing care and tenderness. Home teaching and abundant exercise in the open air was the training the young naturalist received to prepare him for his actual schooldays. From this time until within a few years of the ending of a great and expansive life, Agassiz was, to a greater extent than is generally known, influenced by his mother. She was always his close guide and ad-

viser, and that her wisdom was result-producing is well shown as we follow up the well-rounded epochs which mark his career. It is often said that great men are the sons of noble mothers. In this case it was particularly true: the mother of Agassiz being a woman of great ability and good judgment; a strong and lovable character that left its mark on every step in the life of the naturalist.

CHAPTER II.

SCHOOL DAYS.

Agassiz the Elder—Early College Life—College at Bienne—Vacation Days — Auguste Agassiz — Making Collections — Forming a Library—Village Festivals—Taste for Natural Science—A Manifesto—Agassiz Outlines His Career—Study of Fishes—Rambles in the Fields—First Lectures on Zoölogy.

AGASSIZ the elder, while a clergyman, was prominently interested in educational affairs and had a voice in all matters pertaining to schools; not from any especial desire on his part, but because he had a recognised fitness for the calling. His influence, it is said, was felt as much in the schools of Orbe, Motier, and Concise as in the pulpit, and one of the valued possessions of his descendants to-day is a piece of silver presented him by the municipality of Orbe as a token of their appreciation of his services in the cause of education. It is not surprising, then,

that the clergyman determined that his son should have all the educational advantages attainable; and at the age of ten we find young Agassiz entered as a student at the college of Bienne, twenty miles from Motier, enthusiastic to begin what he considered his real education. The first year at this college, which was conducted by Mr. Rickly, was one of hard study; the daily work requiring nine hours, though the teachers saw that there was an abundance of out-door recreation, so that the pupils, despite the long study hours, became vigorous and rugged.

After a year Agassiz was joined at college by his younger brother Auguste, whose tastes in many ways were similar to his own. A more delightful companionship between brothers can hardly be imagined. When the schooldays ended at the vintage, which was a festival as now in some portions of Switzerland, they together started for home early in the morning, thinking nothing of the twenty-mile walk. The vacation was spent either at Motier or with the kindly old grandfather Mayor at Cudrefin, where some festival was always to be expected and looked forward to. The boyhood of Agassiz was passed in a time when the simple life of the peasantry had not been invaded by modern commonplace, and there was an air of romance about the very ordinary things in life. Even the picking of the grape was invested with a picturesqueness it does not now possess, and was the season of joy and gaiety. Easter was an especially festive occasion. Easter eggs were in vogue then as now, and a singular game was played to determine who should be

king of the feast, previous to which a dance would take place on the green in front of the home of Grandfather Mayor.

During these schooldays Agassiz's love of nature grew more intense and expressed itself in various ways. Late in life he said, "I am conscious that at successive periods of my life I have employed very different means and followed very different systems of study." When about twelve years of age, his methods were very much like many boys of to-day. He possessed a mania for collecting, and rapidly accumulated natural objects of all kinds, while a library grew under the united efforts of the two brothers; Auguste contributing his spending money for this purpose. Agassiz bought such books as he could find, and began a serious attempt to memorise the names of all the animals he collected, believing that the Latin equivalent was essential to complete knowledge. This, he says, seemed to him the highest attainment and legitimate aim of a naturalist, and he accumulated great volumes of manuscript containing the names of all the animals and plants he found, and modestly expressed the hope that in time he might be able to give the name of every known animal.

The young naturalist made remarkable progress during his schooldays at Bienne, so much so as to attract the attention of all his instructors; and during the last year we find his first announcement of a preference for the natural sciences. He already rebelled at the prospect before him of having to enter mercantile life, and outlined his wishes in a paper

remarkable in a boy of his age and showing that his aims and aspirations were lofty from the very first. His manifesto was addressed to the audience of his imagination and doubtless was never intended to meet other eyes than his own. In it he expresses a wish to "advance in the sciences"; also a desire to serve his apprenticeship at Neuchâtel for a year or more, then to enter some university in Germany for a four years' course; and finally to finish his education in Paris. "Then," said this lad of fourteen, "I could begin to write." From this time on all his determination and energies evidently tended in this direction. "I am resolved, so far as I am allowed to do so, to become a man of letters," he wrote; then regrets that he can go no further from a lack of books. He needed "d'Anville, Ritter, an Italian dictionary, a Strabo in Greek, Mannert and Thiersch; and also the works of Malte-Brun and Seyfert," — books which would be considered advanced for boys of much maturer years.

The future of young Agassiz had been planned by his parents, who had decided that when he attained the age of fifteen, he should enter upon a commercial life in the firm of his uncle at Neuchâtel. That they also saw the dawning capacity for a totally different field of work is not improbable, as when the time came they readily granted a delay of two years, during which Agassiz was to study at the college of Lausanne,—a movement fatal to their hopes of making him a business man, as during this period he developed rapidly, and despite difficul-

ties which would have daunted many an older man, entered upon the life of his choice.

Agassiz was about fifteen years of age when he entered the college of Lausanne. Here he devoted himself more and more to the sciences, in which he was aided and encouraged by scientific men, among whom was Professor Chavannes, Director of the Cantonal Museum, who was the possessor of a collection that delighted the young student and who gave him privileges he had never dreamed of. All the time he could spare from his studies was spent in the woods and fields searching for favourite specimens, or studying their habits. Insects were obtained from the bark of trees and old refuse; every stream and pond was made to deliver up its finny treasures, which were bred and studied, while the transformations of his cocoons into butterflies, was a constant delight. At home, during his vacations, the house was turned into a veritable museum, while his rooms at college were laden with the results of forages in field and stream. "What I know of the habits of the fresh-water fishes of Central Europe," he says, "I mostly learned at that time."

It was while at Lausanne, in 1823, that Agassiz listened to his first course of lectures on zoölogy, which he describes, with just a suspicion of sarcasm, as consisting chiefly of extracts from Lamarck and Cuvier. Brief and unsatisfactory as may have been these lectures, they resulted in imparting a new zest to his studies and in pointing out the false standard he had raised. He now found that to name an animal correctly was a very unimportant matter, and

appreciated for the first that the various authorities upon whom he was relying for information, differed in their views regarding the classification of animal life. He at once saw the opportunity for himself: he, too, could express an opinion as to classification. The only essential was knowledge of anatomy, and to obtain this he began the study of medicine that, as he has written, "I might see for myself where the truth was." The young student was aided in this by his uncle, Dr. Mathias Mayor, who had long been attracted by his great promise and who consulted with his parents and advised them to allow him to study medicine and become a physician, this profession evidently being more to his tastes. They did not require much urging, and, as a result, Agassiz's prospects for a business career had an abrupt ending, and he entered the medical school at Zurich with enthusiasm, determined to move rapidly on to a high position in the field of his choice.

CHAPTER III.

CHARACTERISTICS AND HABITS.

Appearance of Agassiz—Strong Personality—Captivates a Stranger—Filial Affection—Meeting Well-Known Naturalists—Love of Books—Copies Made—Determination of Character—Habits of Study and Observation—The Home Collections.

AGASSIZ was now a youth of commanding appearance, tall, strong of limb, robust, his fine head, broad forehead with expressive eyes set well apart — characteristics that attracted attention and must have created the same impression upon his comrades that they did upon the writer when he first saw him in the early sixties. One insensibly felt himself in the presence of a man of true greatness.

The strong personality of the youth is well illustrated in an incident which occurred while he was a medical student at Zurich. It was the custom of the

two brothers, as we have seen, to travel over the country afoot, returning from their vacations in this way. During such a journey a gentleman passing in his carriage noticed the boys and requested them to join him at lunch, which he carried. They accepted the invitation and were soon unfolding their confidences to the courteous stranger, who was especially attracted to the older boy; so much so, that some days later, when the lads had returned to Zurich and the incident had almost passed out of their memory, a letter arrived at the parsonage embodying a request from the stranger that he might adopt Louis, further stating that he was a man of wealth, a resident of Geneva, and that he would undertake the entire expense of the young man's education. Such an offer, which meant not a little, to a family of moderate means, was most tempting; but filial love and affection won the day, and the young man declined even by inference to sunder any of the ties that bound him to home and family.

This faculty which Agassiz seemed to possess, of attracting and impressing all with his mental vigour and charm of manner as well as his tastes for the sciences, now brought him into contact with men older than himself, all of whom aided in maturing his mind and giving him a stimulus in new channels. Among those who took an immediate interest in his work and future, was Professor Schinz, a distinguished scientist of the time, who was his professor in natural history and physiology. Professor Schinz invited him to his home, introduced him to other

naturalists, and gave him his first impetus in the actual field of original investigation. He was the possessor of one of the best libraries in the city and was an ardent ornithologist. Agassiz was given the privilege of his books and collections and at once began to reap the harvest.

In the present day of cheap books and public libraries, when every village has its collection, it is difficult to realise the conditions that prevailed during the boyhood of our hero and the struggles which he had to surmount in the attainment of knowledge, and in this we see the strong features of his character—determination and thoroughness. His parents were by no means rich, and were straining every point in keeping the two boys at school, and had little or no money for any incidentals or luxuries. Books, then, no matter how cheap, were impossibilities; yet this did not deter the young naturalist. If he could not own the books he could at least copy them, and this is what he did, his brother aiding him, and hours were spent in this arduous work by both boys, Auguste's devotion to his brother making it a labour of love. In after years, Agassiz, in commenting upon this lack of books, expressed the belief that it was really an advantage as it prevented him from relying too much on them; their absence forcing him to investigate for himself.

The work accomplished in this way by this youth of seventeen or eighteen is a monument to his patience, and deserves the especial attention of my younger readers. What young man of to-day would be willing to copy a bulky volume for the sake of

owning a copy? yet Agassiz did this on many occasions. As an example of his indefatigable industry, he copied two volumes of Lamarck's *Animaux sans Vertèbres*, Auguste copying almost as much more for him.

While ostensibly devoting himself to the study of medicine, Agassiz undoubtedly paid most attention to the sciences of anatomy and zoölogy. He passed much time in the company of Professors Schinz and Hirzel, accompanying them in their trips and spending happy days in the intercourse of nature, rendered so much more delightful by the association of congenial spirits.

The room of the two boys, who lived in a private family, was a perfect museum: the corners and shelves heaped with shells, stuffed fishes, plants and specimens of all kinds, while from window and door-top came the notes of various feathered songsters that here made their home. Agassiz had over fifty birds alive in his room at one time, living examples for study, and from which he turned to the collection of mounted birds owned by Professor Schinz. Each species he carefully described, this being in his estimation a necessity, as he did not have the means to purchase even the most inexpensive treatise on birds.

When not engaged in study the brothers took to the field and forest. Every stream and lake was familiar to them, while every secret nook and corner famous for its fish was known.

They knew almost to a day when the birds re-

turned or left and where the various kinds built their nests. The life histories of the various animals were their novels, and the accidental death of their pets the tragedies of their lives.

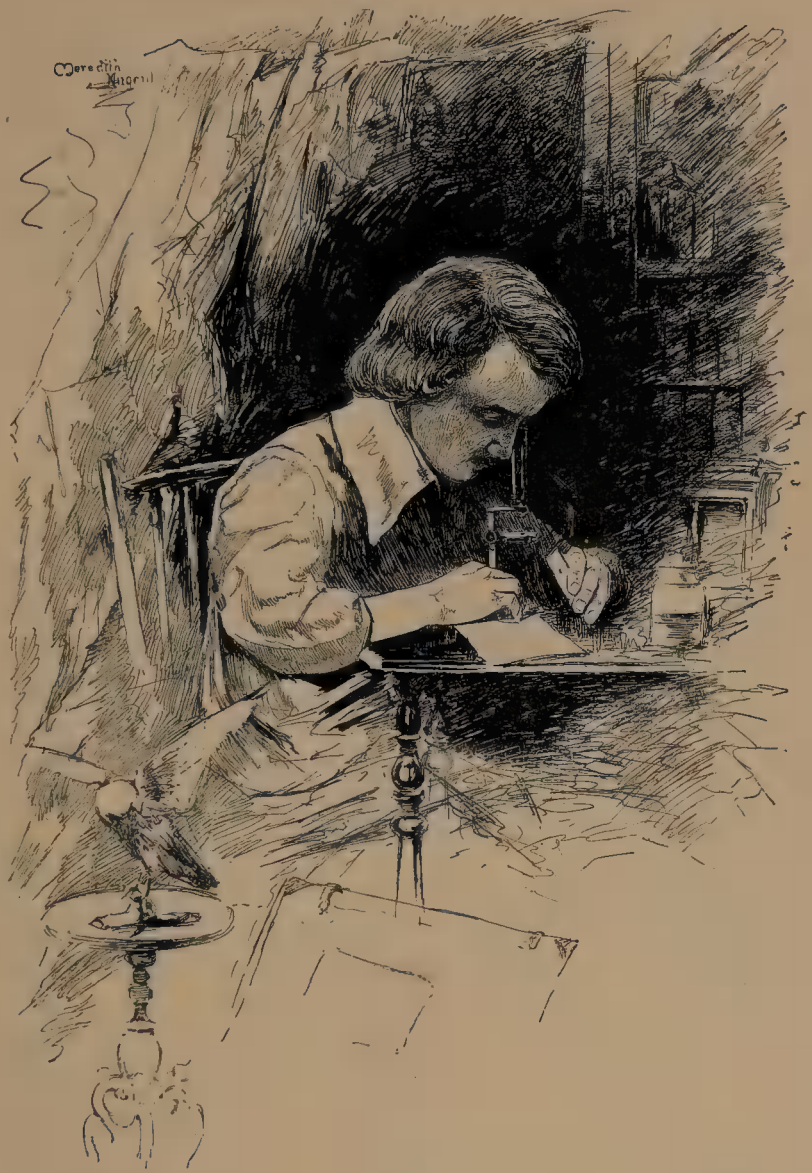
CHAPTER IV.

AGASSIZ AT HEIDELBERG.

Early Associations—Reasons for Entering Heidelberg—Studying the Collections of Tiedemann—Agassiz and His Friends—An Accomplished Linguist—College Life—How the Honors Were Divided—Physical Exercise—Strong Religious Convictions—Collecting Fishes.

THE lives of men are to a greater or less extent moulded by early associations. Agassiz was particularly fortunate in his friendships, and in his youth had immediate contact with men distinguished in various branches of learning that undoubtedly had no little influence in shaping his later career.

Agassiz not only appreciated this, but he entered Heidelberg University in 1826 that he might profit by the direct association with men who figured in the professions in which it was his purpose to excel. His work was laid out, his plans formulated, and



AGASSIZ AT NINETEEN.

with remarkable prescience he took advantage of every point that would aid in his laudable ambition. The men who influenced his career were Leuckart, Tiedemann, and Braun.

Tiedemann placed his collections of books and specimens at his disposal, while the famous zoölogist Leuckart encouraged him in every way, imparting the enthusiasm that was so prominent a feature in his own character. Leuckart was a daring spirit, and his lectures encouraged the advanced students to move on for themselves into the unknown, to theorise and draw inferences from their own investigations. He was one of the rare men of that or any day who could make what are generally considered prosaic studies interesting and even delightful to the masses, —a faculty which Agassiz possessed later in life to an eminent degree.

With Leuckart Agassiz continued his studies in animal life; with Bischoff he rambled over the fields, learning botanical wisdom from this eminent authority. Sometimes they spent the day among the flowers; again it was with the microscope, studying the pollen or smaller forms. From Braun he received the first inspiration which made him the palæontologist he became; and in this scientist's collection of fossils he delved, storing up facts which became of use later on.

Agassiz was now not merely a scientist; he did not neglect other studies for rambles in the field. Even as a boy he was an accomplished linguist, speaking French and German so fluently that he would think in one language and express himself in

the other, while Latin, Greek, English and Italian were all familiar to him.

The school life of the young student at Heidelberg was a season of constant endeavour to perfect himself in the various branches of study. He had selected a boarding-place that had many of the attractions of the home at Motier, it being in the faubourg of the city which his window faced, while at the rear was a fine garden with trees and shrubs which Agassiz soon found abounded in birds with which he was familiar. His habits were severe and methodical, and his strict manner of living shows that he had himself under complete control. An early riser, he breakfasted at half-past six, and less than an hour later was listening to the lectures given in the Museum. There was no recess in the modern acceptation of the word, as if half an hour was gained from lecture or lesson it was devoted to a study of the anatomical preparations or to some special investigation suggested by Professor Schinz. After this and often before the hour previous to dinner, Agassiz practised fencing with a friend, believing that it cultivated the eyes as well as all the faculties; and that he accomplished so much in later years was undoubtedly due to the fact that he took an abundance of physical exercise with the mental.

After dinner at one, Agassiz with some friend would stroll through the country for an hour, then returning to study until five, when a lecture by the Chancellor of the University occupied an hour. This was followed by a walk, or by a bath in the Neckar. The evenings were devoted to study until

nine o'clock, when with some companion he perhaps visited the Swiss Club. Such was the life of the young naturalist day after day.

In later life Agassiz was distinguished among naturalists by his strong religious convictions, and it may be said that from his earliest days he showed these predilections and possessed a mind of singular purity. This is well illustrated in his letters to his parents during his college life, which reflect the high moral tone which pervaded his nature. Alone he held his evening service after retiring, and in silence communed with the distant loved ones, talking to or with them, as he expressed it, in the conviction that those at home also held him in their thoughts.

Warm-hearted, with a magnetic manner, lovable in the best sense, it is not surprising that Agassiz made at this time many sincere friends, and that the association often benefited both is well shown by the zoölogical knowledge of Braun, who in later years became the famous director of the Botanical Gardens, Berlin, and the fund of information possessed by Agassiz on botanical subjects.

Young Braun was captivated with his new comrade and particularly impressed by his charm of manner. He describes him to his family as "a rare comet on the Heidelberg horizon," and was never weary of extolling his praises. He was attracted by the breadth of Agassiz's reflections and by the intimacy he seemed to have with all natural objects. He remarked with surprise that the young man from Orbe was familiar with the name of every animal they met, could tell a bird as far as he could hear its song.

The friendship of the young men grew apace and was of an ideal character. Agassiz had parted with his brother, who had entered commercial life, and all his affection was poured out at the new shrine. Braun was as studious and earnest in the pursuit of knowledge as Agassiz, and the companionship benefited both. To show how they utilized time, they agreed that when one was engaged in mounting a bird, pinning an insect, or pressing a plant the other should read aloud; in this way they jointly read a number of important books in various departments of science. Young Braun had a friend, one Karl Schimper, also a botanist, who was equally captivated by the frank and ingenuous manner of Agassiz, and a strong friendship was soon formed between them.

The university life of Agassiz at Heidelberg was interrupted by his illness in 1827, and after many days of great danger Braun took him to his own home at Carlsruhe, and later saw him safely to Orbe, where in his invigorating native air he soon recovered.

To stimulate interest and communicate to each other the facts they drew from their several fields of study, the young men during Agassiz's convalescence were in the habit of asking each other questions by mail. Thus Braun propounded puzzling questions to Agassiz in botany, while Agassiz in return gave him problems in zoölogy to solve.

All during the year 1827 Agassiz was pushing his investigations in every possible direction. He made some elaborate studies with frogs and toads, his sister making the drawings. His interest in insects was accelerated by an acquaintance with the pastor

of Vallorbe, who had a collection of three thousand specimens. While at Neuchâtel he made a careful study of the fishes of the Swiss lakes, making discoveries that attracted the attention of the scientific men of Europe. He made an extensive collection of fishes, preserving some in alcohol, while others he mounted, his work being distinguished for its excellence. He also made many corrections in the classification of fishes. Fishes that had been named twice he carefully noted, and one of his papers written at this time contains a list of all the fishes he had found and the lakes from which they came, while other papers of equal interest showed the most unflagging enthusiasm.

CHAPTER V.

THE LITTLE ACADEMY.

In Munich—The Journey—Stuttgart Museum—The Little Academy—First Lectures—An Audience of Learned Men—A Room and a Museum—Daily Routine—Objections to a Medical Career—Desire for Travel.

IN August, 1827, Agassiz received a letter from his friend Braun announcing that he had decided to go to Munich and inviting him to join him. The inducements held out were free lectures, lodgings as cheap as at Heidelberg, theatre open to students at a very moderate sum, and the association of such men as Oken, Schubert, Fuchs and others, not to speak of rich museums for study and observation.

Agassiz had already cast longing eyes at Munich. He believed that up to the present time he had neglected his philosophical education, and now saw in the suggestion of Braun an opportunity to recover

the lost ground. The offer was accepted with pleasure, and the latter part of October, 1827, found the two friends together again, journeying from Carlsruhe to the University of Munich. The trip was a most enjoyable one for the young men, and for Agassiz the longest and most important of his life. The way led through Stuttgart, where for the first time he visited a large and well-appointed museum, the fine collections of which greatly impressed him, many specimens being entirely new. The mammoth attracted his attention, and in a letter to his brother he referred to it as a "carnivorous animal," a belief entertained by naturalists at the time. From Stuttgart they journeyed to Esslinger, visiting Hochstetter and Strudel, two distinguished botanists of the day, with whom they exchanged specimens to their mutual advantage. At Goeppingen they tarried to visit the owner of a fine collection of fossils, also one of shells not known to him, from the Adriatic, which the young men arranged and labelled for their host, receiving some of the shells in return. In every place, from Ulm to Augsburg, the travellers saw something to interest them, and doubtless the trip terminated with regret.

We find Agassiz soon domiciled in Munich at the Sendlinger Thor No. 37, a locality now famous for its association with the great naturalist. The house was beyond the strict limits of the town, convenient to the Anatomical School and Hospitalwhere Agassiz studied, and, better than all in his estimation, commanding a view of the Tyrolean Alps which he loved so well.

This movement of Agassiz may be considered one of the epochs in his eventful career. He was like a swelling seed ready to develop and produce the perfect plant upon the application of the right stimulus, and this came in the association at Munich with some of the most brilliant specialists of the day. Agassiz thus referred to this in later years:

"I cannot review my Munich life without deep gratitude. The city teemed with resources for the student in arts, letters, philosophy, and science. It was distinguished at that time for activity in public as well as in academic life. The King seemed liberal; he was the friend of poets and artists, and aimed at concentrating all the glories of Germany in his new university. I thus enjoyed for a few years the example of the most brilliant intellects, and that stimulus which is given by competition between men equally eminent in different spheres of human knowledge. Under such circumstances a man either subsides into the position of a follower in the ranks that gather around a master, or he aspires to be a master himself." He daily met kindred spirits, men who were not slow in recognising the slumbering genius. Here were Gruithuisen the brilliant astronomer, Fuchs the mineralogist, Oken, Martius the botanist, Schubert, whose name as a zoölogist still lives, Starke, Seiber, Döllinger, and others. From each he drew some inspiration, and often referred in after years to these old instructors, giving this or that one the credit of instilling into his mind the germs that produced such rich results. Döllinger was the professor of anatomy and physiology, re-

markable for the accuracy of his work; everything that he did was well done. From his deductions there was, as a rule, no appeal, and from him Agassiz learned habits of accuracy and care in all his observations and to weigh cause and effect. Döllinger also had a marked effect upon his career. His methods were peculiar and original. He cared nothing for posthumous fame; rarely if ever communicated the results of his observations to paper, preferring to distribute his fund of information by word of mouth, satisfied if it was taken advantage of by his pupils, who often elaborated his ideas and produced important results. In referring to this much beloved tutor Agassiz says: "I could enumerate many works of masters in our science that had no other foundation at the onset than inspiring conversations with Döllinger."

From Oken Agassiz received much valued mind training. It was from him that his first tangible ideas of classification were obtained, while the finished lectures of Schilling gave him ideas not only of facts in nature but of style in delivery.

The student life of Agassiz was an ideal one; associated with men of the highest mental status as his teachers, and surrounded by many admiring and enthusiastic friends, the days passed only too quickly. It was the custom of the students to make excursions into the country together and to tarry at various places to discuss their observations and discoveries. Döllinger was often their companion and took an active interest in their studies, while one evening of each week they were invited to the

homes of Oken and Von Martius. As might be expected, Agassiz's room was the headquarters for all these congenial souls, and gradually their meetings took a definite form, and the young man began in turn to assume the rôle of lecturer to the others, thus obtaining practice which became of value in after years.

This association of kindred spirits in Agassiz's room became known as "The Little Academy," and from it graduated some of the most distinguished scientists of the day. These meetings were red-letter days in these young lives. The room in which "The Little Academy" held its sessions would contain about twenty. Here we may imagine young Agassiz reading a paper upon the fresh-water fishes of his native lakes, or dwelling upon the wonderful transformation of the tadpole into the adult form, while Braun, Schimper, Michahelles, Mahir, and other friends listened with rapt attention. In the background, with appreciative ear, perhaps sat Döllinger, Oken, or Von Martius, who gravely smoked their pipes while words of wisdom fell from the lips of the young naturalist. No picture in the youth of Agassiz has a more dramatic interest than this, when the very Solons of science sought the friendship of the young man and listened with pleasure to his utterances.

The university days were well apportioned. Agassiz was up literally with the birds he loved so well, and after a sunrise breakfast was away to the hospital for work in surgery, the lesson lasting from eight to nine. From then until eleven o'clock he

usually spent in the library poring over the works which related to the studies of his choice. From eleven until one the university lectures were attended, after which with Braun or Schimper he dined at some restaurant. From two until five came other lectures, varying with the day; then the friends went for a long walk, renewing their studies upon their return and dining at nine o'clock at some café as was the custom of the students. This was the daily life of Agassiz, varied only by the meetings of "The Little Academy" and occasional excursions into the country.

It was at one of the meetings of "The Little Academy," that Agassiz determined if possible to go to Brazil some day,—a dream eventually fulfilled.

The desire was created by Martius, who gave an interesting discourse upon his famous journey to that country and the large collection he made.

Agassiz was ever on the alert for new discoveries and while at college added not a little to general zoölogical knowledge. Friday was then as now "fish day," and the markets were well supplied with representatives of the finny tribe that offered a special inducement to the members of "The Little Academy," and the specimens were well and carefully examined on those days, often to the amazement of the dealers, who wondered what these young men saw in a common fish to talk so much about, to draw, and count its fins and even scales. Agassiz frequently found rare specimens among the fish, and once an entirely new species to repay his ardor.

The room of "The Little Academy" almost daily

received additions in the way of natural-history specimens and was a veritable museum: bottles of strange insects, stuffed birds, skins of animals, boxes of botanical specimens, fossils, rocks, woods,—everything to delight the eye of the collector.

Agassiz had formed the acquaintance of Dr. Born, and in addition to his regular work he engaged with him upon a natural history and anatomy of the fresh-water fishes of Europe. With all this he found time to interest himself in various other matters, one being the "Vaudois Society of Public Utility," in which his father took an active interest.

He soon became restive in the college work. Progress was too slow for him, and even now, while hardly twenty-one, he longed to branch out and find wider fields. He had determined if possible to make the natural sciences his life work, the profession of medicine being regarded by him with but little enthusiasm. Any digression from this object, however, was discouraged by his parents, and he promised them that he would exert himself to the fullest to take the degree of M.D., which to them was assurance of a future with possible tangible results.

CHAPTER VI.

THE YOUNG AUTHOR.

Influence of Von Martius—Offer of the Work Left by Spix—Hesitation and Motive—An Intended Surprise—Discovery—First Artists—Scholarly Men as Intimates—Consent of Parents to a Scientific Career.

F all the professors under whom Agassiz studied at Munich none influenced him and his future life more than the genial Von Martius, whose stories of adventure and incident in foreign climes had the greatest charm for the young students. Von Martius had enjoyed superior facilities and the friendship of the King of Bavaria, who in 1817 sent him and Spix to Brazil to explore the country in the interest of science. Von Martius made a specialty of plants, and after his return published a finely illustrated volume upon his discoveries, while Spix issued works on the mammals, birds, and reptiles.

The intention of these naturalists was to complete the natural history of Brazil—a magnificent project, but before it could be accomplished Spix died. Upon Von Martius devolved the responsibility of finishing this great work, and he was in the midst of some perplexity as to who should describe the fishes when Agassiz appeared upon the scene. Von Martius soon recognised his ability, especially in the department of ichthyology, and finally astonished the young man by suggesting that he undertake the work.

At this time Agassiz was but twenty-one years of age, and the tender of so important a commission by so distinguished a naturalist was an honour well calculated to turn the head of an older man. Here was the goal of authorship well within his grasp, and to say that he received the offer with delight but faintly describes his actual sensations. Yet Agassiz did not accept immediately, and in his hesitation we have a glimpse of the real nobility of his nature. He knew that his parents earnestly desired to see him a physician and surgeon, yet every day he felt himself by taste, sentiment, and his surroundings drawn in an opposite direction where a possible future as a scientist seemed to beckon him. The proposition of Von Martius was the opportunity of a lifetime, the successful accomplishment of which would give him an immediate name and fame. Yet he took days to consider the offer, thinking that the work would possibly take him away from the studies in which he knew his parents wished him to excel. He finally decided that he could undertake the pub-

lication in justice to himself and his parents, and concluded to say nothing about it to them until it was completed, then giving his family the surprise that their son while yet a student was a distinguished author.

It was this work that prompted him to make the following proposition to his father: "If during the course of my studies I succeed in making myself known by a work of distinction, will you not then consent that I shall study, at least during one year, the natural sciences alone, and then accept a professorship of natural history, with the understanding that in the first place, and in the time agreed upon, I shall take my doctor's degree?"

To this his father replied: "Let the sciences be the balloon in which you prepare to travel through higher regions, but let medicine and surgery be your parachutes." All the young author's evenings were devoted to the work on Brazilian fishes, which he wrote in Latin, but the pleasant surprise he had planned came to a sudden ending. Dr. Schintz, who knew what Agassiz was doing, was visiting Lausanne, when meeting the father and uncle of the latter he delighted them with his praises of the young man, who he said was sure to attain fame. Not knowing that the work was a secret he referred to it in glowing terms, much to the surprise of the father and uncle and to the regret of Agassiz, who soon heard of the disclosure from his brother, who offered congratulations and said: "In all frankness I can assure you that the stoutest antagonists of your natural-history schemes begin to come over to your

side. Among them is my uncle here, who never speaks of you now but with enthusiasm."

The spectacle of a young student of twenty-one writing a book on Brazilian fishes in Latin, while pursuing a course of surgery and medicine was a remarkable one then and would be equally so to-day. Agassiz was soon recognised as a leader by his fellows, and so lovable and kind was his disposition that he had their friendship as well.

The work of Spix required the services of an artist; and J. C. Weber was engaged and later Joseph Dinkel, both of whom were associated with Agassiz for many years. The latter is described by one of the artists as being at this time a most exemplary and lovable person; always bright, never ill-tempered, and with a cheery word for every one. He enjoyed the club life and merry times with other of the students but never was an active participant, rather holding himself aloof, being reserved and dignified in his demeanour. His intimate associates were the scholarly men who were known to each other in "The Little Academy" by such nicknames as Cyprinus, Molluscus, Rhubarb, and others. Let it not be understood that Agassiz was a prude, or over dignified from a false sense of superiority; nothing could be further from the truth. He was manly, brave, open hearted and handed; a nature's gentleman in every sense of the term; a youth in tastes and desires but a man in ambition. All his mental faculties seemed to have developed early, and while not yet of age the desire to become eminent was firmly implanted and grew day by day.

To his artist companion he said when commenting upon young men who wasted their time, "I will be a leader of others"; and to his father: "Here is my aim and the means by which I propose to carry it out. I wish it may be said of Louis Agassiz that he was the first naturalist of his time, a good citizen, and a good son beloved of those who knew him."

Agassiz now longed to graduate and embark upon some exploring expedition which would give him a wide field. The work on fishes had attracted the attention of naturalists, and, fortified with the commendation of his instructors, he appealed to his father to allow him to turn all his energies to natural science and to make his profession that of a scientist. His letter to his father, presenting the various arguments, shows the energy and ambition which animated him. He referred to various expeditions which were about starting, notably that under Humboldt, and expressed a wish to join one. So completely had the idea seized him that for months he had been literally in training for the proposed trip to foreign lands. He even went so far as to train a friend and comrade, William Schimper, as an assistant and hunter, and the two youths passed many happy hours in their imaginary adventures in the cause of science. A skilled taxidermist, he practised in all the other arts that would be required. He frequented a blacksmith's shop to familiarise himself with tools; practised with the sabre and other weapons, being already a fine fencer. Long walks were taken until he could travel for thirteen leagues a day for a week in summer, carrying a heavy load, all to

prepare himself for the forced marches which he supposed would be a part of the explorer's life.

Such was the intense ambition of Agassiz at this time, and we need not be surprised that his parents finally relinquished the idea of seeing him a physician and consented that he should follow the line in which he was drifting. He was now free to look forward to a future in accordance with his wishes. He felt sure that the work on fishes, upon which he was engaged, would give him a reputation that would place a professorship within reach, and he bent all his energies to obtain the degree of Doctor of Philosophy; principally because it would aid in the professorship, and because Martius desired him to have a prefix to his name on the title-page of the great work on fishes. Agassiz, Schimper, and Michahelles all made application for examination at the same time, addressing the Faculty in long letters in Latin to that effect (as Agassiz naïvely said, "Because, you know, among savants it is the thing to speak and write the language you know least"). Permission was granted the young men and they were put on honour not to obtain aid in any way from outside sources. The examination was by no means easy, yet Agassiz passed it with honour, and so became a Doctor of Philosophy at the early age of twenty-one years.

The first part of the *Brazilian Fishes* was now published,—a proud event indeed for the young author. The first copies were sent to Cuvier, to whom it was dedicated, and the second to his parents, who were more than delighted at the first great effort of their

son. We can well imagine the satisfaction and pleasure of the young author upon seeing the commendatory notices in the press of the day, upon receiving a long letter of thanks from the great Cuvier, and upon hearing that his parents were offered congratulations from all sides at the great work accomplished by their son. The feeling at home is happily expressed by the last line of a letter from his father, who, after referring to his pride and joy, wrote: "The old father who waits for you with open heart and arms sends the most tender greeting."

The author of an elaborate work, with the title of Ph.D., Agassiz now turned his attention to securing the degree of M.D., which he had promised his parents; yet he did not neglect his science studies. The fascinations of Rondolet now absorbed his attention, and he was greatly impressed with the knowledge displayed by this naturalist. Linnaeus was not to his taste, while Aristotle delighted him, his books always possessing a charm for him. In after years he gave Linnaeus the appreciation this great naturalist deserved.

Certain occurrences gave Agassiz a special interest in the profession of medicine at this time, and he took up the study with all his accustomed energy and enthusiasm. He began a special course of study with Euler, the two spending many evenings together reading medical books in French and German. Yet the natural-history studies were not neglected, the work on fishes still occupying his attention, and a collection of fossil fishes sent him by the

Director of the Munich Museum gave an additional zest to the study. It is most interesting to note in his letters to his family the honest determination to obtain his degree of M.D., though it was always secondary, in point of fact, to his zoölogical studies. Agassiz's means were extremely slender, yet he found a way to employ two artists, paying them out of his modest allowance. Frequently after paying them he dined himself at the cheapest *café* he could find, expending but a few cents for his repast.

During all these struggles Agassiz was always the same manly, good-natured, studious youth, with an ambition that never flagged or diverged from the one object to which it was directed. That a young man of his years could produce so much work is almost incomprehensible, yet nothing was neglected, and we find him moving along in two general lines—one leading to the profession of medicine, the other to that of the scientist. His scientific work, as we have seen, attracted the attention of scientists everywhere and is best known, as he ultimately made that his choice; yet had Agassiz chosen the field of medicine he undoubtedly would have become distinguished, as his work in that direction as a student was phenomenal, over seventy-five theses on anatomical, surgical, obstetrical, pathological, and other subjects having been written by him, showing a remarkable amount of research, thought, and investigation.

A short time previous to graduation Agassiz submitted his books on fresh-water and fossil fishes to a publisher, Mr. Cotta of Stuttgart, making a

demand for 20,000 Swiss francs. In the latter part of March, 1830, his examination began, occupying nine days. At the termination Agassiz was requested to leave the room; when recalled he was informed by the Dean of the Faculty that they were much pleased with his answers and congratulated themselves that they could give a diploma to one who had already become so distinguished. In a letter to his mother, Agassiz said: "Dear mother, dismiss all anxiety about me. You see I am as good as my word." And so he was, as on April 3d, he received the coveted degree and became a Doctor of Medicine.

CHAPTER VII.

CLIMBING THE LADDER.

Struggles of a Young Doctor—Work upon the Fossil Fishes—Looking toward Paris—Arrival in that City—Cuvier—Meets Humboldt—A Strange Dream—Death of Cuvier.

AGASSIZ was now twenty-three years of age, a Doctor of Medicine and of Philosophy, a man of science, with a name already known throughout Europe, the author of a volume on fishes, and another book in press, for which he received a liberal fee, and with this prestige we find him passing out of the university and returning to his home to enter upon the actual struggle of life. He established himself with his artist, Mr. Dinkel, in Concise where his parents had removed, and laboured hard for nearly a year, endeavouring to establish a practice while continuing the work on fossil fishes, the desire for untrammelled work in pure science growing stronger and stronger. His ambition

was to go to Paris, which was then the centre of scientific thought, and finally he determined to make the effort. His uncle came to his rescue financially, enabling him to undertake the journey, though under circumstances that were not particularly encouraging.

Agassiz arrived in Paris with his artist on the 16th of December, 1831, and was more than delighted at receiving immediate recognition from some of the eminent savants of the day. Cuvier invited him to his home and introduced him to scientific Paris, which extended to him a warm welcome. He established himself near the Jardin des Plantes and plunged into scientific work with his accustomed ardour. His daily life in Paris is described in a letter written at this time, which shows how indefatigable was his energy. In the morning the clinical lectures occupied his attention, and in the afternoon he visited the Museum of Natural History, remaining there the rest of the day. After dinner he devoted himself to his medical studies, as he had decided to pursue them together with the scientific course.

From this time on we find Agassiz's life influenced by association with the great minds of Humboldt and Cuvier. The latter recognised at once the genius of the young naturalist and made every effort to aid him, and it was not long before he offered Agassiz and his artist a nook in his own laboratory where he could watch and encourage him. Agassiz was diplomatic, and it may be said had determined upon the conquest of Cuvier before going to Paris. He knew that the eminent scientist was contemplat-

ing the publication of a work on fossil fishes which would materially interfere with his own plans. He had a faint hope that Cuvier would turn his work over to him or possibly invite him to join in the authorship; and to equip himself as well as possible he had obtained all necessary data and material before going to Paris. Agassiz, who could not brook the slightest delay, upon the very first day of his arrival in Paris took his manuscript to the scientist and explained what he had done. He was gratified to find that Cuvier was surprised and pleased, and far from having any feeling that the young naturalist was encroaching upon his domain, he gave Agassiz access to his treasures, and when assured of his capability renounced his own work and handed over his notes on British and other fossil fishes, requesting Agassiz to make full use of them.

That Agassiz was delighted need not be said, as for a young man to be given the confidence of the greatest scientist of the day was indeed an honour. It did not turn the head of the young Swiss, however; its effect was to spur him on to still greater effort and to impress upon his mind the fact that there was more than ever need for him to work and render himself a credit to those who placed this implicit confidence in him. His duty to himself, to the world, to become a great teacher of science was never lost sight of, and shortly after this he wrote to the loved ones at home: "I work regularly fifteen hours a day, sometimes even an hour or two more, but I hope to reach my goal in good time."

His daily life now and his association with Cuvier

was a delight; a period often looked back upon in later years as one of the bright spots in his career. In all probability, Agassiz's friends did not appreciate the poverty of the young student at this time, and his struggles to pay his artist and actual expenses and make a presentable appearance were truly heroic. Some idea of his condition is obtained from a letter to his brother in March, 1832, in which he apologises for not sending him a book which though costing but little would have left him penniless. Agassiz had an income of forty dollars a month. Out of this he paid his artist about twenty-five dollars, leaving him fifteen dollars for maintenance. This lack of sufficient means was a serious drawback in every way, and he found himself so reduced that he was ashamed to present certain letters of introduction having no suitable coat. There is no doubt that at this time he often without a murmur denied himself proper food that he might store his brain with toothsome facts. A new species of fossil fish, doubtless, sometimes constituted his mental dinner, his eyes feasting upon it while the inner man vainly protested.

Nothing could tempt him from the path laid out, and at this very time he refused a position as editor of the zoölogical section of the *Bulletin*, which would have given him an income of two hundred dollars, because it would take two hours a day from his studies. His parents, who knew of his financial condition, entreated him to leave Paris; but he would not consent, and put off the loved ones with many excuses often ingenious if not pathetic.

He was now working upon a fossil fish which is known to-day as *Cyclopoma spinosum*, and to be seen in *Recherches sur les Poissons Fossiles*, vol. iv., tab. 1, pp. 20, 21. For a long time it puzzled him, and he put a more than ordinary amount of work upon it; but one night, after having laboured over the problem, he awoke feeling that he had seen the characteristics of the fish which he had been so long vainly endeavouring to determine. He sat up in bed, wonderingly trying to recall the dream; but it passed away, leaving merely a strong impression. The following night the dream was repeated, but eluded him again. On the third night he prepared for the recurrence of this singular psychological phenomenon, by placing paper and pencil by the bedside. Again the nocturnal mental picture was presented, and, half awake, the young naturalist traced in the darkness, as well as he could, what he considered an improbable outline of the fish. The day following he took his sketch to the Jardin des Plantes, and by using the midnight and mysterious sketch as a guide he cut away the stone and found identical characteristics hitherto unknown hidden away, making his work of classification an easy one.

Agassiz now lost his good friend Cuvier, whose last words to the young student was the warning, "Be careful, and remember that *work kills*." The day following the warning, Cuvier fell, on his way to the Chamber of Deputies, stricken with paralysis, and France lost its greatest naturalist.

CHAPTER VIII.

AGASSIZ AND HUMBOLDT.

Friendship of Humboldt—His Influence on the Life of Agassiz—Discouragement—Aid from an Unexpected Quarter—Humboldt to the Rescue—The New Book—A Professorship Offered.

THE death of Cuvier fell with no little weight upon the young naturalist. It meant the loss of a friend, whom he had learned to love as well as respect, and again threw him, to a greater or less extent, upon his own resources. His parents were importuning him to return to his home and follow his profession, and money was as rare as some of his zoölogical treasures. In the fulness of his enthusiasm Agassiz never utterly desponded, though there were seasons when the clouds looked dark and unpromising, and possibly at no time in his career was he so dejected; yet the result showed that at least in this instance his cloud had a silver lining. Soon after his

arrival in Paris he had called upon Baron von Humboldt regarding a publisher, and he had offered to write to Cotta in his behalf. The latter did not reply, and days lengthened into weeks of suspense, and the young scientist was as near despair as his buoyant nature would permit. He determined to face the inevitable—to renounce his hopes of becoming a scientist, almost convinced that he had made the good fight as far as he could go without compromising himself. He decided to discharge Dinkel the artist, who had done so much for him, and to return to his native town and become a teacher, and in this way endeavour to earn a living. What it must have cost Agassiz to come to this determination we can readily imagine, after having followed him through so many difficulties and noted the intense enthusiasm and ambition which characterised his every movement.

But the young naturalist was not destined to be diverted from the path of science. One day he received a letter from Humboldt, couched in the most delicate and friendly language, with an accompanying letter of credit for one thousand francs. The aid was so timely that it seemed to Agassiz almost a miraculous intervention; it was one of the small events in the life of the man that was destined to produce great results. Agassiz opened his heart to his benefactor, and from this time on they became close friends.

The attention of the young Swiss was now turned to the attainment of a professorship in some college in his own country, and in this endeavour Humboldt aided him in every way. Finally, one day in June, 1832, he received a letter from M. Coulon, of

Neuchâtel, stating that a professorship of natural history was open and that the very small sum of eighty louis had been guaranteed for three years by certain persons, in the hope of securing the services of Agassiz who was now looked upon by them as an eminent man of science.

Agassiz's desire to obtain a professorship is mentioned in the following letter* to M. Louis Coulon:

"PARIS, March 27, 1832.

". . . When I had the pleasure of seeing you last summer, I several times expressed my strong desire to establish myself near you, and my intention of taking some steps toward obtaining the professorship of natural history to be founded in your Lyceum. The matter must be more advanced now than it was last year, and you would oblige me greatly by giving me some information concerning it. I have spoken of my project to M. de Humboldt, whom I often see, and who kindly interests himself about my prospects and helps me with his advice. He thinks that under the circumstances, and especially in my position, measures should be taken in advance. There is another point of great importance for me about which I wished also to speak to you. Though you have seen but a small part of it, you nevertheless know that in my different journeys, partly through my relations with other naturalists, partly by exchange, I have made a very fair collection of natural history, especially rich in just those

* Letters of Agassiz to Louis Coulon, Mem. Soc. Phys., Genève, 1874, xxiii., 472.

classes which are less fully represented in your museum. My collection might, therefore, fill the gaps in that of the city of Neuchâtel, and make the latter more than adequate for the illustration of a full course of natural history. Should an increase of your zoölogical collection make part of your plans for the Lyceum, I venture to believe that mine would fully answer your purpose. In that case I would offer it to you, since the expense of arranging it, the rent of a room in which to keep it, and, in short, its support in general, is beyond my means. I must find some way of relieving myself from this burden, although it will be hard to part with these companions of my study, upon which I have based almost all my investigations. I have spoken of this also to M. de Humboldt, who is good enough to show an interest in the matter, and will even take all necessary steps with the government to facilitate this purchase. You would render me the greatest service by giving me your directions about all this, and especially by telling me: 1. On whom the nonination to the professorship depends? 2. With whom the purchase of the collection would rest? 3. What you think I should do with reference to both? Of course you will easily understand that I cannot give up my collections except under the condition that I should be allowed the free use of them."

Humboldt was almost as pleased at the proffer of a professorship, as Agassiz himself, and he addressed a letter* to M. Louis Coulon, in which he said :—

* Letters to Louis Coulon, Memoirs Soc. Phys., Genève, 1874, xxiii., 472.

". . . I do not write to ask a favour, but only to express my warm gratitude for your noble and generous dealings with the young savant, M. Agassiz, who is well worthy your encouragement and the protection of your government. He is distinguished by his talents, by the variety and substantial character of his attainments, and by that which has a special value in these troubled times, his natural sweetness of disposition. . . . It gratifies me to see your kindness toward a young man to whom I am so warmly attached; whom the illustrious Cuvier, also, whose loss we must ever deplore, would have recommended with the same heartiness; for his faith, like mine, was based on those admirable works of Agassiz which are now nearly completed."

Humboldt wrote also to the governor and gained the influence of Von Buch for Agassiz, and as a result he accepted the professorship.

From now on, Humboldt showed an active interest in the expanding life of the young naturalist. He had complete faith in his future, and did not hesitate to announce to his scientific friends and the world at large that young Agassiz, who was but twenty-five years of age, was one of the shining scientific lights of the day. In the letters which passed between these great naturalists at this time, their tender and affectionate friendship is well shown. Humboldt was always paying Agassiz some delicate attention, while Agassiz constantly sought some opportunity to express his gratitude to his friend and patron, and accord him the credit he deserved. The full nature of this friendship, the modesty of

Humboldt, the whole-souled nature of Agassiz is well illustrated in a little incident regarding the prospectus of one of the latter's books on fossil fishes. Agassiz had said in the prospectus: "Finally, I owe to M. de Humboldt not only important notes on fossil fishes, but so many kindnesses in connection with my work that in enumerating them I should fear to wound the delicacy of the giver."

To this Humboldt had responded: "Your prospectus is full of interest, and does ample justice to those who provided you with materials. To name me among them was an affectionate deceit, the ruse of a noble soul like yours; I am a little vexed with you about it."

Of Agassiz at this time Ernest Favre writes: "A warmth which nothing could repress was with him united with facility and charm of expression. Always ready to frame theories, to discuss them, and to advance new ideas, he captivated his auditors by the vigor and clearness of his exposition. His public and class lectures, too, were always extraordinarily successful. Even when he discussed the most abstruse subject his auditors hung upon his lips. The talent for speaking, which he possessed to a high degree, was one of his most valuable means of influence, and contributed greatly to his celebrity."

Humboldt, being the greatest scientist of the day, as may be imagined, was a power in the land. Above all, he was a friend of the king, and as Neuchâtel was at this time under Prussian sovereignty his influence was invaluable. Humboldt not only took a deep interest in the forth-coming book and the sale of

Agassiz's collection of specimens, but he obtained a number of subscribers for the former and made the author important suggestions, procured press notes in influential publications, and in many ways showed that his friendship was practical.

CHAPTER IX.

THE YOUNG TEACHER.

First Lectures to Pupils—Departure for Neuchâtel—Success as a Teacher—Field Lectures—Call to Heidelberg—The Chair Declined—Threatened Blindness—Preparing for it.

IF I were to sum up the greatest attainment of Agassiz, or express his most marked success, in a word, it would be the term teacher. He was the greatest teacher in science in modern times, a genius who opened up a new world in this direction, his appearance in the field being essentially epoch making.

We have seen that Agassiz lectured to his comrades in "The Little Academy," there obtaining valuable training; but his first actual labours as an instructor began when he was twenty-five years of age, and consisted of a series of lectures on natural history at the gymnasium at Neuchâtel. In this work

THE FISHING JAGUAR.

we at last see him at the goal of all his desires and ambition, and from this on until the end, in all the positions he held it was always Agassiz, the teacher, that was pre-eminent. He was the father of modern natural history, and did more to popularise the study and interest the masses in the secrets of nature than any other man or men of his time. Agassiz's fame was now international and well established, and his return to Neuchâtel created no little excitement. His first lecture in his new position was "Upon the Relations between the Different Branches of Natural History and the then Prevailing Tendencies of all the Sciences." It was delivered in the hall of the Hotel de Ville, November 12, 1832, and was listened to by a large and attentive audience. It is interesting to note that this lecture had an immediate effect upon the people. As he rose and stood before his audience this first night we may well imagine that he felt some little trepidation; if so, he soon mastered this, words and sentences falling from his lips, which kept his listeners spell-bound; they had never heard the subject so clearly and forcibly presented. The young teacher was tall and handsome, and his fine face all animation, his cheery reassuring smile, his beaming eyes and enthusiasm created at once a response in his audience.

Neuchâtel soon came to be considered a scientific centre, and a decided interest in science was awakened among the people. To this M. Coulon contributed not a little, aiding Agassiz in the formation of a scientific museum and in the accumulation of specimens of various kinds.

Agassiz was the pioneer of science in this locality, and his unwonted enthusiasm soon made itself felt, and, as later on in America, he drew around him a choice following of bright minds, embryo scientists who in later years became well known in the world. Among them were C. Vogt, Desor, Gressly, Guyot, who followed him to America, Nicolet, of Montmollin, as well as several fellow-students from Munich, Dinkel, Weber and Buckhardt.

To open a large and elaborate lithographic establishment at Neuchâtel would seem hazardous, yet, H. Nicolet, one of the citizens, was so imbued with the value of the work that he undertook this, and a vast establishment took form from which all the famous plates of Agassiz were turned out. M. Vogt gives an idea of the work at Neuchâtel at this time. "It might be supposed," he said, "that in such complicated machinery the wheels would sometimes have interfered with each other. The printing office constantly demanded copy, the lithographic establishment designs, and the work of his original researches never ceased; hardly had he the time necessary to complete one set of labours before Agassiz had new plans and assumed new tasks. Every thought that passed through his head was converted into a great work, with hundreds of folio plates, hundreds of pages of text; in all this he was the acknowledged master, as well as in the collection of new material for his work. He knew how to draw all Europe into contribution. Often boxes which had been sent for and awaited with feverish impatience remained weeks and even months un-

opened, because in the meanwhile, another subject occupied attention, and the objects they contained had lost their interest."

Among the visitors to Neuchâtel was Leopold von Buch, the well-known geologist of Berlin, an admirer of Agassiz. On one occasion he said: "When I am at Neuchâtel, and I knock at the door of Agassiz, I am always afraid." "Why?" asked his companion, "I dread," said Von Buch, "lest he will take me for a new species."

This was a witty suggestion of one of the criticisms made of Agassiz's methods at the time. It was said that he was too liberal in making species, —a charge that has been brought against every naturalist of note.

Agassiz did not confine his teaching to the gymnasium, but gave private lectures to his friends throughout the winter on a variety of topics. Some were at social gatherings; others during walks abroad under the blue sky with examples all about. Agassiz drew his inspiration from the hills and fields, and his enthusiasm was imparted to his hearers, so that in a very short time he acquired a reputation as a singularly successful teacher. He had the faculty of imparting knowledge to a rare degree. His greatest delight was to teach the children, and his class of little folks, whom he taught for the love of imparting knowledge, was a source of much pleasure. Sometimes he took them over the fields and far away; teaching them geography by climbing a hillside to look down upon the lake or study the shape of some mountain; again

they gathered flowers, and while standing among them he explained their secrets to his young pupils, who caught the infection from his beaming eyes and expressive face. Sometimes they had an object lesson on the fruits of the tropics, each child holding a banana, an orange, a lime or some product of foreign soil, after which the objects were eaten,—a convincing and telling ending to the lesson and one, doubtless, eminently satisfactory to the pupils.

No one thought of Agassiz as an instructor; he was always the delightful companion, and the end of his talks always came too soon. In speaking of this, Professor Louis Favre once said: "They were *fête* days for the young people, who found in their professor an active companion, full of spirits, vigour, and gayety, whose enthusiasm kindled in them the sacred fire of science."

The reputation of so successful a teacher could not be confined to Neuchâtel, and it was not long before the young instructor began to receive calls from other institutions. Professor Leuckart, who had held the chair of zoölogy at Heidelberg, was called to Freiburg, and the position was tendered Agassiz, who sent the letter to his friend Humboldt, whose advice he always sought, telling him that his inclination was for various reasons to remain in Neuchâtel. He hoped to sell his collections to the local society and thus realise money enough to enable him to remain a while in the town where he had received so warm a welcome. Humboldt agreed with him in this decision; and we find the young teacher declining one of the greatest honours that could have

been bestowed upon him at this time, as the offer of a university of the standing of Heidelberg meant that the person to whom the tender was made was considered second to none.

Agassiz continued his work in Neuchâtel until the close application resulted in practical blindness. His eyes gave out, and for weeks he feared that he would become blind. While sitting in the darkened room, he prepared himself for this possible fate by practising daily touching fossils until he developed such a delicate sense of feeling that he was confident that if he lost his eyesight he could carry on his scientific work by the sense of touch alone.

It was during his recovery from this affliction that Agassiz married Cecile Braun, the sister of his friend and college-mate. They had long been intimate, and she was thoroughly in sympathy with his work, many of the illustrations of his books being from her pencil. The bride was brought home to Neuchâtel, much to the delight of Agassiz's parents, who, especially his mother, approved his marriage as completing the full rounding out of his life.

Honours began to pour in upon the young teacher, now twenty-six years of age. His book on fossil fishes attracted attention among scientists all over the world, and he received many invitations from the English scientists, as Murchison, Buckland, Lyell and others to visit England and examine their treasures in the way of fossil fishes. Especially gratifying was a letter from Sir Charles Lyell, containing the information that he was deemed worthy the Wollaston prize of about seven hundred francs. The famous

geologist fully appreciated the struggles of the young Swiss, as in his letter he added: "In the mean time I am desired to tell you that the Society declines to receive your magnificent work as a gift, but wishes to subscribe for it, and has already ordered a copy from the publishers. . . ."

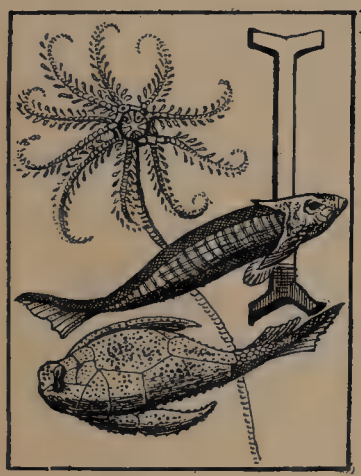
The prize overjoyed Agassiz who was still extremely poor, and in a letter to Lyell he said that the news was received with tears of joy and gratitude. He was not ashamed of his poverty and said so, having spent his last franc on his scientific work. The publication was received everywhere with great enthusiasm, and to-day, nearly sixty years later, has never been equalled for its thoroughness and the care displayed in the preparation. The title was *Researches on the Fossil Fishes.*

For ten years, from 1833 to 1843, Agassiz laboured upon it, and when it is remembered how young a man he was, the work is a marvel, suggestive of the brilliant genius from which it emanated.

CHAPTER X.

WINNING FAME.

Curiosity of English Scientists to see Agassiz—New Honours.—Visit to Bex—Sale of Original Drawings—Glacial Theories—Proffers of Professorships.



IN the year 1833 there was intense curiosity among English naturalists to see the young Swiss teacher, who had carried off the Wollaston prize, and in 1834 this was gratified, Agassiz having decided to make the trip to England. He was assured a warm welcome and received it from every quarter especially from the great English savants. He now met Sir Charles Lyell and Murchison, the geologists, the genial Buckland, Sir Philip Egerton, Lord Cole, and many more who received him cordially and opened to him the palæontological treasures of Great Britain. Still in the developmental stage, Agassiz needed the

new surroundings and associations which he enjoyed at this time, and undoubtedly the friends he made during this visit had no little effect upon his career and methods of work. The two men who perhaps aided him the most, and whose warm friendship he enjoyed through life were Lord Cole and Sir Philip Egerton, both owners of fine collections of fossil fishes which were placed at his disposal.

During this trip to England Agassiz was put to a severe test which demonstrated how perfect was his knowledge of the structure of fishes and how accurate were his deductions. His fame had spread over all England, and naturally there were many who doubted his powers. A few weeks before, a fossil fish had been discovered in a lower strata than previously known; so low, in fact, that up to that time no organic remains had been found there, the rocks having been considered azoic. During a discussion at a scientific meeting which Agassiz attended, a naturalist propounded a question to Agassiz, who was ignorant of the discovery, which required a description of a possible fish from such rocks. The situation was dramatic. Agassiz in complete ignorance that he was the victim of so crucial a test; the eager listeners —some doubting, others hoping, perhaps, that they could trip the distinguished foreigner—all expectant. There was a moment's silence, then Agassiz proceeded modestly to the blackboard, and after a short prelude in which he referred to his views of creation and its order, he drew with the crayon the outlines of the possible fish. As it took form under his skilful hand, a murmur of amazement broke from the

naturalists, merging into applause and congratulation, much to the astonishment of Agassiz, who stepped back to see one of his colleagues raise a screen and display upon the wall the original of the fish his master-hand had conceived from the depths of his well-stored mind. "To such an extent," says Dr. Stebbins, "had this great scientist advanced in a knowledge of the plan of God in nature."

Hardly a day passed that Agassiz did not receive letters asking him to visit various localities. One which attracted especial attention was from Charpentier, who had made a reputation by his studies of the glacial systems of Europe. He urged Agassiz to make him a visit, offering as an inducement some fossils which he had discovered, and in 1836 Agassiz decided to spend the summer with him, little dreaming that his experiments would give him even more renown than the Brazilian fishes and other publications which he brought out. There was hardly a field in natural science that Agassiz had not investigated, and on the question of glaciers he had well-defined views which differed materially from those of Charpentier, who now urged him to visit him.

Agassiz did not accept the theory of his correspondent, that the bowlders found all over Switzerland were distributed by the agency of ice; indeed, he considered it so very improbable that he felt confident that he could soon disabuse Charpentier of the belief, and with this in view he began the journey to Bex in the valley of the Rhone. The result of his summer expeditions was a complete victory for

Charpentier; indeed, Agassiz concluded that if anything his friend had taken a too conservative view of the action of ice.

Agassiz was at this time greatly hampered by a lack of funds; indeed the work on fossil fishes came to a standstill for a while. He had parted with his collection and every available franc that he earned went to further what was the work of his life. He now had nothing to dispose of but his original drawings, the sale of which was finally effected through the efforts of his friend Sir Philip Egerton, who used his influence with the British Museum where they ultimately found a home through the munificence of his cousin, Lord Francis Egerton.

The proceeds from this sale were not sufficient to enable Agassiz to still employ the artist, so Sir Philip Egerton and Lord Cole defrayed the expenses of the latter, with the understanding that the original drawings should ultimately become their own.

The summer at Bex was a revelation to the young teacher. He wandered over the valley of the Rhone, studied the great moraines, observed the huge bowlders lying about here and there, and gradually the part that had been played by the ice age of the past was fully appreciated, and his mind was filled with new thoughts and ideas which found expression later on.

During the winter following his visit to Bex he investigated the evidences of glacial action near Neuchâtel and in the Jura, and in the spring when the Helvetic Society of Natural Science met at Neuchâtel under his presidency, he unfolded his

accumulated knowledge and outlined to his interested hearers a theory which in later years was accepted by the scientific world at large. His views astonished his auditors, and as they became spread abroad he drew the entire school of glacial students about him,—Von Buch, Elie de Beaumont, Charpentier, and even Humboldt.

This conversion was not immediate, as at first he was attacked from all sides. Von Buch, whom a contemporary said, "was not famous for sweetness of temper," became incensed at Agassiz and would not even listen to the theories which he so boldly announced and so completely supported. Yet Agassiz was prepared for antagonism and was especially ready for his friend Von Buch as is shown in the following closing remark in his speech which was evidently intended to mollify the irate scientist: "When M. Von Buch affirmed for the first time, in the face of the formidable school of Werner, that granite is of plutonic origin, and that the mountains were raised, what said the Neptunists? He was at first alone in his support of the theory, and it was only by defending it with the conviction of genius that he made it prevail. Happily, in scientific matters, numerical majorities have never at first decided any question."

Agassiz seemed to grasp the situation at once. He saw from the evidences before him a glacial sheet of ice covering all Europe, appearing and disappearing according to the changes of temperature in vast eras of time. He pictured the earth, covered with vegetation, gradually encompassed by a sheet of ice that

became as firm as rock, and in moving carried all before it, depositing the erratic bowlders all over Europe. The theories advocated at this time by scientists were that these deposits were caused by freshets, floods, and other local phenomena, and, as might be expected, the young president of the Helvetic Society was attacked from all sides with good-natured but active antagonism. Humboldt at first took exception to his views, and wrote him that "Von Buch rages, as you may already know, considering the subject (of glaciers), as he does, his exclusive property."

Von Buch with difficulty controlled his temper when he listened to what he firmly believed to be heresies of the grossest kind. He laughed when shown the glacial markings at Neuchâtel, and said that the lines were caused by the boys of Neuchâtel in sliding down the hills of that picturesque region, exclaiming as he left the spot, "*O Sancte de Saussure, ora pro nobis.*"

Humboldt feared that his young friend would be drawn away from his studies of fishes by the fresh charms of the glaciers and protested vigorously. "For mercy's sake," he wrote, "take care of your health which is so dear to us. I am afraid you work too much, and (shall I say it frankly?) that you spread your intellect over too many subjects at once. I think that you should concentrate your moral and also your pecuniary strength upon this beautiful work on fossil fishes. In so doing you will render a greater service to positive geology, than by these general considerations (a little icy withal) on the

revolutions of the primitive world; considerations which, as you well know, convince only those who give them birth. . . . Your ice frightens me, and gladly as I would welcome you here, my dear friend, I think, perhaps, for the sake of your health, and also that you may not see this country, always so hideous, under a sheet of snow and ice (in Febuary), you would do better to come two months later, with the first verdure."

Life was too short for the active mind of Agassiz. The days passed too quickly; every moment had its value, every second its meaning in its accumulation of time. He seemed to appreciate that the moments are but the ticks of the human clock, every one of which brings the running-down time nearer and nearer. An hour, a moment wasted was an irretrievable loss and his policy was to make the most of each. This explains the enormous amount of work he accomplished in a comparatively short lifetime. New ideas, opportunities for fresh discoveries were ever appearing, and his inclination was always to enter every new field ready to conquer. Not alone a zoölogist, but a geologist, botanist, physician, a student of nature, a teacher of nature's secrets in the broadest sense, such was Agassiz, and it is not strange that Humboldt closed one of his letters with the warning that he was attempting too much. "No more ice," said the *savant*, "not much of echinoderms, plenty of fish, recall of ambassadors *in partibus*, and great severity toward the book-sellers, an infernal race, two or three of whom have been killed under me."

We shall see that Agassiz did not accept this advice any more than he did that of his friend Cuvier who adjured him to beware of too constant work, the work that kills. It was impossible for a man like Agassiz to restrain his mental out-grasping. It was his life, his nature, and was to be to the end. Every day new plans were born. His reputation was growing apace, and tenders of professorships and requests for lectures came from all sides. M. de la Rive, of Geneva, now begged his acceptance of a professorship in the academy at Geneva, with a salary of three thousand francs, while another invitation greeted him from Lausanne, offering a similar position with a liberal salary. But to all these he turned a deaf ear, and in 1838 we find him with work rolling up ahead like a billow of the sea. He had established a lithographic printing-house in Neuchâtel, so that his plates could be made here. He was now the manager of this business, a professor of natural history in the college, and the president and central figure in a number of societies; at the same time he was engaged upon his great work *The Fossil Fishes*, investigating the fossil echinoderms and mollusks, and delivering lectures to students and friends on a variety of subjects. In brief, he was the embodiment of mental and physical activity, and in all the annals of scientific men we find but few parallels to his energy. His watchful and discerning eye seemed to penetrate the sciences, many of which were at a standstill, giving them fresh impetus. In every direction he saw something new, some undeveloped feature. The

fact that shells were studied without regard to the living portion attracted his attention, and, as a result, he began moulding the interior of shells, thus producing casts of the animals. One of his books, *Études Critiques sur les Mollusques Fossiles*, with many fine plates, was a partial result of this discovery.

In this year, 1838, Agassiz was honoured with membership by the Royal Society of London, his name having been presented by Sir Philip Edgerton. He was now thirty years of age, yet few scientists in all Europe had greater results to show than this young teacher, who in his own estimation had but begun his career as a man of letters and science.

CHAPTER XI.

A GLACIER HUNT.

Interest in Glaciers—Opposition of Scientists—Visit to Glaciers—The Hotel Neuchâtelois—Curious Experiments—Descent into the Glaciers—The Heart of a Glacier—Ascent of the Jungfrau—Injecting Coloured Fluids—The Work on Glaciers.

DESPITE the protests of Humboldt and other friends Agassiz grew more and more interested in the glacial problem that his discerning eye saw was yet unsolved. He determined to investigate it thoroughly, and to this end began a series of glacier hunts, a search for these marvels of ice formation, ancient and modern. The vicinity of Mont Blanc was naturally the point of greatest interest, and one of his first trips was to the valley of the Hassli where moves a vast river of ice, a later trip being made to the glaciers of Mont Blanc. These

pleasure trips, for he was often accompanied by his friends and pupils, were fruitful in results, and demonstrated to Agassiz that he was correct in his original surmises. He was at this time in the full flush of vigorous manhood; few of his companions could compete with him in physical endurance, and many a wild race he led his friends Dinkel and M. Desor, who became equally interested in the history of glaciers.

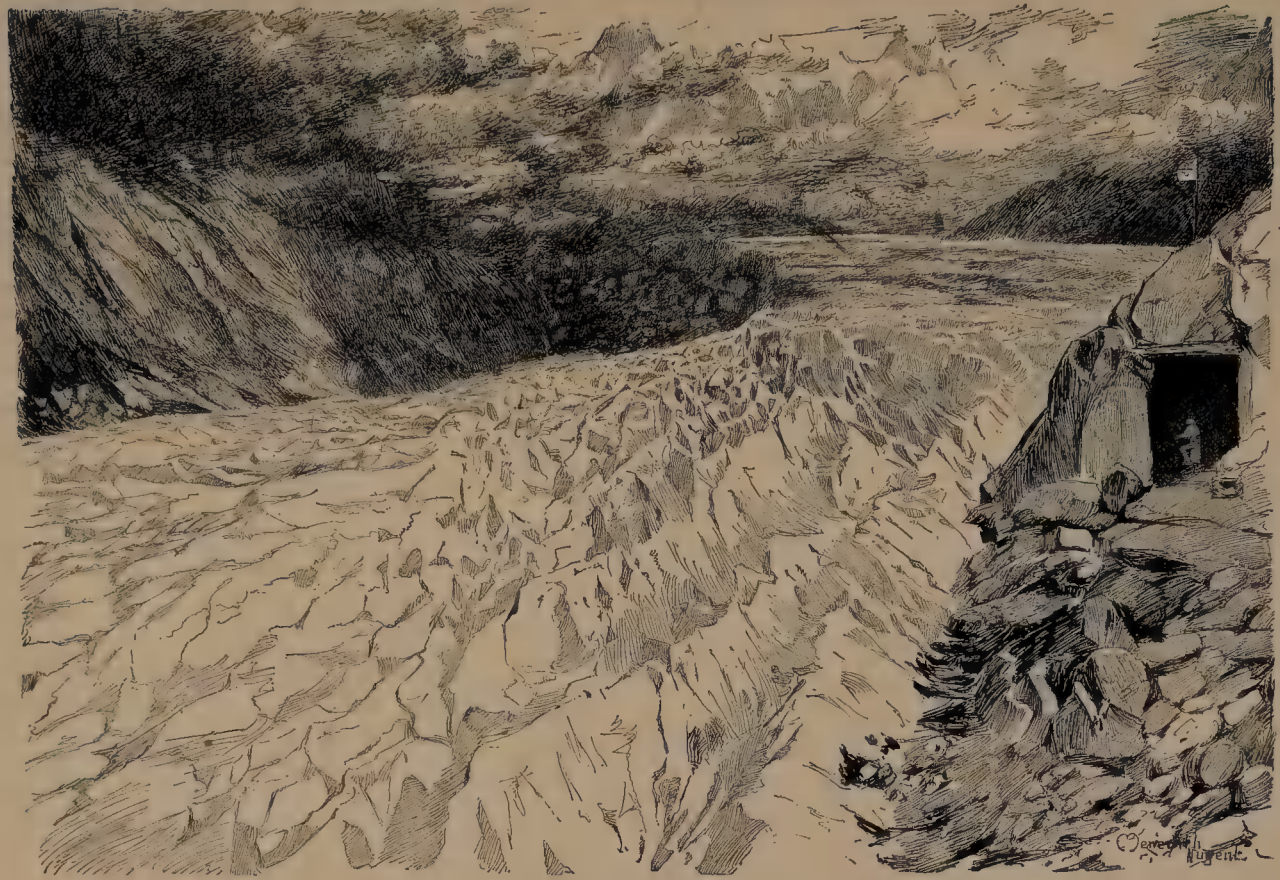
The new study brought him another friend, Arnold Guyot, who was from this time on his colleague. By a special agreement these friends took up this great subject of glaciers together. In 1838 we find Guyot in the Central Alps, watching the movement of glaciers and observing the structure of the great mass, while Agassiz was walking over the rough country in the Bernese Oberland, Chamounix and Haut Valais, studying the glaciers of ancient days when they covered the land. At the end of these delightful expeditions the two friends met at the meeting of the Geological Society of France, in the town of Porrentruy, and discussed before other savants the results of their season's work, encountering no little opposition, as we may imagine, as the new theories were by no means received with favour. Buckland, who was also a student of glaciers at this time, wrote:

"I am sorry that I cannot entirely adopt the new theory you advocate to explain transported blocks by moraines; for supposing it adequate to explain the phenomena of Switzerland, it would not apply to the granite blocks and transported gravel of Eng-

land, which I can only explain by referring to currents of water."

It should be remembered that later Buckland became an enthusiastic convert to the young Swiss teacher and his theories.

The stroller through Princeton College will be told that this institution of learning contains in its museum five thousand specimens of rocks presented by Professor Guyot. These were collected by him when studying the glacier system with Agassiz and Desor; the work was carried on after a regularly organised plan, the idea being to publish the results of each in a volume, which, however, was never carried to completion. As with everything Agassiz attempted, the unsolving of the secrets of the glaciers was begun in a thorough and systematic manner. The first important expedition was made in the summer of 1839, Agassiz ascending the range of Monte Rosa and Matterhorn, having as companions M. Desor, M. Bettanier, and Studer, the geologist, who went up the glacier a sceptic and came down a thorough convert. The party encamped on the edge of the river of ice and made daily excursions to the different points of interest, so that by the end of the season Agassiz had examined every glacier in the vicinity, not to speak of those from the Mönch, the Jungfrau, the glacier of the Rhone and the Aar. It was during this summer that he made the remarkable discovery of the rate of speed attained by these rivers of ice. In 1827 an investigator named Hugi built a cabin upon the ice of the glacier at the foot of the Abschwung. Agassiz visited the cabin



THE HOUSE ON THE GLACIER.

twelve years later and made the discovery that during that time it had travelled a mile and a fifth, or was about four thousand feet below the original site.

In his ardour and enthusiasm for science Agassiz was enabled to throw off the ordinary troubles of life, but there were times when his inadequate means cut like a knife and poverty seemed a band of steel holding him back. We see glimpses of this in a letter published by Ernest Favre in the Smithsonian Report:

"I am frightened at the approach of a new year, the time for the settlement of accounts in Neuchâtel, and I work like a madman to be able to meet my indebtedness. If God preserves my health I hope, after one or two years of continued labour, if I moderate my expenses, and particularly if I abstain from publishing anything more on my account, to settle my affairs completely, but for the time I am horribly cramped, I must say almost paralysed; but it is my own fault, and I must bear patiently the consequences until I can succeed in getting myself afloat again." "My great regret in the present condition of my affairs is that I am obliged to employ a portion of my time with matters I ought not to have neglected, and which occupy me now much more than if I had always attended to them, and I am obliged to retard some of the publications I greatly desired to make next, but which it would be imprudent for me to undertake at present, for I should reproduce the embarrassment from which I only just commence to be relieved if I did not conduct all my enterprises with the utmost circumspection."

"My life," he wrote at another time, "is now a vortex, in which the best part of my nature is hardly conscious of its existence, so numerous and pressing are the exterior exigencies from which I suffer."

The season in this ice-land of romance passed only too quickly and the summer of 1840 was looked forward to by the enthusiasts with unbounded pleasure. As soon as the season permitted, Agassiz and his party were again established on the glacier of the Aar. They were provided with two excellent guides, and on the moraine they formed a shelter partly under a huge bowlder, which with blankets and poles they transformed into a rude house, which was facetiously called the Hôtel des Neuchâtelois. Agassiz was the landlord, or proprietor of this glacial hotel, and the register might have shown the names of Edouard Desor, Charles Vogt, Count Pourtalès, afterward so well known in America, Henri Coulon, Célestin Nicolet, Jacob Leuthold, and Johann Währen, the two latter having been guides to Hugi, the builder of the cabin on the glacier in 1828.

The following extract from a letter of M. Desor, dated on the Aar, will convey an impression of life on a glacier, showing that it required no little scientific ardour to continue it:

"You are much mistaken if you suppose that all is pleasure, satisfaction, and intellectual enjoyment at the Hôtel Neuchâtelois. We have been shut up three days in our tent, unable to venture out, the *gux**

* A whirlwind of snow, called so in the Oberland.

is so furious. Do you know what a *gux* is? I think not; and you are happy in your ignorance. I can only say in regard to it that if the founders of the various religions had known of the *gux* they would not have imagined a hell for lost souls, but would simply have sent them to the *Finsteraarhorn*, and secured for them a perpetual *gux*. . . . It takes hold of the limbs, dries the skin, renders the imagination heavy and obtuse, prevents the exercise of the culinary art. In the night of the 21st to 22d it overturned our cabin, and we were obliged to work until morning to restore it again. Imagine how delightful it must have been to work in the open air at a temperature two degrees below zero, while a tempest was constantly blowing clouds of pulverised ice in our faces." The open nature of this "hotel" can be imagined when it is known that it afforded but poor protection against wind or rain; yet the party was a jolly one under all circumstances. Burkhardt tells how the first man to awake in the morning aroused the others by directing one of the many streams that coursed down the wall, on the faces of the sleepers.

One of the first trips was to this cabin, which they had found in 1839. It had gone to pieces in its voyage of four hundred feet during the winter.

The great work of Agassiz,—*Système Glaciaire*, was one of the results of this series of exploits and investigations. Count Pourtalès was the meteorologist, Vogt the microscopist, Nicolet studied the flora and rocks, Desor the moraines, and in this way a vast number of facts were obtained. Guyot says in

his biographical sketch of Agassiz, "all the physical laws of the glaciers were brought to light."

In the daily expeditions Agassiz displayed his intrepid nature, always being to the fore, adventurous, bold and hardy, leading expeditions over the glacier that astonished the guides themselves. Altogether the summer was a most successful one, and the autumn saw Agassiz in Great Britain studying the glaciers there and combating the English scientists who refused even then to entertain his ideas. Referring to this, Agassiz once said in a public lecture, at Penikese: "Among the older naturalists, only one stood by me. Dr. Buckland, Dean of Westminster, who had come to Switzerland at my urgent request for the express purpose of seeing my evidence and who had been fully convinced of the ancient extension of ice there, consented to accompany me on my glacier hunt in Great Britain. We went first to the Highlands of Scotland, and it is one of the delightful recollections of my life that as we approached the castle of the Duke of Argyll, standing in a valley not unlike some of the Swiss valleys, I said to Buckland: 'Here we shall find our first traces of glaciers'; and, as the stage entered the valley, we actually drove over an ancient terminal moraine, which spanned the opening of the valley."

Agassiz did not confine his trips to the glacier to the summer alone. In the winter of 1841 he visited the glacier of the Aar, and hunted for the stakes he had planted the previous summer, one object being to learn if the water flowed beneath the glacier as it did in the summer. The results of this trip are

given in Agassiz's work, already referred to, while many interesting incidents are culled from a sojourn on the glacier by his fellow-student, Desor.

In the summer of 1841 Agassiz visited the glacier again, now with new additions to his staff—Forbes of Edinburgh, Heath, of Cambridge, De la Linth, and Burkhardt, the artist. This season the plan was to penetrate to the very heart of the glacier, and to this end a boring apparatus was brought up with which the glacier was punctured at various places.

Agassiz finally determined to descend into the heart of the glacier itself, and against the advice of his companions he was lowered by ropes into a glacial well, nearly ending his career by his temerity. The so-called wells were deep well-shaped crevices, descending into the very heart of the glacier, and the fact that the mass was moving at a rate of forty feet per day suggested that the well-hole might disappear at any time. This did not deter the adventurous scientist. A stream of water was flowing into the well, and having diverted this into another channel a tripod was erected over the opening, and from this Agassiz was lowered, seated upon a board in turn attached to the rope. His object was to determine how deeply the laminated structure which he had observed penetrated.

Having arranged with his friends that they were to lower until he shouted to them to stop, word was given and the explorer sank out of sight on one of the most adventurous expeditions on record. No one before had entered the heart of a glacier; no one had gazed at the so-called blue bands in the

centre of the great ice mass, and we can but imagine the sensations of the enthusiast as he slowly descended; the gloom growing deeper and deeper, the rich blue of the ice more intense. He had descended to a depth of eighty feet when an obstacle was met with in the shape of a parti-wall separating the well. He first essayed the larger opening, but finding that this radiated into a number of small tunnels he gave it up and tried a smaller and slowly descended, now being almost one hundred and twenty feet from the surface of the ice. Every foot of the wall was carefully scanned, and he was completely absorbed in the wonders of his surroundings when suddenly he found himself in ice-cold water. He had reached the bottom without observing it, and had plunged into an icy bath of unknown depth. His shout of distress was at first misunderstood, and he was being steadily lowered into what would have been his death when his signal was interpreted and those above began to draw him up. If the descent was dangerous the ascent was much more so. The well was filled with large icicles, which pointing downward presented no obstacle in his descent, but now as Agassiz looked up the one hundred and twenty-five feet of the blue ice the sharp and dangerous points of hundreds of these javelins threatened to cut the rope or fall upon him; and possibly not till then did he realise that he had taken his life in his hands for science and that the trip was a foolhardy one. His friends at the entrance did their work well. Some watched; others took care that the rope did not chafe, while the rest hauled up the explorer

DESCENT OF AGASSIZ INTO THE HEART OF A GLACIER.

who guided his way through the great ice needles successfully and was lifted out amid the applause and cheers of his companions, whose hearty congratulations he had well earned.

The scientific results of this expedition demonstrated that the laminated structure of the glaciers penètrated to a depth of at least eighty feet.

The remainder of the summer was passed in the regular work as outlined, and at the end the scientists proposed ascending the Jungfrau, which has become historical, and which has been described in vivid language by M. Desor in his *Séjours dans les Glaciers.* The start was made from the hospice of the Grimsel on the last of August, the party being composed of six guides and two travellers besides the naturalists. The first night after a long walk over the glacier was spent at Méril, and by five the next morning they were speeding along, led by Jacob Leuthold, the famous guide. The trip to the glacier of Aletsch was fairly easy, but beyond this the journey became not merely difficult but dangerous. Here they halted for a rest prior to the final start. The locality was one to impress the mind with the grandeur of nature. They were in a vast amphitheatre of ice, inclosed by giant mountains, the Jungfrau, the Mönch and others, capped with eternal snow. Provided with the merest necessities, they started up the pass, which lies between the Jungfrau and Kranzberg, and soon were struggling upward over the various terraces, sinking into the snow, passing vast crevasses on thin layers of ice, facing a thousand dangers which often menaced

them on every hand. Now fastened by ropes; again climbing over *crevasses*, apparently bottomless, on the ladder they carried, or scaling cliffs, carefully cutting their way, they slowly ascended the mountain of ice and snow. They were finally stopped by a gulf of great depth; a fall into which would have meant instant death. Across this, the intrepid Leuthold threw his famous ladder, the same that had served him with Hugi nine years previous, and over this they crept, to find upon the opposite side an abrupt wall of ice. This was ascended by cutting steps in the ice, and once upon the summit they found themselves upon a broad terrace, leading to the Col of Rothnal, with magnificent views of the Aletsch and Rothnal valleys. From here on the axes of the guides cut their way, and a portion of the time they walked over a platform of snow and ice so thin that by driving their stocks through they could see the vast amphitheatre below—a stupendous and awe-inspiring spectacle. The precipice was so near that it dazed them to look at it, and one of the guides was so appalled by the sight and danger that he was unable to continue.

On they pressed, each man realising that a slip, a false movement, might be the last; yet none faltered, least of all Agassiz, who was always to the fore, cheering and admonishing, filled with enthusiasm and awe at the sublime evidences of the Creator's power that were everywhere visible. Finally, after an heroic effort, the summit of the Jungfrau appeared, the mist gradually dissipating, leaving the grand peak in full view. A few feet more and it was

theirs; but suddenly a sharp and apparently insurmountable ridge appeared, disorganising their forces and bringing them to a complete standstill. The guide was equal to the occasion; throwing his alpenstock over the ice-ridge and using it as a grapple he soon reached the top, then assisted Agassiz, who stood on the pinnacle of the famous Jungfrau and looked off upon one of the grandest scenes in the world. The actual peak was so narrow that but one person at a time could stand upon it, so the adventurers took their turn in clasping arms about the apex, drinking in the wonders of the scenery.

The descent was easily made, and in less than a third of the time taken in the ascent they were in the lowlands again, safe and highly elated at the satisfactory termination of the adventure.

The experiments of Agassiz did not satisfy his opponents, and the glacial war was fought between Switzerland, England, and France, with renewed vigour. Murchison wrote him, referring to his last discovery: "You will see that I have grappled honestly and according to my own faith with your ice, but have never lost sight of your great merit. My concluding paragraph [in an accompanying discourse] will convince you and all your friends that if I am wrong it is not from any preconceived notions, but only because I judge from what you will call incomplete evidence. Your *Venez voir!* still sounds in my ears."

In his address at the Anniversary Meeting of the Geographical Society of London, 1842,* he said:

* Extract from Report in vol. xxxiii of the *Edinburgh New Philosophical Journal.*

"Once grant to Agassiz that his deepest valleys of Switzerland, such as the enormous Lake of Geneva, were formerly filled with snow and ice, and I see no stopping-place. From that hypothesis you may proceed to fill the Baltic and the Northern seas, cover southern England and half of Germany and Russia with similar icy sheets, on the surfaces of which all the northern bowlders might have been shot off. So long as the greater number of the practical geologists of Europe are opposed to the wide extension of a terrestrial glacial theory, there can be little risk that such a doctrine should take too deep a hold of the mind. . . . The existence of glaciers in Scotland and England (I mean in the Alpine sense) is not, at all events, established to the satisfaction of what I believe to be by far the greater number of British geologists."

Yet in later years Murchison became an ardent convert to the theories advanced by Agassiz, and Darwin, who was the antipodes of Agassiz in many things, agreed with him on the glacial question.

If Agassiz neglected for a time his zoölogical studies by his incursions into glacial lore, his fame increased and grew in other ways. The King of Prussia was his staunch supporter, and being especially interested in glaciers gave the naturalist one thousand dollars to continue the work; so in 1842 he again visited the glacier with a new party, when to their regret they found that the Hôtel des Neuchâtelois, as Agassiz had named their cabin, was sadly in need of repairs. Its day of usefulness as a hotel was rapidly passing, and as there was absolute danger in it, a

AGASSIZ ON THE PINNACLE OF THE JUNGFRAU.

tent or cabin of canvas was used instead. Mrs. Agassiz in her life of her husband follows the history of the bowlder. She states that it had begun to split in 1841, and in 1844 broke apart, the elements completing its ruin in the following years. She adds that as late as 1884, forty years later, a piece of the stone was found bearing the names of some of the party and the number 2. The piece had been carried a long distance by the river of ice.

Some of the experiments made this year were extremely interesting. One was to introduce coloured fluid into the glacier and thus trace the network of fissures which it was supposed carried water into the heart of the glacier. To watch the fluid, a gallery was cut through the body of the glacier thirty feet below the surface. Other experiments showed the rapidity of advancement and that the centre moved more rapidly than the edges—a result proved by the position of a row of stakes which had been driven across the glacier the previous September, and now found to form a crescent, the centre being far in advance of those on the sides. The rate of advancement of the glacier day and night, the topographical survey of the glacier, the surface waste, these and others were the points observed.

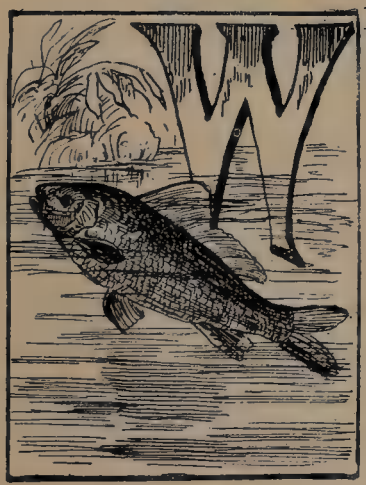
The letters of Agassiz written at this time show what sacrifices were made to add to the knowledge of glacial science. The results of these investigations, representing seasons of labour and adventure, were summed up in a work completed in Paris and published under the title of the *Système Glaciaire*, which embodied, so to speak, the life history of a

single glacier, as the author says in his Preface, he with his companions "lived in the intimacy of the glacier, striving to draw from it the secret of its formation and its annual advance." The work is a monument to the genius of Agassiz in other than zoölogical fields.

CHAPTER XII.

THE AMERICAN TRIP.

Glacial Studies—New Books—Variety of Works—Suggestion of Prince Canino—An Opening in America—Plans for the American Trip—The Monthyon Prize—Visit to Paris—Arrival in Boston—First Lectures—American Scientists—Impressions of America—Marine Studies—The Home in East Boston.



WHILE the attention of Agassiz in the year 1842 seemed fully occupied with his glacial investigations he by no means neglected his other work. He appeared to have a marvellous faculty for covering many and different fields of investigation at the same time. Now expounding his theories on glacial action, now issuing a new book, or superintending the artists upon another, his active mind was never at rest.

It was during the very height of these glacial investigations that he produced some of his most im-

portant zoölogical works, as *Études Critiques sur les Mollusques Fossiles*, a most elaborate work containing one hundred plates, a volume on tertiary shells with fourteen plates, also a work on fossil echinoderms, with thirty-seven plates. Add to these the *Nomenclator Zoölogicus* and his *Bibliographia Zoölogiæ et Geologiæ*, upon which he worked at this time, and we may form some conception of the labours of this remarkable man.

The Prince of Canino, Charles Bonaparte, was, in all probability, among the first to discuss with Agassiz a proposed visit to America. In a letter to Agassiz in 1842, this friend and naturalist wrote: "I indulge myself in dreaming of this journey to America in which you have promised to accompany me. What a relaxation! and at the same time what an amount of useful work."

In another letter he begged Agassiz to keep him in mind for the American trip, as in 1844 he would find himself free to go. That Bonaparte appreciated that the move would mean much to science is shown by the sentence, "The mere anticipation of this journey is delightful to me, since I shall have you at my side, and may thus feel sure that it will make an epoch in science."

The stupendous undertakings of Agassiz, while they were far-reaching in their scientific value were not remunerative, hence he was continually in financial straits. These difficulties became so overpowering that he was forced to write to Bonaparte that the trip to the United States, though tempting, was impossible unless he could go under conditions that

would also be remunerative. Referring to this he wrote Prince Bonaparte in April, 1843, as follows: "Do you think any position will be open to me in the United States, where I might earn enough to enable me to continue the publication of my unhappy books, which never pay their way because they do not meet the wants of the world?"

Late in 1843 the work *Recherches sur les Poissons Fossiles* was completed, and in the following year the monograph on the *Fossil Fishes of the Old Red Sandstone*, the latter especially a labour of love.

The idea of an American trip, one that would open up new and untrodden fields for scientific research, and that would possibly prove in some way remunerative, was ever in Agassiz's mind. It grew in interest, and in 1845 he began seriously to investigate the opportunities for success. He wrote to Sir Charles Lyell, who was familiar with America, regarding it, and in reply the latter suggested as a possible source of income the Lowell Institute, then famous for its lecture courses, and communicated with the Institute. This resulted in Agassiz receiving an offer for a course of lectures, which proved to be the beginning of a new career, and gave to America her greatest scientist. The possibilities of the American trip were made greater by the aid of the King of Prussia, who tendered Agassiz fifteen thousand francs for scientific investigations.

Agassiz left Neuchâtel in March, 1846, going to Paris, and his departure from the old home where he had formed so many pleasant associations cast a gloom over the entire community. M. Louis Favre

in referring to it writes: "Great was the emotion at Neuchâtel when the report was spread abroad that Agassiz was about to leave for a long journey. It is true he promised to come back, but the New World might shower upon him such marvels that his return could hardly be counted upon. The young people, the students, regretted their beloved professor not only for his scientific attainments, but for his kindly disposition, the charm of his eloquence, the inspiration of his teaching; they regretted also the gay, animated, untiring companion of their excursions, who made them acquainted with nature, and knew so well how to encourage and interest them in their studies."

One of the brightest features in Agassiz's character, is the fact that he sank all personal interests in science. He was devoted to it, his life seemed a consecration to the dissemination of knowledge. This is well shown in a letter to Professor Silliman, written previous to his trip to America and published in the *American Journal of Science*, 1874: "In order to prepare for the extra expense, I shall be obliged to live very economically and in a manner little in accordance with the royal munificence which has furnished the means of making this journey." And again: "My sphere is entirely too circumscribed by the scientific world, and all my ambition is limited to being useful to the branch of science I particularly cultivate. With all this I am no misanthrope; but I learned early that when one has no fortune, one cannot serve science and at the same time live in the world. If I have been able to pro-

duce numerous expensive publications, it has been only by following this system of economy and voluntary seclusion; and the results which I have obtained thus far have rewarded me so well for the privations which I have suffered, that I have no temptation to adopt another style of life, even should I hereafter, and especially in your country, suffer more trouble than I have had to sustain in my own."

Agassiz remained in Paris some time, completing his second work on glaciers. While here he received the Monthyon Prize of Physiology from the Academy in appreciation of his work on fossil fishes. From Paris he went to England, sailing from there for America, arriving in Boston in October, 1846. His fame had long preceded him, and the name of Agassiz was a familiar one to the people of Boston, and when he appeared upon the platform, ready to begin his series on *The Plan of Creation*, he was accorded a warm and enthusiastic welcome. Fresh from Europe and entirely unfamiliar with the democratic institutions and methods of America, he found himself confronted by an audience of to him an extraordinary nature. It was composed not of the wealthy people exclusively, but of the rich and the poor, side by side. The plan of securing tickets to the Lowell Institute was to draw lots for them, thus giving all classes an equal opportunity to benefit by the bequest. Agassiz was obviously at a disadvantage in his imperfect mastery of the English language, yet such was his charm of manner, his forcible and simple method of presenting facts, that

his hearers were delighted, and he scored an immediate success. Many distinguished scientists had addressed the same listeners, yet none had so captivated and appealed to them, or so aroused their enthusiasm. The lecturer spoke in broken English and often paused to select a word in his limited vocabulary, but in no instance did the audience lose patience. His forcible manner of expression, his marvellous skill in illustrating, by which he showed the growth and development of forms, delighted his auditors and he held their attention until the last.

At this period Agassiz was thirty-nine years of age, in his prime, and enthusiastic on almost every subject where the possible extension of knowledge might lie. He found a new field in America and immediately took his place as the first and greatest of science teachers. Between his lectures he travelled and familiarised himself with the people, their manners and customs, and despite what were to him incongruities he was impressed with the feeling that here in this free land there was even a greater field, a broader mission, than he could find in Europe, and there is little doubt that he early conceived the hope that he might remain in America permanently. He was impressed with the fact that here he was brought closer to the people.

In a letter to a friend he wrote to the effect that one of the strangest sights he ever witnessed was a meeting of three thousand workmen who had gathered together to found a library. He remarked their neat appearance, the absence of any evidence of poverty, and insensibly contrasted the labouring

A GAPO, OR FLOODED FOREST. (BRAZIL.)

classes of Europe and America and their several chances of advancement.

At an early day he availed himself of an opportunity to meet Professor Silliman of Yale, with whom he had corresponded for a number of years. Asa Gray of Boston, Redfield, Professor Torrey, of Princeton, Henry Lea, the Le Contes, Dana, and others he now met, and in a trip taken to Washington he was overwhelmed with attention. He avoided social entertainments as such, almost invariably, having a good excuse in the fact that as the King of Prussia paid him for his time, his services belonged to him. "For this," he says, "no one can quarrel with me, and so far as I am concerned it is much better." On this tour Agassiz met the late Professor Spencer F. Baird, then a professor in Dickinson College in Carlisle. While visiting the larger cities he was constantly in demand and invited to receptions and entertainments; but he avoided all he could. A gentleman who called upon him at the Mayor's in New York, at this time, failed to gain an audience, and at last obtained the startling information that Mr. Agassiz was a very queer man and evidently in the fish business as he spent most of his time around the docks, especially at the fish-market, bringing home all sorts of fish, crabs, and turtles, "and," said the informant, "the more worthless the fish is the more he likes it. He 's daft, I 'm thinking." The listener took the hint and paid his respects to Agassiz at the fish-market, finding him just about to start home, loaded down with "new species," which he had discovered temptingly arrayed on the fish-

dealer's marble slab. Agassiz says himself at this time, "Wishing to employ my time as usefully as possible I postponed my visits to the *savants* of the city and the delivery of my letters, till I was on the eve of departure that I might avoid all invitations."

Agassiz made the trip up the Hudson and was delighted with West Point, where with Professor Bailey he renewed acquaintance with the glacial moraines and polished bowlders. At Albany he visited the State Museum and was deeply impressed with the publications on science which were available to the humblest citizen. During all this trip he made many accurate observations of the fauna and formed good representative collections, and, further, recorded many impressions regarding American scientists. To those at home he wrote, "The liberality of American naturalists to me is unparalleled." He appreciated the pluck and enterprise of the American scientists and näively said, "What they need is leisure." Agassiz did not anticipate becoming a citizen of the busy Republic at this time, but in after years, when he became a member of the body politic, he fully appreciated this lack of leisure and ultimately fell a victim to the American curse of overwork. The course of lectures given at the Lowell Institute was so eminently successful that upon its termination, another was begun upon glaciers, his favourite topic.

The associations which Agassiz made, the customs of the people, the manner of living, and the political freedom enjoyed, all impressed him strongly, and we find him becoming an enthusiast on every-

thing American. "Never," he wrote to Chancellor Favargez, "did the future look brighter to me than now." How firmly the American idea was taking possession of his being is shown by a quotation from a letter to a friend in which he says: "I am constantly asking myself which is better,—our old Europe, where the man of exceptional gifts can give himself absolutely to study, opening thus a wider horizon for the human mind, while at his side thousands barely vegetate in degradation or at least in destitution; or this new world, where the institutions tend to keep all on one level as part of the general mass,—but a mass, be it said, which has no noxious elements. Yes, the mass here is decidedly good. All the world lives well, is decently clad, learns something, is awake and interested. Instruction does not, as in some parts of Germany, for instance, furnish a man with an intellectual tool and then deny him the free use of it. The strength of America lies in the prodigious number of individuals who think and work at the same time. It is a severe test of pretentious mediocrity, but I fear it may also efface originality."

To Milne Edwards he wrote: "Naturalist as I am, I cannot but put the people first,—the people who have opened this part of the American continent to European civilisation. What a people! But to understand them you must live among them. Our education, the principles of our society, the motives of our actions differ so greatly from what I see here, that I should try in vain to give you an idea of this great nation, passing from childhood to maturity

with the faults of spoiled children, and yet with the nobility of character and the enthusiasm of youth. Their look is wholly turned toward the future."

Of all the scientists Agassiz selected Dana as showing the most promise, considering him the head and leader. He held Gould, Wilkes, De Kay, Holbrook, and Pickering in high estimation, declaring the latter to be a well of science. Le Conte, Wyman, Torrey, Gray, Pierce, Jackson, James Hall, Rogers, Dr. Morton, and others he fully appreciated, and wrote to friends in Europe regarding their work and high aims in the world of science.

Never before had Agassiz enjoyed so favourable an opportunity to study marine life, and with avidity he availed himself of the facilities afforded by the neighbouring shore of Nahant, where later he made his home. Here he made many remarkable and interesting discoveries among the lower forms of marine life, which were read by his friends in Paris before the Academy of Sciences. It was at this time that Dr. Holder, late curator of zoölogy at the American Museum of Natural History, New York, and father of the author, met Agassiz, joining him in many of his expeditions along Lynn Bay and the shores of Nahant.

To the author he often referred to Agassiz, especially to his principles, not only holding him up as one of the greatest of living scientists in his estimation, but believing that the feature in his doctrine that the Creator was everywhere shown by the teachings of nature, would as time advanced give him increasing fame and an undying place in history.

George B. Emerson was one of the acquaintances formed by Agassiz at this time and the following gives his impressions of the latter:

"A little more than twenty-seven years ago, as I was sitting in my study, a message came to me that two gentlemen desired to see me. They were immediately admitted, and Dr. Gould introduced me to Louis Agassiz. His noble presence, the genial expression of his face, his beaming eye and earnest, natural voice, at once gained me, and I responded cordially to his introduction. He said, 'I have come to see you, because Dr. Gould tells me that you know the trees of Massachusetts; I wish to be made acquainted with the Carya. I have found the leaves and fruit of several species in the Jura Mountains, where they were deposited when those mountains were formed; but, since that time, none have been found living in Europe. I want to know them as they are now growing.' I told him that I knew all the species found in New England, and should be glad to show them to him. 'But I have,' I said, 'presently to begin my morning's work. If you will let me call upon you immediately after dinner, I shall be glad to take you to them.'

"At the time fixed, I called on him at his lodgings, and took him in my chaise, first to Parker's Hill, where one species of hickory grew, then through Brookline, Brighton, and Cambridge, where two others were found, and to Chelsea, where a fourth, and one that might be a variety, were growing. I pointed out the characteristics of each species in growth, branching, bark, fruit, and leaves, and

especially in the buds. He listened with the most captivating attention, and expressed surprise at my dwelling upon the peculiarities of the buds. 'I have never known the buds to be spoken of as characteristic,' said he; 'that is new to me.' He admitted the distinct peculiarities of structure in the buds; and, I have no doubt, remembered every word I said, for, a few months afterwards, I saw, in a newspaper, that Mr. Agassiz would give a lecture, in Roxbury, on the buds of trees. We drove on to Chelsea Beach, which stretches off several miles,—apparently without end,—and, as the tide was very low, was then at least a quarter of a mile wide. He was charmed with everything, expressing his pleasure with all the earnestness of a happy child, hardly able to restrain himself in his admiration and delight. He told me that he had never before been on a sea-beach, but that he was familiar with the undulations and wave marks on the old beaches laid open in the Jura Mountains.

"I need not say what a pleasant drive this was. I had long felt great interest in various departments of Natural History, but had been so fully occupied with my own duties, as a teacher, that I had been unable to indulge myself fully, and that for a small part of the year, in one only. Here was a companion who was intimately acquainted with all, and with the most distinguished men who had been advancing them, and who was ready and happy to communicate wealth of information upon every point I could ask about.

"Some days after, I invited all the members of this Society (Boston Society of Natural History) to meet

Mr. Agassiz at my house. Every one came that could come. They conversed very freely on several subjects, and Agassiz showed the fulness of his knowledge, and his remarkable powers of instant observation. All seemed to feel what a precious accession American science was to receive.

"Not long afterwards, Mr. Agassiz accepted an invitation to spend Christmas with us. We took some pains, ourselves and our children, among whom were then two bright boys, full of fun and frolic, one in college, and one nearly prepared to enter. He was easily entertained, entering heartily, joyously, and hilariously, into everything, games and all, as if he were still as young as the youngest, but full of feeling, and moved, even to tears, by some poor lines to him and his native land."

A number of friends had followed Agassiz to this country, among them Count François de Pourtalès, who became one of America's distinguished naturalists, Mr. E. Desor, and Mr. Jacques Burkhardt, so that his new home in East Boston often had much the semblance of the old Swiss residence. Here, as there, hard work was the order of the day, and this bachelor's-hall, for so it might be called, as Mrs. Agassiz and her children were still in Europe, became the centre of scientific interest and head-quarters for the naturalists—who had become inspired by his methods and enthusiasm.

The establishment of Agassiz in this home in East Boston forms the beginning of an epoch in the scientific history of America. From this little centre waves began to radiate that spread over the entire

country. Agassiz's reputation as a teacher increased; pupils came from far and near, and a revival in American scientific circles took shape that not only produced telling results in science but caused Agassiz to remain in America and cast his fortunes henceforth with the great Republic.

CHAPTER XIII.

AGASSIZ AT HARVARD.

The Scientific School at Cambridge—A Professorship Tendered—The Agassiz Household—Death of Mrs. Agassiz—The Museum of Comparative Zoölogy—Agassiz and the Coast Survey—Trip to Lake Superior—Second Marriage—Expedition to the Florida Reef—Acceptance of a Professorship in the Charleston Medical College—Ill Health—Return to Cambridge.

IN 1848 the King of Prussia gave Agassiz an honourable discharge from his service, and the naturalist was free to turn in any direction that he desired. It so happened that Amos Lawrence now founded a scientific school at Cambridge as a branch of Harvard University, and having been attracted by the brilliant attainments of the Swiss scientist, he offered him the chair of Natural History with a salary of fifteen hundred dollars. This Agassiz accepted in 1848, and at the age of forty he became a professor of the University at Harvard, with Felton, Longfellow,

Pierce, Asa Gray, and Jeffries Wyman as colleagues, while Channing, Emerson, Whittier, Ticknor, Motley, Lowell, and others of that brilliant coterie became his intimates. The home in East Boston was broken up, Agassiz removing to Cambridge, his new home soon becoming the centre of a social and scientific interest, as the strong personality, the genius of the man captivated every one and imparted new life and inspiration to all who surrounded him. His family—wife, son, and young daughter—were still in Switzerland that now (1848) was undergoing no little political excitement, due to the proclamation of France. The household in Boston was cared for by a Swiss clergyman named Christinat, who had long been an intimate friend and companion, and whose devotion and love for the scientist was not only affecting but suggestive of the strong and loyal attachment Agassiz was capable of inspiring among all who came in contact with him. Agassiz was especially attached to Mr. Guyot, who followed him to America and became a member of his family at a time when Agassiz needed the presence of a close friend, as he had recently been apprised of the death of his wife who had for years been an invalid. In speaking of Mrs. Agassiz Prof. Guyot, in his biographical memoir of Louis Agassiz, says: "She was a noble-minded young woman of rare moral excellence. A dignified serenity, tempered by much gentleness and simplicity of manner, won for her at once respect and affection. Her deeper feelings were often veiled by a natural reserve which, however, never assumed the appearance of coldness. Her talent for drawing was of

the first order, and she was fond of placing it at the disposal of her favourite brother, Alexander. The drawings of natural objects which she executed for him, and later for Agassiz, commanded the admiration of all by their taste and exquisite correctness."

The new home gradually assumed the appearance of a zoölogical garden on a modified scale. Here the stranger would meet many surprises. The obstruction beneath his feet might be a living turtle; here might be seen a number of live alligators, there a rabbit, while near at hand an eagle, a bear, and some young opossums awaited investigation.

As an example of the persistence and thoroughness of Agassiz, he was one evening the guest of a Boston Microscopical Club when a member made the statement that he had studied a certain form four days, and finding that nothing resulted from this elaborate investigation gave it up as impracticable. After some discussion the guest of the evening, Agassiz, was called upon. He astonished them by saying that he also had studied the object in question, having it under his eye at stated periods *night and day for six weeks.* It is needless to say that he set the microscopists an example by his persistent labour, and, as Dr. Stebbins has said: "The spirit of Agassiz took possession of their souls."

This period of Agassiz's life was epoch-making. He embarked upon his duties as a professor of zoölogy with all his accustomed vigour, and made his presence felt at once. He instigated a new departure in American natural history and founded what may be termed the Agassiz school of natural science teach-

ing, which holds to-day wherever the greatest success is found. His lectures were fully attended, and he drew to the institution scholars from every portion of the country, who had heard of his fame and were desirous of emulating his methods. Finding the appliances for teaching crude and imperfect, he immediately began to work upon the problem that, when solved, resulted in the greatest comparative museum in America—the Museum of Comparative Zoölogy at Cambridge. There was at that time no museum at Cambridge and no specimens, though they were accumulating day by day under the skilled hands of Agassiz and his friends. The laboratory consisted of an ancient shanty, which stood on four water-logged piles on the Charles River near the Brighton Bridge. Here specimens were packed, and at the rude tables the students and their preceptors often worked, making under the leaking roof and crazy walls many interesting and valuable incursions into the fields of science.

Agassiz now had abundant opportunity to devote himself to marine zoölogy—a subject to which he had always been inclined, but which from his residence in the interior he had never enjoyed. The Coast Survey offered him every facility, and he made many and valuable trips with Captain Henry Davis. The work which he accomplished attracted the attention of Dr. Bache, then superintendent of the Coast Survey, and recognising the results that could be produced, he aided Agassiz in every way possible, placing the "Bibb" at his disposal whenever the opportunity occurred.

Agassiz's expeditions were not confined to the sea. In 1848 he organised a party made up of some of his pupils, having as its objective the shores of Lake Superior between Fort William and Sault Sainte Marie. The trip lingered long in the memory of those who made it. Here Agassiz was at his best, discussing and teaching as he investigated. Once upon the ground the party camped, the evenings being devoted to lectures from Agassiz or discussions on the observations of the day. Here he renewed his glacial studies and expounded to his young friends his favourite theories, which found abundant expression.

The entire Superior region was worked up in a manner novel and telling. The country was accurately surveyed, while the fishes of the lake were represented in a fine collection. The complete account of the trip was afterwards published, and stands to-day the most exhaustive treatise on the locality ever made.

During this year Agassiz issued his *Principles of Zoölogy*, written conjointly with Gould,—a work that had a remarkable sale and is selling to-day. Agassiz still had an idea that he might return to Europe, but in 1850 an event occurred which undoubtedly settled the question. This was his marriage with Elizabeth Graves Cary, the gifted woman who now survives him.

The question of a museum was ever uppermost in Agassiz's mind, and one day he received a letter which seemed an inspiration in this direction, an opportunity to add greatly to his collections. The

letter was from Dr. Bache, offering him a six-weeks' tour on the Florida Reef to answer certain questions regarding the growth and formation of coral. Nothing could have been offered Agassiz that would have delighted him more. We can well imagine that Darwin's writings on coral reefs had excited his interest and that he longed to make incursions into this most fascinating of all fields of zoölogy. Dr. Bache gave him the entire control of a vessel, and the expedition started well equipped with appliances and assistants.

One result of this expedition was to provide the growing collection at Cambridge with fine specimens of corals, sea fans, shells, fishes, in fact, a very fair representation of the fauna of the gulf as found at Tortugas, and, which now rest in the fine museum at Cambridge. Agassiz had stopped in Charleston, S. C., on his way south, there forming extremely pleasant acquaintances, and in 1851 he received the offer of a professorship in the Charleston Medical College which, curiously enough, he found to be more remunerative than his present position, as the professorship at Harvard required him to give outside lectures to bring the salary up to his expenses. This, and the fact that hard work was telling upon him and that he required a quieter life, inclined him to accept, and in 1851 we find him installed and at work in a new laboratory on Sullivan's Island, which was washed by the warm waters of the gulf which brought the forms he now had become familiar with directly to his doors. Here the naturalist passed many happy hours, obtaining what was a rest to

him, though every moment had its duties. It was during his stay in Charleston that he received the Cuvier prize, also the letter from his proud mother, in which she wrote: "Your fossil fishes, which have cost you so much anxiety, so much toil, so many sacrifices, have now been estimated at their true value by the most eminent judges. . . . This has given me such happiness, dear Louis, that the tears are in my eyes as I write it to you."

France became jealous of America in the possession of Agassiz, and the Emperor Napoleon offered him a position that would have attracted the ordinary man, the highest scientific office in his gift, also intimating that as a citizen of France it was not exactly the right thing for him to give the benefits of his mind to a foreign country. To this Agassiz replied, "that he was not a citizen of France and that his family owed nothing to it but exile and poverty; and that he prized more highly the spontaneous gratitude and gifts of a free people than the patronage of emperors and the formal regard of nobles."

The influence of Agassiz had now permeated every portion of the United States and everywhere his methods were accepted and followed. He was an indefatigable collector in America as he had been in Europe, and in 1855 he had accumulated specimens covering almost every field in natural history. The museum which was so needed at Cambridge was ever in his mind, and his desire was to make it not merely a display of animals but instructive in its very arrangement. He had constant fear for his treasures, which were stored in Cambridge in an old

building on the college grounds. The college allowed four hundred dollars per annum for their care, but this was totally insufficient, and Agassiz exhausted his private resources in attempting to have them properly preserved; finally his efforts were appreciated, certain wealthy men coming to the front with ten or twelve thousand dollars with which the collection was purchased for Cambridge University.

Agassiz resigned his professorship at Charleston in 1853 on account of ill health, and during the following year, which he spent at Harvard, he received an urgent invitation from the university of Zurich. But he had become Americanised, and could not be tempted from his allegiance to the land of his adoption. Again at Cambridge, he made a study of the fishes of all the great rivers and lakes, provided sea captains with cans of alcohol, when they started on their voyages, for the chance specimens which might be picked up, and all over the country, among all classes, formed friends who became, to a more or less extent, his disciples and aiders, and specimens of all kinds poured into the new hall of science which Harvard had built for the scientist.

In 1855, Agassiz with his wife established a school for young ladies, which soon became one of the institutions of Boston. The idea did not originate with the scientist, but was one of the many plans formulated by his wife and children to aid him. The following from the circular of the school shows that Agassiz took an active part in it, and there are many in Boston to-day who look back with tender recollections to the pleasant hours spent in the

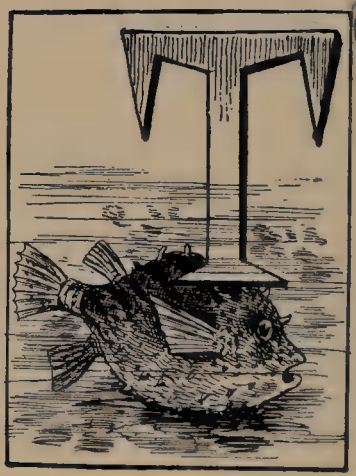
master's company: "I shall myself superintend the methods of instruction and tuition, and, while maintaining that regularity and precision in the studies so important to mental training, shall endeavour to prevent the necessary discipline from falling into a lifeless routine, alike deadening to the spirit of teacher and pupil. It is further my intention to take the immediate charge of the instruction in Physical Geography, Natural History, and Botany, giving a lecture daily, Saturdays excepted, on one or other of these subjects, illustrated by specimens, models, maps, and drawings."

This school was continued eight years, and through this means he was relieved from pecuniary anxieties.

CHAPTER XIV.

LIFE IN CAMBRIDGE.

Continued Honours—Invitation to Paris—Receives the Order of the Legion of Honour—Bequest of Francis C. Gray—The Museum—Visit to Europe—Dedication of the Museum—Growth of Corals—The "Contributions"—Fiftieth Birthday—Patriotism—Founder of the National Academy.



THE growing fame of Agassiz, his continued work in science, and the accomplishment of such grand results in so varied fields of investigation and research kept him constantly before the world, and he was the continued recipient of many honours. Among the strong temptations to leave the country of his choice was an invitation from Paris in 1857, tendering him the chair of Palæontology in the Museum of Natural History—a position until then held by the celebrated D'Orbigny. No offer that Agassiz had re-

MOUTH OF THE RIVER JAVARI, A TRIBUTARY ON THE RIGHT OF THE AMAZON.

ceived touched him more, as he still remembered how far above him seemed this chair when a few years before he was a struggling student in the great city of Cuvier and Humboldt. Agassiz refused this honour which was later renewed with the proviso that he should accept at his own convenience. But he remained firm, and his French admirers gave up the attempt, and later the Order of the Legion of Honour was conferred upon him, showing the esteem in which the Emperor held him. It was reported at this time, and with truth, that Agassiz had written to a friend, "Were I offered absolute power for the reorganisation of the *Jardin des Plantes*, with a revenue of fifty thousand francs, I should not accept it. I like my independence better."

This and the fact that he continued to refuse these honours aroused, if possible, a stronger feeling for him in the hearts of American people. He had become one of them; was now an American scientist, teacher, and patriot. The increased attention which was given him aided in the accomplishment of his heart's desire, which was the founding of a great museum. He spent much time in planning this museum which was to be, as everything he formulated, instructive, broadening, object-teaching. With his friends he discussed his plans, and upon the death of Francis C. Gray, fifty thousand dollars was bequeathed for the establishment of a museum on the plan of his friend Agassiz. Among other conditions was the following: "That neither the collections nor any building which may contain the same shall ever be designated by any other name

than the Museum of Comparative Zoölogy at Harvard." This was the wish of Agassiz, who did not desire it to bear his name, which would have delighted every one, but to-day, it is generally known and rightly, as the Agassiz Museum. He was its founder, its builder from inception to finish. The legacy of Mr. Gray was followed by others. The University granted the land for the building site, and the State provided lands to the value of one hundred thousand dollars for the edifice, to which were added other sums—the subscriptions of private parties, and finally, the present Museum of Comparative Zoölogy with its fine collections was begun.

It should not be supposed that Agassiz obtained the appropriation from the State without some trouble. He met the legislators appointed to confer with him in the hall of the Capitol, and was listened to by the members of both Houses as he plead for science as a man would for his life. He spoke for Massachusetts and education, claiming that the Bay State should take the lead and keep it. He had determined to give his life to that end if Massachusetts would aid him. "My great object," he said, "is to have a museum founded here which will be equal to the great museums of the Old World. We have a continent before us for exploration, which has as yet been only skimmed on the surface. My earnest desire has always been to put our museums on a footing with those of Europe or even ahead of them." The address stirred the hearts and patriotism of the hearers, though there were some who cast ridicule upon the proposition to build, as they said,

"a palace for bugs." But the enthusiasm and faith of Agassiz in the people of Massachusetts was not misplaced, and the bill passed.

After a short visit to Europe in the summer of 1859 Agassiz returned and witnessed the dedication of the museum in 1860. It so happened that in this year the author of the present volume was an active worker, for the pleasure of it, for the new museum, and during a residence on the Florida reef, where the author's father was stationed as an army surgeon, thousands of specimens were collected and sent to the Agassiz Museum. Many of the rare shells and corals in the cabinets the author dived for in the deep lagoons of the locality, bringing up also bright-hued gorgonias, pink-lipped conchs, and other forms which were sent North as best we could by sailing, vessels that stopped here. Letters soon came from Agassiz expressing delight at the variety of the forms, with suggestions for research in new directions; letters that showed his great enthusiasm on all questions appertaining to natural history. Some of the investigations made here came as a surprise to Agassiz. The latter requested Dr. J. B. Holder to observe if possible the growth of corals. Dr. Holder was an ardent naturalist, an admirer and disciple of Agassiz, and the work was a labour of love. To better study the corals a wall of dead concrete rock was built out into the gulf, forming a tide-water aquarium through which the water flowed and ebbed, and within this were placed various marine forms which were to be studied, among them the corals. Agassiz had spent some time in this locality with Bache, and his

estimate of the growth of corals was very low. In a paper and afterwards in his *Methods of Study* he says in substance that a brick placed under water in 1850 by Captain Woodbury was taken up in 1858 and found to have a crust of coral upon it a little more than half an inch in thickness. This is evidently a mistake, as Captain Woodbury was not ordered to Tortugas until 1857. The brick referred to is probably one sent to Prof. Agassiz by Dr. Holder. The piece of brick when first found had a small head of *Meandrina convexa* upon the side. Dr. Holder watched it a year, keeping it in the aquarium under what might be considered unfavourable circumstances for its rapid growth, and found that in twelve months it doubled its diameter, or from one inch it had increased to two, the growth being one inch in a year instead of half an inch in eight years; or in another case mentioned by Prof. Agassiz, half an inch in ten years. Dr. Holder thus established the fact that the growth of this genus of corals was much more rapid than was generally supposed. A cut of the coral is figured in Holder's *Elements of Zoölogy*.

The new museum, while it occupied much of Agassiz's time and resources, did not prevent him from devoting attention to various new fields. He was continually bringing out some new work, and his "Contributions" are monuments to his industry in these years. Humboldt wrote regarding the latter: ". . . I hear that by some untoward circumstances, no doubt accidental, you have never received, my dear Agassiz, the letter expressing the pleasure

which I have with all true lovers of science respecting your important undertaking, *Contributions to the Natural History of the United States.*" This series was originally intended to embrace the facts he had accumulated in America,—a work of great expense that was carried through by the aid of Francis. C. Gray, who aroused so great interest in the subject that a remarkable subscription list was obtained. In the Preface Agassiz says: "I must beg my European readers to remember that this work is written in America, and more especially for Americans; and that the community to which it is particularly addressed has very different wants from those of the reading public in Europe. There is not a class of learned men here distinct from the other cultivated members of the community. On the contrary, so general is the desire for knowledge, that I expect to see my book read by operatives, by fishermen, by farmers, quite as extensively as by the students in our colleges or by the learned professions, and it is but proper that I should endeavour to make myself understood by all."

The series of ten volumes was never completed, but the four that were, stand to-day a monument to his energy and to his extraordinary fact-collecting faculty as exhibited in his American life.

The completion of the first volume celebrated his fiftieth birthday.

On the eve of this anniversary his pupils gave him a serenade. As midnight came their young voices rose in a grand choral of Bach's, and when the master appeared, bewildered and delighted, he

was greeted with flowers and congratulations by many who loved him well.

This birthday was made memorable by a dinner given to Agassiz by the famous "Saturday Club," of which Dr. Holmes said when referring to Longfellow: "On one occasion he read a short poem at the table. It was in honour of Agassiz's birthday, and I cannot forget the very modest, delicate musical way in which he read his charming verses."

The poem is probably familiar to all—yet it is fitting that it should find place here.

"THE FIFTIETH BIRTHDAY OF AGASSIZ.

"It was fifty years ago,
In the pleasant month of May,
In the beautiful Pays de Vaud,
A child in its cradle lay.

"And Nature, the old nurse, took
The child upon her knee,
Saying: 'Here is a story-book
Thy father has written for thee.'

"'Come wander with me,' she said,
'Into regions yet untrod,
And read what is still unread
In the manuscripts of God.'

"And he wandered away and away
With Nature, the dear old nurse,
Who sang to him night and day
The rhymes of the universe.

"And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song,
Or tell a more marvellous tale.

" So she keeps him still a child,
And will not let him go,
Though at times his heart beats wild
For the beautiful Pays de Vaud ;

" Though at times he hears in his dreams
The Ranz des Vaches of old,
And the rush of mountain streams
From glaciers clear and cold ;

" And the mother at home says, ' Hark !
For his voice I listen and yearn ;
It is growing late and dark,
And my boy does not return.' "

May 28, 1857.

The " Saturday Club " referred to was a favourite organisation with Agassiz. Dr. Holmes writes regarding it : " At one end of the table sat Longfellow, placid, quiet, benignant, soft-voiced, a most agreeable rather than a brilliant talker, but a man upon whom it was always pleasant to look,—whose silence was better than many another man's conversation. At the other end sat Agassiz, robust, sanguine, animated, full of talk, boy-like in his laughter. The stranger who should have asked who were the men ranged along the sides of the table would have heard in answer the names of Hawthorne, Motley, Dana, Lowell, Whipple, Peirce, the distinguished mathematician, Judge Hoar, eminent at the bar and in the cabinet, Dwight, the leading musical critic of Boston for a whole generation, Sumner, the academic champion of freedom, Andrew, ' the great war governor ' of Massachusetts, Dr. Howe, the philanthrophist, William Hunt, the painter, with others not unworthy of such company."

Agassiz took no active part in the civil war. His sympathies were with the North, and during the struggle he was naturalised as an American and lost no occasion to aid the cause of humanity by word or deed. In truth, his opinions, widely expressed in Europe during the war, had more effect than is generally supposed.

His discussion with Dr. Howe in 1863 on the position of the negro, attracted universal attention, and abstracts of the answers which Agassiz gave to the circular sent out by Dr. Howe were copied widely in this country and Europe. The question before the people was what to do with the liberated slaves and what position should they occupy. The particular question which Dr. Howe, the philanthrophist, asked of Agassiz, the naturalist, was, "Is it probable that the African race, represented by less than two million blacks and a little more than two million mulattoes, unrecruited by immigration, will be a persistent race in the country? or will it be absorbed, diluted, and finally effaced by the white race, numbering twenty-four millions, and continually increased by immigration, beside natural causes."

Agassiz's reply was, in brief, that the negroes could not be compared to the Indians who fell away and disappeared before the white man. They were more pliable, and as they readily adapted themselves to various conditions of life they would hold their own; indeed, increase in the South; and time has shown that he was right. Regarding the political rights of the negro Agassiz said: "I have no hesitation in

saying that they should be equal to other men before the law."

While Agassiz took an active interest in all questions his greatest thought at this time was the museum, which ever grew under his guidance. Hardly a day passed but some new idea or scheme took form in his fertile mind; now the aid of consuls in foreign lands was involved; now the fishing fleet was asked to collect for the museum; even the smacks which ran down the coast to Cuba carried the copper cans of alcohol of the Agassiz Museum, while the captain of every whaler bore in mind the circular, letter, or personal request of the ardent and indefatigable naturalist. In October, 1863, Agassiz conceived the daring plan of collecting the fishes of the rivers of the world—a work requiring a long time and endless labour and research, and the well conceived plan was put into execution and to a marked degree was successful.

Agassiz was not alone the naturalist at Harvard. His advice on all matters was requested and taken, and his influence felt in the university life. It was partly at his suggestion that the Academic Council was founded, which was a monthly meeting of the professors, at which the various topics of interest were discussed. It was Agassiz who introduced the college lecture system. He was the father of a liberal elective system and made himself felt in almost every branch of the college life. Besides this, he founded many societies and kept them alive and active by the part he took in their work. He founded the National Academy of Sciences, which is now the

leading scientific body of the United States, and was the originator of numerous natural history societies throughout the United States.

Professor Burt G. Wilder relates the following amusing incident of Agassiz and his Harvard friends while off on a collecting tour:

"A summer party of Harvard professors were driven through the White Mountains. As the coach slowly ascended a hill, Agassiz and others would leave it and presently return laden with stones and wild flowers, or ornamented with beetles and butterflies pinned to their hats and the lapels of their coats. Professor Felton sat alone in the coach perusing a favourite Greek author. 'Who are those fellows?' at last asked the coachman, in whose eyes plants were interesting merely as food for his animals, minerals as likely to impede progress, and insects as apt to interfere with personal comfort. 'They are a party of naturalists,' said Felton. 'Ah!' replied he, 'that accounts for it, poor fellows.' A few days later he drove another party, to whom he confided his experience as follows: 'Last Thursday I had the queerest lot of passengers you ever saw; they were men grown and dressed like gentlemen; but they kept jumping out of the coach, and like little children ran about the field chasing butterflies and bugs, which they stuck all over their clothes. Their keeper told me they was *naturals;* and judging by their conduct, I should say they *was.*'

"Then," adds Professor Wilder, "the great naturalist was taken for a harmless lunatic; but he persisted, and the people at last listened to his precept

and followed his example. And if, to-day in almost any part of the United States, a man may pursue living creatures otherwise than for sport, and talk of them for another object than passing an idle hour, and nevertheless retain the respect of the community; if, in short, the occupations of natural history collecting and teaching are now honourable and at least more lucrative than before, it is to Agassiz more than any other one man that the change must be ascribed."

Agassiz had many opportunities to materially increase his income; he had but to turn aside from his scientific work. To all these suggestions, however, he was obdurate. He declined a very advantageous offer to write a text-book on the ground that he did not believe in text-book teaching; indeed it was inimical to his methods. To another offer to lend himself to a legitimate and tempting financial scheme he replied, "I have no time to make money." Vacation in the ordinary sense was unknown to Agassiz. Every trip had some significance to the scientific world, every "rest" a new line of investigation, from which he returned freighted with collections and facts. In the fall of 1864 he undertook an elaborate study of the glacial phenomena on the Maine islands, the results of which are graphically given in one of his most interesting works, *Geological Sketches.*

CHAPTER XV.

AGASSIZ IN BRAZIL.

Failing Health—Brazilian Trip—Naturalists of the Party—Arrival in Brazil—Courtesy of Dom Pedro—Lectures in French before the Emperor—Visit to Coffee Plantation—Strange Ant Nests—Hunting in Brazil—Attempt to Observe the Tapir—Curious Animals—Ant-eaters, Sloths, etc.

IN the year 1865 Agassiz was fifty-eight years of age. Few men had accomplished so much, yet if questioned the great naturalist would have expressed remorse that he had done so little. He saw the book of nature spread before him, God's word expressed in every leaf, fish, or fossil, in every mountain stream or glacier, and considered it a sacred duty to preach this great sermon of God, the maker of nature, and his work to all mankind. How impassioned was his teaching the world knows. Time was all too short for him; every hour had its duty and must

ÉGARITEA BOAT OF THE UPPER AMAZON.

be accounted for. Such was the doctrine of this brilliant mind; yet no one could stand the physical and mental strain its fulfilment demanded, and he, the man who had slept on the glacier night after night with only a blanket beneath him, who had buffeted a thousand mental and physical storms, began to fail. The pace was telling. The advice of his friend Cuvier that "work kills" was in a fair way to be demonstrated; in short, a rest and change was demanded, and Agassiz took it in a characteristic manner—by forming one of the most important expeditions of his life, one which resulted in many valuable discoveries and much arduous labour. He had decided to make a trip to Brazil as a vacation, and while the matter was under discussion he met a friend, Mr. Nathaniel Thayer, of Boston, who generously offered to equip a party and defray the expenses of the expedition. The party was composed of Professor and Mrs. Agassiz, his old friend Burkhardt, as artist, John G. Anthony, conchologist, Orestes St. John and Frederick C. Hartt as geologists, John A. Allen, ornithologist, and George Sceva as preparator. In addition to these a number of volunteers joined the party. Agassiz's brother-in-law, Thomas G. Cary, Walter Hunnewell, S. V. R. Thayer, Newton Dexter, William James, Thomas Ward and Edward Copeland, also Dr. and Mrs. Cotting.

It will be remembered that Agassiz was given the Spix collection of Brazilian fishes to describe by his companion Martius, and from that time he had always longed to study these beautiful forms in their

homes. This was the chief object of the expedition which in three weeks arrived in Rio Janeiro.

Agassiz went immediately to the Emperor, from whom he had received many favours, to pay his respects. His Majesty gave the visitors every attention and aided materially in the collection of rare specimens.

It would be impossible to follow the naturalists throughout this trip. It was a zoölogical expedition, and to this feature especial attention is called, though a full description of Agassiz's South American tour would take the reader through every possible field of thought or natural history.

Dom Pedro returned the call of Agassiz in the Imperial yacht, and by his attention and interest proved himself the enlightened and enthusiastic scientist he was. The Emperor was fully in sympathy with Agassiz, and a warm friendship sprang up between the two men whose tastes were a bond that broke away the barriers of ceremony and rank. The Emperor promised his hearty co-operation, and a few days later the actual work of the expedition was begun, and the plans Agassiz had laid out put in operation.

This was Agassiz's first visit to the extreme tropics. He had spent days and weeks on the glaciers, sleeping, eating, and living on the great ice rivers, and had always looked forward to the time when he could enter the forests of the tropics and observe the various forms that made up its fauna. Here was the opportunity, and Agassiz embraced it with all his old-time enthusiasm, which, it is needless to

say, was imparted to all his colleagues. The laboratory which he established was the centre of attraction, and when the object of the strangers became known specimens poured in from every quarter.

The first trip of importance was over the road of the Union and Industry Company from Petropolis to Juiz de Fora. Here Agassiz obtained his first actual view of the wealth of tropical vegetation, which, with the variety of palms, exceeded his greatest expectations.

At Juiz de Fora he found an ardent ally in a German engineer, and hardly had the party been there a day before the neighbourhood was being scoured by all the children for specimens.

This German gentleman had a fine collection of natural objects which greatly interested Agassiz. From him news was received of the great northern victories—the capture of Richmond and Petersburg and the ending of the war.

Agassiz was particularly desirous of observing the evidences of glacial action in Brazil, which he believed must be present, and while near Tijuca he was gratified to find what he considered unmistakable evidence of the drift. Although supposed to be resting Agassiz was never quiet. He gave lectures on the steamer all the way to Brazil, and upon his return to Rio from Tijuca he hardly allowed himself a moment of leisure. His mind was entirely absorbed with the new work he had in view. When not actively engaged in collecting or investigating some subject he was caring for his specimens, working from early morning until late into the night. He organised his

aids and divided them up into various parties which he proposed sending into the interior, one of especial interest to him being a trip to the upper Rio San Francisco. Here he proposed that one of the party should cross the forest to the river Tocantins and follow it down to the Amazon, while others were to follow the valley of the Piauhy to the coast. To arrange for these trips required a great amount of work which would have tested the strength of a much stronger man.

During the time these preparations were being made Agassiz formed collections that gave a very complete idea of the fauna of the vicinity of Rio, as well as a part of Minas Geräes.

Dom Pedro took a personal interest in the work and requested Agassiz to deliver a series of scientific lectures in French,—doubtless the first of the kind ever given in the country, which to his great gratification were received favourably. The Emperor and his family honoured him by attending the lectures, and the audience was composed of the intelligence and fashion of the Brazilian capital.

After the series were completed Agassiz left Rio to visit the *fazenda* of Senhor Lage, where he wished to observe the culture of the coffee plant. He spent a number of delightful days here, during which he witnessed the festival of San João, which continued an entire week and consisted principally of hunting. Agassiz joined in the hunts, and, as a result, each sportsman became an enthusiastic collector for the American naturalist, who at the end of the week had accumulated a large number of rare

and valuable specimens from almost every branch of the animal kingdom. The method of hunting was eminently characteristic of the Brazilians. A clearing was made in which food was scattered, the hunters concealing themselves in the treetops or on the branches in huts or covers made of leaves from which they shot the capabara, the peccary, or other animals that ventured into the open.

On one of the rides from this place Agassiz made a study of the famous Cupim or Termites nests, which had been piled up to the extraordinary height of six feet with a diameter of three or four feet. These were hard as rocks, and it was necessary to split them open with axes to study their interiors. The nests he found were built of earth around the trunk of an old tree, the interior being permeated by endless passages—the halls of the remarkable house, which led down into the ground. Agassiz was much interested in this subject and watched the various kinds of ants which came out with all the delight of a student. To show the remarkable extent of the nests of the Sauba ants, which he also observed, he found that if smoke was blown into their dens it would reappear one quarter of a mile away. The wonders of ant life were almost inexhaustible. Here were ant armies passing over the country in every direction, often looking as if covered with green from the fact that each ant carried a green leaf in its powerful jaws. Agassiz was now in his element, and returned from his various tramps loaded down with collections of all kinds. He was particularly desirous of obtaining a tapir, wishing to compare it to certain extinct

forms and to observe it in its native wilds if possible. To afford him this opportunity, Mr. Lage, with whom they were visiting, organised a hunt, but after much excitement in false alarms they were destined to disappointment.

CHAPTER XVI.

AROUND PARÁ.

Amazon Life—The Natives—The Four-Eyed Fish—New Discoveries of Fishes—Forest Fishes—Tropical Scenery—A Canoe Voyage—Visit to a Forest Home—Indian Houses in the Submerged Forest—Opinions of the Natives Regarding Agassiz.

AUGUST found Agassiz and some of his friends at Pará, and, contrary to his expectations, in a delightfully cool climate, well adapted for the work of collecting which he had laid out for himself. On the way they had observed new jelly-fishes belonging to the *Phizostomidæ*, which were lifted aboard the steamer and given to the artist who made life-studies of the wondrous creatures in colours. Agassiz was particularly impressed with the wonders of the Amazon, and in referring to the islands he terms them "an archipelago of islands in an ocean of fresh water." He was much

interested in the natives, from whom he obtained many peculiar fish that were not included in the Spix collection with which he was so familiar. Their plan of work amused him not a little. This was to stretch a seine across the river, then go up stream by the bank and come down in the water, shouting and driving the fish before them—catching in this way sufficient to fill their canoes.

One rare fish observed here by Agassiz for the first time was what the Indians called *Tralhote*, being the *Anableps tetrophthalmus* of science. The term implies "four-eyed," from the peculiar structure of the organs of vision which are divided by a membranous fold into two halves, which is supposed to allow the fish to see in the air as well as in the water. The anableps was often observed hopping along at the surface, as if trying to see objects out of the water.

Agassiz was happy and fortunate in the presence in the party of a Brazilian naturalist, Major Coutinho, who gave him no little aid, possessing a knowledge of the Indian language that was invaluable, and made collections for him of all kinds.

Agassiz was constantly on the lookout for evidences of the drift and of glacial action, and was not a little puzzled by the peculiar deposit found in the valley of the Amazon. In a letter to the Emperor he wrote: "I am as far as ever from being able to point out the origin of these materials and the direction of their transportation. Now that Major Coutinho has learned to distinguish the drift from the decomposed rocks, he assures me that we

COMBAT OF THE JAGUAR AND GREAT ANT-EATER.

shall find it throughout the valley of the Amazons. The boldest imagination shrinks from any generalisation on this subject, and yet we must gradually familiarise ourselves with the idea that the cause which has dispersed these materials, whatever it be, has acted on the largest scale, since they are probably to be found all over the continent."

Although the especial interest of the naturalist was centred in the glacial drift and fishes, the latter received the most attention, and, as an evidence of his energy, he discovered at Pará more new species than were then known from the entire basin of the Amazon. One of the finest steamers plying on the river had been placed at his disposal, and under the most favourable auspices the party moved slowly up the great river, passing by hundreds of islands, a continuous panorama of rich tropical verdure. The weather was so delightful that they used hammocks swung on the deck of the vessel, literally living out-of-doors. At a little town named Breves they made the first stop, and it becoming noised about that a passenger desired bugs and animals of various kinds, the evening found Agassiz the centre of a crowd of children laden with animals of all kinds from centipedes to live monkeys. Many of the fishes so obtained were very rare and some new to science.

The shores of the river had a great charm for the naturalist, the majestic palms and their great variety forming a never tiring vista. Here he first became familiar with the rubber tree of commerce, observing the natives tap the trees as he had seen the

maples tapped for sugar in New England. What he termed the "forest fishes," those found about the trunks of submerged trees, interested him greatly, fifteen species finding place in the rapidly growing collection, ten of which were new. It is difficult for the layman to appreciate what an absolutely new species means to the ardent naturalist and what a keen sense of delight he experiences in the discovery, and later in the description. In one day eighty-four species of fish were taken, fifty-one of which were new. In fact, so rapidly did the new forms come in that it was almost impossible to care for them, much less make coloured drawings. At the town of Obydos Agassiz was pleased at being greeted by Dr. Marcus, who had years before forwarded specimens from the Amazon to the Cambridge Museum. From here he made an extended canoe voyage, which resulted in many valuable discoveries and afforded a fine opportunity for studying the natives, who wondered as did many of the whites, why the stranger should be so interested in the animals which they considered entirely worthless.

The method by which the natives adapted themselves to their surroundings was especially interesting to Agassiz. Owing to the large amount of submerged land and the dangers from a sudden rise in the river, many of their homes were built on piles sunk in the soft mud or soil. One Indian invited Agassiz to visit his house, and leading the way the naturalist followed him into the heart of the forest. The Indian had provided him with a long pole to cross the creeks on the logs safely, but finally the

water became so deep that he could not touch bottom with the pole. The logs, too, began to roll about, and Agassiz was obliged to confess that he could not follow this road. The Indian asked him to wait, and while Agassiz balanced himself on the slippery logs he went for a canoe and soon conveyed him to the opposite shore, where stood a picturesque little home in which the wife and children lived. In referring to the return Agassiz says: "I shall never forget that row, the more enchanting that it was so unexpected, through the narrow water-path, overarched by a solid roof of verdure, and black with shadows, and yet it was not gloomy, for outside, the sun was setting in crimson and gold, and its last beams struck in under the boughs and lit the interior of the forest with a warm glow. Nor shall I forget the face of our Indian friend, who had welcomed us so warmly to his home, and who evidently enjoyed our exclamations of delight and the effect of the surprise he had given us. The creek led by a détour back into the river, a few rods above the landing where our steamer lay. Our friendly boatman left us at the stairway, with a cordial good-bye, and many thanks from us at parting."

Agassiz was particularly impressed with the courtesy and kindness of the natives. Everywhere they showered attentions upon him, and examined Mrs. Agassiz—her hair, clothes, and articles of jewelry with the greatest curiosity. In the morning she would be awakened by the Indian woman bringing her flowers, repaying the courtesy by allowing them to examine her toilet articles. The native men

undoubtedly looked upon Agassiz as a mild and harmless lunatic, for what sane man would come thousands of miles to hunt for creatures that were utterly useless? In fact, the more useless they were the more the *Americano* seemed to care for them, which amused the natives greatly, while no doubt it was difficult for them to show their contempt for a man who would exchange a good chicken for a few fishes, and little ones at that.

FUNERAL VASE OF THE
MANAO INDIANS

VEGETATION OF THE CANAL DES BRÈVES.

CHAPTER XVII.

UP THE RIO NEGRO.

Interest of Dom Pedro—Wooding up a Rio Negro Steamer—At Teffê—Fishes That Carry Young in Their Mouths—Collecting Plants at Fonte Bôa—Laboratory at Teffé—Remakarble Family of Fishes—The Studis—Distribution of Fishes—Routine Work—Floating Islands—Numerous New Species of Fishes.

THE fifth of September Agassiz and his party entered the Rio Negro, and the trip was begun with great enthusiasm on the part of all. The influence of the Emperor was felt even in this out-of-the way section of the country, a steamer being placed at their disposal by his orders. Agassiz was more than astonished at the variety and abundance of the fishes found, and especially at the fact that they differed so in different localities not very far apart. To the President of Pará he wrote: "I hasten to inform you of the extraordinary success which continues to

crown our efforts. It is certain that from this time forth, the number of fishes inhabiting the Amazons greatly exceeds all that has hitherto been imagined, and that their distribution is very limited on the whole, though a small number of species have followed us since we left Pará and others have a range more or less extensive. You remember, perhaps, that, when alluding to my hopes, I told you one day that I believed in the possibility of finding from two hundred and fifty to three hundred species of fish in the whole basin of the Amazons, even now, having passed over less than one third of the main stream, and only diverged here and there to some points beyond its shores, I have already obtained more than three hundred. It is incredible, above all, if you consider that the total number known to naturalists does not reach one third of what I have already collected. This result scarcely allows one to foresee the discoveries to be made whenever the affluents of the great river are explored with the same care."

At every point during this trip there was something to interest the naturalist.

At Coari on the Coari River the travellers were much amused at the manner of passing wood aboard the steamer. Ten men having formed in a line a log was passed from one to the other and counted as it was received, seven logs a minute, according to Agassiz's estimate, finding their way into the hold of the steamer, which explained why the "wooding up" stops were of so long duration. At Teffé one of the most interesting discoveries was made, proving that some fishes carry their young in their mouths

at certain times. This discovery so fascinated Agassiz that he made his headquarters here for a month, carefully studying the fish, which he named after the Emperor, and which is described in the following letter to his Majesty:

"SIRE:—On arriving here this morning I had the most agreeable and unexpected surprise. The first fish brought to me was the Acara [see accompanying cut], which your Majesty kindly permitted me to dedicate to you, and by an unlooked-for good fortune it was the breeding season, and it had its mouth full of little young ones in the process of development. Here, then, is the most incredible fact in embryology fully confirmed, and it remains for me only to study, in detail and at leisure, all the changes which the young undergo up to the moment when they leave their singular nest, in order that I may publish a complete account of this curious history. My anticipations as to the distribution of fishes are confirmed; the river is inhabited by several very distinct ichthyological faunæ, which have, as a common link, only a very small number of species to be met with everywhere. It remains now to ascertain with precision the limits of these ichthyological regions, and I may perhaps be drawn on to devote some time to this study, if I find the means of accomplishing it. There is a question which now becomes very interesting; it is to know how far the same phenomenon is reproduced in each one of the great affluents of the river Amazon, or, in other words, whether the fishes of the upper regions of the Rio Madeira, the

Rio Negro, etc., etc., are the same as the lower course of these rivers. As to the diversity of fish in the whole basin, my expectations are far surpassed. Before arriving at Manaos I had already collected more than three hundred species—that is to say, at least three times the number of species thus far known. About half have been painted from life by Mr. Buckhardt; if I can succeed in publishing all these documents, the information I shall be able to furnish on this subject will exceed all that has thus far been made known. We are here without news from the south since we left Rio, and all we had learned then was, that after a very stormy passage your Majesty had reached the Rio Grande. May God protect and bless your Majesty!

"With sentiments of the most profound respect and the liveliest gratitude, I am,

"Your Majesty's very humble and obedient servant,

"L. AGASSIZ."

While Agassiz studied these fishes the other members of the party were up the various streams in the vicinity, and new facts were being added to science every day. At Fonte Bôa Agassiz made a fine collection of fossil plants and more new fishes, which kept artists and naturalists continually at work. Their headquarters at Teffé were delightful, the house being located in a green field descending gradually to the river. Near the house was a turtle-tank, which Agassiz immediately secured for his specimens and soon converted into an aquarium. The house took on the air of a laboratory. Cans, bags, and barrels stood about; there were swinging shelves for

specimens that were liable to be eaten by ants, tables for dissecting, while specimens were seen everywhere.

The first haul of the seine here was a most prolific one, resulting in the capture of thousands of fishes, among which were many new species that were eagerly examined and quickly sketched or painted to the life by the artists.

Agassiz had now secured about four hundred species of fishes, half of which had been copied in colour by Buckhardt. The specimens as soon as possible were transferred to glass jars, and thus the artist painted them as they poised before his eyes in all the glory of their brilliant colouring. Agassiz found that by this method he was correcting much careless work that had been done by previous investigators, who from studying poor and faded specimens had duplicated species many times over. Among the fishes found at Teffé was one (Geophagus) which had a most remarkable method of reproduction. In a letter Agassiz says, in referring to it: "The eggs pass, I know not how, into the mouth, the bottom of which is lined by them, between the inner appendages of the branchial arches, and especially into a pouch, formed by the upper pharyngeals, which they completely fill. There they are hatched, and the little ones, freed from the egg-case, are developed until they are in a condition to provide for their own existence. I do not yet know how long this continues; but I have already met with specimens whose young had no longer any vitelline sac, but were still harboured by the progenitor."

To Milne Edwards he wrote from here: "The embryology and metamorphoses of the Chromides, which I have just been studying, have convinced me that the fishes with labyrinthic branchiæ, separated from all other fishes by Cuvier, as a family entirely isolated on account of the strange structure of its respiratory organs, are closely related to the Chromides. Thus this group becomes, by its various affinities, one of the most interesting of the class of fishes, and the basin of the Amazon seems to be the true home of this family. I will not fatigue you with my ichthyological researches; let me only add, that the fishes are not uniformly spread over this great basin. I have already acquired the certainty that we must distinguish certain ichthyological faunæ very clearly characterised. Thus the species inhabiting the river of Pará, from the borders of the sea to the mouth of the Tocantins, differ from those which occur higher up; those of the lower course of the Xingu differ from those of the lower course of the Tapajoz. Those of the numerous igarapés and lakes of Manaos differ as much from those of the principal course of the great river and of its great affluents. It remains now to study the changes which may take place in this distribution in the course of the year, according to the height of the waters, and perhaps also according to the epoch at which the different species lay their eggs. Thus far I have met but a small number of species having a very extensive area of distribution. One of these is the Studis gigas, found almost everywhere. It is the most important fish of the river, that which, as food,

BURIAL-PLACE OF MANAO INDIANS.

corresponds to cattle for the population along the banks. Another problem to be solved is, how far this phenomenon of the local distribution of fishes is repeated in the great affluents of the Amazons."

Referring again to this remarkable discovery Agassiz says: "The species which lay their eggs in the sand belong to the genera Hydrogonus and Chætobranchus. Like the North American Pomotis, they build a kind of flat nest in the sand or mud, in which they deposit their eggs, hovering over them until the young are hatched. The species which carry their young in their mouth belong to several genera, formerly all included under the name of Geophagus by Heckel. I could not ascertain how the eggs are brought into the mouth, but the change must take place soon after they are laid, for I have found in that position eggs in which the embryo had just begun its development, as well as those in a more advanced stage of growth. Occasionally, instead of eggs, I have found the cavity of the gills, as also the space enclosed by the branchiostegal membrane, filled with a brood of young already hatched. The eggs before hatching are always found in the same part of the mouth, namely, in the upper part of the branchial arches, protected or held together by a special lobe or valve formed of the upper pharyngeals. The cavity thus occupied by the eggs corresponds exactly to the labyrinth of that curious family of fishes inhabiting the East Indian Ocean, called Labyrinthici by Cuvier. This circumstance induces me to believe that the branchial labyrinth of the eastern fishes may be a breeding

pouch, like that of our Chromides, and not simply a respiratory apparatus for retaining water. In the Amazonian fish a very sensitive network of nerves spreads over this marsupial pouch, the principal stem of which arises from a special nervous ganglion, back of the cerebellum, in the Medulla oblongata. This region of the central nervous system is strangely developed in different families of fishes, and sends out nerves performing very varied functions. From it arise, normally, the nerves of movement and sensation about the face; it also provides the organs of breathing, the upper part of the alimentary canal, the throat and the stomach. In the electric fishes the great nerves entering the electric battery arise from the same cerebral region, and now I have found that the pouch in which the egg of the Acara is incubated and its young nursed for a time, receives its nerves from the same source. This series of facts is truly wonderful, and only shows how far our science is still from an apprehension of the functions of the nervous system."

The beaches of the Amazon were found to be of great interest, being the resort of many singular creatures. Here were strange turtles, the nests of fishes, alligators, and birds. The Indians were very skilful in discovering the nests of turtles where there was no evidence of their existence upon the surface. They would move quickly along, then suddenly stop and throw up the sand, to invariably find the eggs ten or twelve inches below the surface. Here the large alligators lay in the sun and could be easily shot from the canoe, or

their habits and ways watched from some convenient ambush.

The native methods of taking fishes and large game was extremely interesting. A popular one was by the bow and arrow, even fishes as large as the gigantic Studis being taken in this manner. Some of the party caught several manatees, which, being too heavy and large to preserve, were skinned and the skeletons saved. One singular find was a log taken from the bottom, the hollow of which was literally packed with small fishes of a certain kind called Anojas by the natives.

Some extremely interesting discoveries were made by Agassiz in the young of fishes. He employed native children to collect all the small or young fishes they could find, and the result was the discovery that in many cases the young of one species resembled the adults of others. An instance of this was found in a new billfish that while young passed through a stage resembling the adult Hemirhamphus which has a long lower jaw.

In October the scientific head-quarters at Teffé was broken up, the party moving on, having obtained not only a fine collection of fishes, but reptiles, birds, shells, botanical specimens, insects, and treasures of all kinds.

Agassiz was most impressed by the peculiar distribution of fishes. He says: "After setting my whole party well under way in Teffé, I made the very instructive excursion with Major Estolano to the Lago do Boto, a small sheet of water by the side of his *sitio* on the banks of the main course of

the Amazons, where I had a fair opportunity of ascertaining how widely different the fishes may be that inhabit adjoining localities in the same hydrographic basin. To this day I have not yet recovered from my surprise at finding that shores which, from a geographic point of view, must be considered simply as opposite banks of the same stream, were, nevertheless, the abode of an essentially different ichthyological population."

Agassiz not only found time to investigate the zoölogy of the region, but there was hardly a department in the field of science that was not touched upon in some way. He was indefatigable in his labours; indeed, was the same Agassiz, enthusiastic, thoughtful, and ambitious, that we have seen in his youthful days.

The routine along the Amazon was one of continued work. The party rose at five in the morning, breakfasted at six, after which they started upon the various trips that had been arranged by the chief. Agassiz was fond of sport, but denied himself much of this pleasure, being obliged to attend to the specimens which were brought in, as in this hot climate they decomposed so rapidly that immediate attention was required. Agassiz gave the artist general directions, and the latter, despite the intense heat and swarms of mosquitoes, often succeeded in making twenty sketches a day, and at the end of the trip Mr. Burkhardt was able to show about eight hundred paintings.

It is impossible to follow the steps of Agassiz throughout the entire Amazonian region, and these

suggestions simply illustrate the compass of his mind and the generalship that characterised all his movements. In science he was a leader of the forces, certainly in America, and was now in a foreign land marshalling them with marked ability, his conquests being the subjugation of ignorance and the dissemination of facts.

It was while descending the Amazon that Agassiz first saw myriads of floating islands drifting down the river—shrubs, trees, great palms, all bound together by entangled vines,—often half an acre in extent, sometimes bearing animals upon them. On many were cranes, herons, and other wading birds, and the captain of the steamer informed Agassiz that upon one occasion, when lying at anchor at Parana, he saw a floating island come down bearing two deer upon it, which he captured as the island struck the ship. At another time a large and powerful jaguar was seen floating along on one of these islands toward the sea. The lands overflowed were prolific places for the collector, the blades of grass and stalks often being covered with insects of all kinds and descriptions, which found safety here. As the steamer continued down the river it took on more and more the appearance of a menagerie. Parrots, half a dozen monkeys, a pair of deer, several tame iguanas, a sloth, and numerous smaller animals making up the collection.

Agassiz in his lectures thus described the life in the forest: "Through such a forest, where the animal life was no less rich and varied than the vegetation, our boat glided slowly for hours. The number and

variety of birds struck me with astonishment. The coarse, sedgy grasses on either side were full of water-birds, one of the most common of which was a small chestnut-brown wading bird, the Jaçana (Parra), whose toes are immensely long in proportion to its size, enabling it to run upon the surface of the aquatic vegetation as if it were solid ground. It was now the month of January, their breeding season; and at every turn of the boat we started them up in pairs. Their flat open nests generally contained five flesh-colored eggs, streaked in zigzag with dark brown lines. The other waders were a small white heron, another ash-colored, smaller species, and a large white stork. The ash-colored herons were always in pairs; the white ones always single, standing quiet and alone on the edge of the water, or half hidden in the green capim. The trees and bushes were full of small warbler-like birds, which it would be difficult to characterise separately. To the ordinary observer they might seem like the small birds of our woods; but there was one species among them which attracted my attention by its numbers, and also because it builds the most extraordinary nest, considering the size of the bird itself, that I have ever seen. It is known among the country people by two names, as the Pedreiro or the Forneiro; both names referring, as will be seen, to the nature of its habitation. This singular nest is built of clay, and is as hard as stone *(pedra)*, while it has the form of the round mandioca oven *(forno)*, in which the country people prepare their farinha, or flour, made from the

mandioca root. It is about a foot in diameter, and stands edgewise upon a branch, or in the crotch of a tree. Among the smaller birds I noticed bright tanagers, and also a species resembling the canary. Besides these, there were the wagtails; the black and white willow-finches; the hang-nests, or Japi, as they are called here, with their pendent, bag-like dwellings, and the familiar "Bem-ti-vi." Humming-birds, which we are always apt to associate with tropical vegetation, were very scarce. I saw but a few specimens. Thrushes and doves were more frequent, and I noticed also three or four kinds of wood-peckers, besides parrots and paroquets; of these latter there were countless numbers along our canoe path, flying overhead in dense crowds, and at times drowning every other sound in their high, noisy clatter.

"Birds of prey, also were not wanting. Among them was one about the size of our kite, and called the red-hawk, which was so tame that, even when our canoe passed immediately under the low branch on which he was sitting, he did not fly away. But, of all the groups of birds, the most striking as compared with corresponding groups in the temperate zone, and the one which reminded me the most distinctly of the fact that every region has its peculiar animal world, was that of the gallinaceous birds. The most frequent is the Cigana, to be seen in groups of fifteen or twenty, perched upon trees overhanging the water, and feeding upon berries. At night they roost in pairs, but in the daytime are always in larger companies. In their appearance

they have something of the character of both the pheasant and peacock, and yet do not closely resemble either. It is a curious fact that, with the exception of some small partridge-like gallinaceous birds, all the representatives of this family in Brazil, and especially in the valley of the Amazons, belong to types which do not exist in other parts of the world. Here we find neither pheasants, nor cocks of the woods, nor grouse; but in their place abound the Mutum, the Jacu, the Jacami, and the Unicorn (Crax, Penelope, Psophia, and Palamedea), all of which are so remote from the gallinaceous types found farther north that they remind one quite as much of the bustard, and other ostrich-like birds, as of the hen and pheasant. They differ also from northern gallinaceous birds in the greater uniformity of the sexes, none of them exhibiting those striking differences between the males and the females which we see in the pheasants, the cocks of the woods, and in our barn-yard fowls, though the plumage of the young has the yellowish mottled color distinguishing the females of most species of this family. While birds abounded in such numbers, insects were rather scarce. I saw but few and small butterflies, and beetles were still more rare. The most numerous insects were the dragon-flies,—some with crimson bodies, black heads, and burnished wings; others with large green bodies, crossed by blue bands. Of land-shells I saw but one, creeping along the reeds; and of water-shells I gathered only a few small *Ampullariæ*."

On arriving at Pará Agassiz was much broken down and fatigued by the arduous duties of the trip, yet he could scarcely restrain himself when new fields opened all about and drew him on. Here he found a letter from the Emperor, who announced that he had a New Year's present for him in the shape of a collection of fishes from the southern rivers of South America, which, with the eighteen hundred species that Agassiz had secured, made a most valuable collection. The great variety of fish life impressed him constantly, and in a letter to the Emperor he said: "Another side of this subject, still more curious perhaps, is the intensity with which life is manifested in these waters. All the rivers of Europe united, from the Tagus to the Volga, do not nourish one hundred and fifty species of fresh-water fishes; and yet in a little lake near Manaos, called Lago Hyanuary, the surface of which covers hardly four or five hundred square yards, we have discovered more than two hundred distinct species, the greater part of which have not been observed elsewhere. What a contrast!"

The expedition throughout Brazil was continued for sixteen months, and its results were given to the world, and the friends of science who made the journey possible, in a joint volume—*A Journey in Brazil*, by Professor and Mrs. Agassiz.

It was a life in the forest, drifting along with the wonders of tropical nature on every hand; and that Agassiz made the most of it is demonstrated by the present collections of the fauna of Brazil in the

Museum at Cambridge, where rest about eighty thousand specimens, all obtained during this trip, which the great naturalist looked upon as a rest and vacation period, a time in which he accomplished more than some workers in science and other fields have in an entire lifetime.

A MESSAYA INDIAN AND HIS GOD BUÊQUÉ.

CHAPTER XVIII.

THE CRUISE OF THE "BIBB."

Return from Brazil—Renewed Work at the Museum—Lectures in New York—The Resolution of Bancroft—The Coast Survey and Science—Appointment to Cornell University—Report to the Legislature—The Cruise of the *Bibb*—Address on Humboldt.

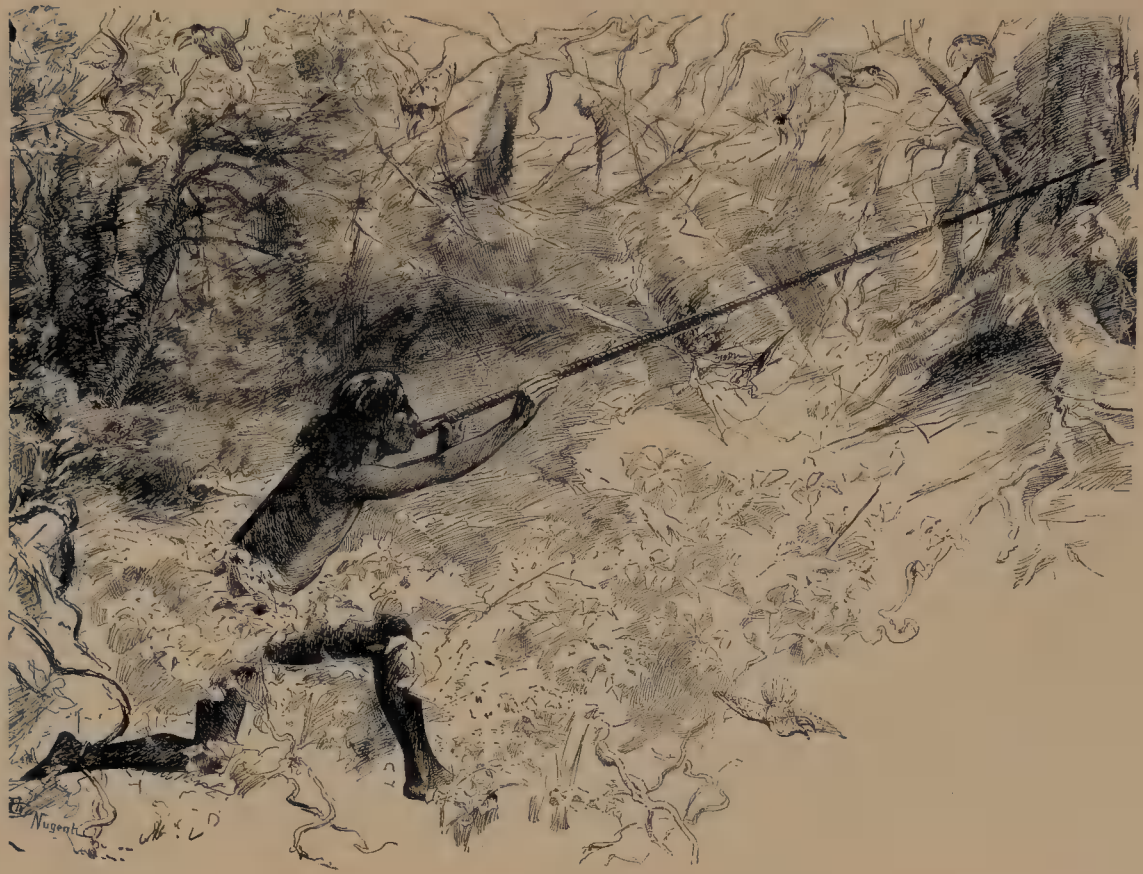
AGASSIZ returned from Brazil in August, 1866, and was soon deeply engrossed in his beloved museum, which was enriched by treasures that a year or so previous he had not dreamed of. The public at large was intensely interested in his work, and there was an immediate and pressing demand upon him for a series of lectures on the trip, which were given, and received with great enthusiasm. Then came a call from New York, and the lectures were repeated at the Cooper Union, the remarkable sight being witnessed of "no standing room" at a series of scientific lectures where

the prices were as high as at the theatre. This course created a very general interest in science in New York, and at the close the following resolution was offered by Bancroft, the historian:

"*Resolved*, That the thanks of this great assembly of delighted hearers, etc., be given to the illustrious Professor Agassiz, for the fulness of his instruction, for the clearness of his method of illustration, for his exposition of the idea as antecedent to form; of the superiority of the undying, original, and eternal force over its transient manifestations; for happy hours which passed too rapidly away; for genial influences of which the memory will last through our lives."

The following months and entire winter Agassiz gave to his collections, the arrangement and care of which involved an enormous amount of work. The following year he devoted to his studies, spending much of the time at Nahant. During this period, he urged upon Professor Benjamin Peirce, then superintendent of the Coast Survey, the propriety of making the survey as valuable as possible to the scientific world,—a suggestion happily adopted.

In this year Agassiz lost his mother, who had always been in close sympathy with his work and in constant communication with him. The loss fell heavily upon him, and undoubtedly affected his own health, which now gave way again, necessitating complete rest. He slowly recovered strength, and in 1868 made an excursion to the West with a large party of prominent men. On his return he stopped at Ithaca where Cornell University was just



INDIAN SHOOTING WITH BLOW-GUN.

opening her doors, and was prevailed upon to accept the appointment of non-resident professor. A memorial tablet in the chapel of the university testifies to the appreciation of the trustees of the important part he took in the opening days of the institution.

Agassiz's ambition to see the museum at Cambridge the leading institution of the kind in the world was now in a fair way to be realized. The Legislature, appreciating what he had done, gave him seventy-five thousand dollars for an additional building, and by private subscriptions this was doubled, so that the treasures from Brazil could be well cared for. In referring to the act of the Legislature, Agassiz wrote in his report:

"While I rejoice in the prospect of this new building, as affording the means for a complete exhibition of the specimens now stored in our cellars and attics and encumbering every room of the present edifice, I yet can hardly look forward to the time when we shall be in possession of it without shrinking from the grandeur of our undertaking. The past history of our science rises before me with its lessons. Thinking men in every part of the world have been stimulated to grapple with the infinite variety of problems connected with the countless animals scattered without apparent order throughout sea and land. They have been led to discover the affinities of various living beings. The past has yielded up its secrets, and has shown them that the animals now peopling the earth are but the successors of countless populations which have preceded them, and whose remains are buried in the crust of our globe. Further

study has revealed relations between the animals of past time and those now living, and between the law of succession in the former and the laws of growth and distribution in the latter, so intimate and comprehensive that this labyrinth of organic life assumes the character of a connected history, which opens before us with greater clearness in proportion as our knowledge increases. But when the museums of the Old World were founded, these relations were not even suspected. The collections of natural history, gathered at immense expense in the great centres of human civilization, were accumulated mainly as an evidence of man's knowledge and skill in exhibiting to the best advantage, not only the animals, but the products and curiosities of all sorts from various parts of the world. While we admire and emulate the industry and perseverance of the men who collected these materials, and did in the best way the work it was possible to do in their time for science, we have no longer the right to build museums after this fashion. The originality and vigour of one generation become the subservience and indolence of the next if we only repeat the work of our predecessors. They prepared the ground for us by accumulating the materials for extensive comparison and research. They presented the problem; we ought to be ready with the solution. If I mistake not, the great object of our museums should be to exhibit the whole animal kingdom as a manifestation of the Supreme Intellect. Scientific investigation in our day should be inspired by a purpose as animating to the general sympathy, as was the religious zeal which built the

Cathedral of Cologne or the Basilica of St. Peter's. The time is passed when men expressed their deepest convictions by these wonderful and beautiful religious edifices; but it is my hope to see, with the progress of intellectual culture, a structure arise among us which may be a temple of the revelations written in the material universe. If this be so, our buildings for such an object can never be too comprehensive, for they are to embrace the infinite work of Infinite Wisdom. They can never be too costly, so far as cost secures permanence and solidity, for they are to contain the most instructive documents of Omnipotence."

In 1869 Agassiz was invited to take a cruise on the *Bibb*, the Coast Survey steamer, along the coast of Cuba, his old friend of the Aar glacier days, Count Pourtalès being the naturalist in charge. This trip proved a most important one, being far-reaching in its discoveries and the deductions which were made. Agassiz thus refers to the dredgings in the Bulletin of the Museum of 1869:

"From what I have seen of the deep-sea bottom, I am already led to infer that among the rocks forming the bulk of the stratified crust of our globe, from the oldest to the youngest formation, there are probably none which have been formed in very deep waters. If this be so, we shall have to admit that the areas now respectively occupied by our continents, as circumscribed by the two-hundred-fathom curve or thereabout, and the oceans at greater depth, have from the beginning retained their relative outline and position; the continents

having at all times been areas of gradual upheaval with comparatively slight oscillations of rise and subsidence, and the oceans at all times areas of gradual depression with equally slight oscillations. Now that the geological constitution of our continent is satisfactorily known over the greatest part of its extent, it seems to me to afford the strongest evidence that this has been the case; while there is no support whatever for the assumption that any part of it has sunk again to any very great depth after its rise above the surface of the ocean. The fact that upon the American continent, east of the Rocky Mountains, the geological formations crop out in their regular succession, from the oldest azoic and primordial deposits to the cretaceous formation, without the slightest indication of a great subsequent subsidence, seems to me the most complete and direct demonstration of my proposition. Of the western part of the continent I am not prepared to speak with the same confidence. Moreover, the position of the cretaceous and tertiary formations along the low grounds east of the Alleghany range is another indication of the permanence of the ocean trough, on the margin of which these more recent beds have been formed. I am well aware that in a comparatively recent period, portions of Canada and the United States, which now stand six or seven hundred feet above the level of the sea, have been under water; but this has not changed the configuration of the continent, if we admit that the latter is in reality circumscribed by the two-hundred-fathom curve of depth."

One of the greatest efforts of this period of Agassiz's life, one which though painful gave him supreme pleasure, was the delivery of an address on the occasion of the centennial celebration of Humboldt's birth. Agassiz as we have seen, had been one of his dearest friends. He had lived with him, worked with him, enjoyed his counsel, and no one was better fitted to speak upon his virtues. The movement was inaugurated by the Boston Society of Natural History, and Agassiz accepted the duty with his usual modesty, feeling and expressing the belief that he was not a biographer. As with everything he attempted, the address was a most impressive one, and stands to-day the most valuable paper on Humboldt extant. In this paper we find much that relates to the great naturalist himself, and the following extracts, taken from the memoirs of the Boston Society of Natural History, are worthy of perusal in this connection.

He says: "Humboldt had at this time (about 1830) two residences in Paris,—his lodging at the Hôtel des Princes, where he saw the great world, and his working room in the Rue de la Harpe, where he received with less formality his scientific friends. It is with the latter place I associate him; for there it was my privilege to visit him frequently. There he gave me leave to come to talk with him about my work and consult him in my difficulties. I am unwilling to speak of myself on this occasion, and yet I do not know how else I can do justice to one of the most beautiful sides of Humboldt's character. His sympathy for all young students of nature was

one of the noblest traits of his long life. It may truly be said that toward the close of his career there was hardly one prominent or aspiring scientific man in the world who was not under some obligation to him.

"At this period I was twenty-four, he was sixty-two. I had recently taken my degree as Doctor of Medicine, and was struggling not only for a scientific position but for the means of existence also. I have said that he gave me permission to come as often as I pleased to his room, opening to me freely the inestimable advantages which intercourse with such a man gave to a young investigator like myself. But he did far more than this. Occupied and surrounded as he was, he sought me out in my own lodging. The first visit he paid me in my narrow quarters in the Quartier Latin, where I occupied a small room in the Hôtel du Jardin des Plantes, was characteristic of the man. After a cordial greeting, he walked straight to what was then my library,—a small book-shelf containing a few classics, the meanest editions bought for a trifle along the quays, some works on philosophy and history, chemistry and physics, his own *Views of Nature*, Aristotle's *Zoölogy*, Linnæus's *Règne Animal*, and quite a number of manuscript quartos, copies which, with the assistance of my brother, I had made of works I was too poor to buy, though they cost but a few francs a volume. Most conspicuous of all were twelve volumes of the new German Cyclopædia presented to me by the publisher. I shall never forget, after his look of mingled interest and surprise at my little col-

VILLAGE OF MOROMOROTÉ, ON THE RIGHT BANK OF THE AMAZON.

lection, his half-sarcastic question as he pounced upon the great Encyclopædia,—'Was machen Sie denn mit dieser Eselsbrücke?' What are you doing with this *ass's bridge?*—the somewhat contemptuous name given in Germany to similar compilations. 'I have not had time,' I said, 'to study the original sources of learning, and I need a prompt and easy answer to a thousand questions I have as yet no other means of solving.'

"It was no doubt apparent to him that I was not familiar with the good things of this world, for I shortly afterward received an invitation to meet him at six o'clock in the *Galerie vitrée* of the Palais Royal, when he led me into one of the restaurants, the tempting windows of which I had occasionally passed by. When we were seated, he half laughingly, half inquiringly asked me whether I would order the dinner. I declined the invitation, saying that we should fare better if he would take the trouble, and for three hours, which passed like a dream, I had him all to myself. How he examined me, and how much I learned in that short time. How to work, what to do, and what to avoid; how to live; how to distribute my time; what methods of study to pursue,—these were the things of which he talked to me on that delightful evening. I do not mention this trivial incident without feeling that it may seem too familiar for the occasion; nor should I give it at all except that it shows the sweetness and kindliness of Humboldt's nature. It was not enough for him to cheer and stimulate the student; he cared also to give a rare indulgence

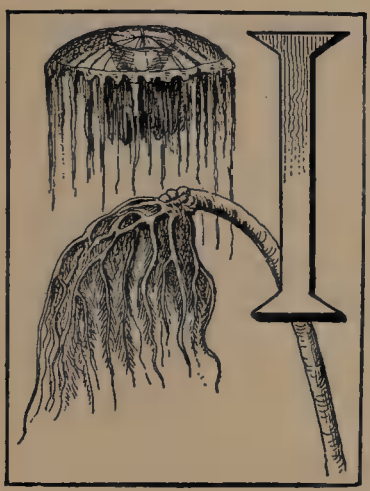
to a young man who could allow himself few luxuries."

Undoubtedly the effort of this address was too great a strain upon Agassiz in his enfeebled condition, and shortly after he showed further evidence of a failure in strength. The great intellect that had fought so many battles gave warning that it must have rest, if indeed it was not too late. Agassiz, though, as we have seen, a man of great physical strength, always overworked himself; his mind invariably laid out work far too great for him to accomplish, and it was this indomitable industry that cut him down in what should have been his prime. Up to this time he had always evaded the doctors by inventing some expedition which would pass as a rest, but now the demand upon him could not be slighted and he took the longest vacation of his life, spending a winter in what was enforced seclusion. In the spring of 1870 he went to Deerfield on the Connecticut River, where to the surprise of his friends he soon recovered, returning to the museum in November, 1870, apparently with a complete renewal of health.

CHAPTER XIX.

ON THE "HASSLER."

Invitation to Go Around the Horn—The Party—In the Gulf Weed—A Singular Discovery—Inhabitants of the Gulf Weed—Nest of a Fish—Defining a Species by its Skin—Off the Rio de la Plata—Discovery of Tertiary Fossils—Living Crinoids—Glaciers of Patagonia—Among the Fuegians—Discoveries at Lota—Reception in San Francisco.



IN the early days of 1871 Agassiz received a communication from Professor Peirce to the effect that he was about to send a new vessel around the Horn to San Francisco, and asking him if he would like to make the trip in the interests of science. The invitation was accepted, and the scientific party was finally made up and included Agassiz, Count de Pourtalès, Dr. Franz Steindachner, Mr. Blake, and Dr. Thomas Hill, ex-president of Harvard University. With his usual interest Agassiz looked forward to the trip which

he believed would result in important discoveries to science. He wrote to Mr. Peirce at this time: "If this world of ours is the work of intelligence and not merely the product of force and matter, the human mind, as a part of the whole, should so chime with it, that from what is known it may reach the unknown. If this be so, the knowledge gathered, should, within the limits of error which its imperfection renders unavoidable, enable us to foretell what we are likely to find in the deepest abysses of the sea."

He thought that the abyssmal portions of the deep sea would be found to contain forms which would resemble those of earlier geological times, and he went so far as to name species he hoped to discover. He expected to find an immediate ancestor of the trilobite, star-fish, and other forms, but in this was disappointed.

The subject of glaciers still occupied his attention and he felt assured that the deep sea would divulge some of the secrets. This is referred to in the same letter to Mr. Peirce, which was published in the *Bulletin of the Comparative Museum of Zoölogy:*

"There is, however, still one kind of evidence wanting, to remove all doubt that the greater extension of glaciers in former ages was connected with cosmic changes in the physical condition of our globe—namely, all the phenomena relating to the glacial period must be found in the southern hemisphere, accompanied by the same characteristic features as in the north, but with this essential difference—that everything must be reversed. The

trend of the glacial abrasions must be from the south northward, the lee-side of abraded rocks must be on the north side of the hills and mountain ranges, and the bowlders must have travelled from the south to their present position. Whether this be so or not, has not been ascertained by direct observation. I expect to find it so throughout the temperate and cold zones of the southern hemisphere, with the exception of the present glaciers of Terra del Fuego and Patagonia, which may have transported bowlders in every direction. Even in Europe, geologists have not yet sufficiently discriminated between local glaciers and the phenomena connected with their different degrees of successive retreat on the one hand; and, on the other, the facts indicating the action of an extensive sheet of ice moving over the whole continent from north to south. Among the facts already known from the southern hemisphere are the so-called rivers of stone in the Falkland Islands, which attracted the attention of Darwin during his cruise with Captain Fitzroy, and which have remained an enigma to this day. I believe it will not be difficult to explain their origin in the light of the glacial theory, and I fancy they may turn out to be ground moraines similar to the 'horsebacks' in Maine.

"You may ask what this question of drift has to do with deep-sea dredging? The connection is closer than may at first appear. If drift is not of glacial origin but is the product of marine currents, its formation at once becomes a matter for the Coast Survey to investigate. But I believe it will be

found in the end that, so far from being accumulated by the sea, the drift of the Patagonian lowlands has been worn away by the sea to its present outline, like the northern shores of South America and Brazil. . . ."

The *Hassler* sailed December 4, 1871, and the moment the prow of the good ship entered the Gulf Stream the ardent naturalists were at work; Count Pourtalès on the temperature of the Gulf Stream, and Agassiz on the fauna of the floating weed known as sargassum. One of the finds was a curious nest—a mass of sea-weed bound in and about and held in place by a delicate cord of gelatinous appearance. The leaves or fronds of the weed were dotted with white eggs the size of a pin's head, and Agassiz soon decided by the use of his glass that each egg held a little fish. But what fish? The parent had not been found with the nest. Agassiz soon bethought him of his previous studies with the pigment cells of fishes, and the first comparison he made satisfied him that the embryos were the young of a Chironectes, young specimens of which he used for comparison.

It will be remembered that in a letter written to Professor Peirce previous to sailing Agassiz expressed the belief that he should discover some early forms of star-fishes; it so happened that at the first haul of the dredge off St. Thomas they took stemmed crinoids which seemed like the ghosts of by-gone days rising from the depths of the sea to remind them of the past. One of the crinoids was kept alive nearly an entire day, and Agassiz had an opportunity to observe its motions, seeing it fold and

A NEST OF FISHES.

unfold its arms. In describing his sensations of delight to Professor Peirce he said: "I could see, without great effort of the imagination, the shoal of Lockport teeming with the many genera of crinoids which the geologists of New York have rescued from that prolific Silurian deposit."

A landing was made at Monte Video when Agassiz examined the geology of the bay, and after dredging off the Rio de la Plata, another stop was made at Port San Antonio, in which place some fine fossils of the Tertiary time were found. Here Agassiz saw his first guanaco. Off the Gulf of St. George many beautiful forms among the star-fishes were taken, the dredge at one time coming up filled with Ophiurans. At Possession Bay the party landed and made a study of the old moraine. At the Elizabeth Islands and San Magdalena, Agassiz observed for the first time a penguin rookery, obtaining fine specimens of the birds. At Glacier Bay he visited the glacier that comes down here, and is a mile across its front, formed of clear blue ice. A forest was growing out of the old terminal moraines, and in the face of the glacier was a huge cave thirty or more feet high and about one hundred feet deep.

An unsuccessful attempt was made to trace this glacier to its source, its upper portion branching off into many small streams of ice. The rate of advance was found to be ten inches a day; indeed, this glacier was examined by Agassiz with all the care and interest that he had given to similar phenomena in Switzerland; the fact that he could compare the two making the investigation of especial interest.

The steamer left Playa Parda Cove in the latter part of March, and as they sailed away six fine glaciers were visible. From here up the coast, new and attractive features appeared every day. Agassiz made the acquaintance of the Fuegians, finding them a most interesting study. The *Hassler* anchored in Smythe's Channel, where more glaciers and fine snow-capped mountains were seen and where Agassiz revelled in many of nature's offerings. At every point, even though they tarried but a few hours, he obtained some new and valuable fact hitherto unobserved or unrecorded. Glaciers were ever in his mind and in his report to Professor Peirce he says:

"*April 27th.*—While I was transcribing my report, Pourtalès came in with the statement that he had noticed the first indication of an Andean glacier in the vicinity. I have visited the locality twice since. It is a magnificent polished surface, as well preserved as any I have seen upon old glaciated ground or under glaciers of the present day, with well-marked furrows and scratches. Think of it! a characteristic surface, indicating glacial action, in lat. 37° S., at the level of the sea. The place is only a few feet above tide level, upon the slope of a hill on which stands the ruins of a Spanish fort, near the fishermen's huts of San Vicente, which lies between Conception Bay and the Bay of Aranco. Whether the polished surface is the work of a glacier descending from the Andes to the sea-shore or not, I have not yet been able to determine. I find no volcanic pebbles or bowlders in this vicinity, which, after my experience in San Carlos, I should expect all along

the shore, if the glaciers of the Andes had descended to the level of the ocean in this part of the country. The erratics here have the character of those observed farther south. It is true the furrows and scratches of this polished surface run mainly from east to west; but there are some crossing the main trend, at angles varying from 20° to 30°, and running S. E. N. W. Moreover, the magnetic variation is 18° 3′ at Talcahuano April 23d, the true meridian bearing to the right of the magnetic. I shall soon know what to make of this, as I start to-morrow for the interior, to go to Santiago and join the ship again at Valparaiso. I have hired a private carriage, to be able to stop whenever I wish so to do. I also take a small seine to fish for fresh-water fishes in the many streams intervening between this place and Valparaiso. The trend of the glacial scratches in San Vicente reminds me of a fact I have observed in New England near the sea-shore, where the glacial furrows dip to a considerable extent eastward toward the deep ocean, while farther inland their trend is more regular and due north and south. . . .

"I had almost forgotten to say that I have obtained unquestionable evidence of the cretaceous age of the coal deposits of Lota and the adjoining localities, north and south, which are generally supposed to be Tertiary lignites. They are overlaid by sandstone containing Baculites. I need not adduce other evidence to satisfy geologists of the correctness of my assertion. I have myself collected a great many fossils, in beds resting upon coal-seams."

At Talcahuana Agassiz started up the coast by

coach, intending to meet the steamer at some northern point. The trip proved fruitful in results and was most enjoyable to the little party, who joined the ship finally at Valparaiso. At Santiago Agassiz was received with distinguished honours. Among the pleasant surprises which greeted him was the announcement of his election as Foreign Associate of the Institute of France, which he considered one of the highest honours he could receive. In a letter to the Emperor of Brazil he refers to it as follows:

"The distinction pleased me the more because so unexpected. Unhappily it is usually a brevet of infirmity, or at least of old age, and in my case it is to a house in ruins that the diploma is addressed. I regret it the more because I have never felt more disposed for work, and yet never so fatigued by it."

A most interesting part of the *Hassler* voyage was that portion devoted to the Galapagos Islands—Albemarle and others. In the former Agassiz studied the peculiar volcanic formation, and in his memoirs he refers to the fact that the party lunched one day in a cave which was nothing more or less than a broken volcanic bubble or air-hole which was forty feet long by ten in height.

The trip up the coast was continued with increasing interest, and finally, in August, 1872, the *Hassler* entered the Golden Gate. Agassiz was received with the greatest cordiality by scientists and laymen. His interest in scientific work on the Pacific Coast was shown in many ways, one result being the endowment of the University of California by Edward

Tompkins of Oakland in the name of Agassiz, while the gift of Lick Observatory undoubtedly could be traced to similar inspiration.

Agassiz was received in San Francisco by Joseph Le Conte, Davidson, Gilman, Drs. Stebbins and Scott, Dr. Ezra Carr, and other well-known men and scientists, finding here many old friends and acquaintances. He was tendered a number of receptions, and the impression he made upon strangers is well illustrated in the following incident. A well-known literary man, now connected with the Academy of Sciences of San Francisco, told the author that he was a guest at a reception tendered Professor and Mrs. Agassiz, General ——— had dined with royalty, was a skilled diplomat, and one of the last men to become disconcerted under any circumstances; yet when he was presented to the distinguished guest of the evening and recalled his work and reputation, he was singularly confused. "His personality impressed me to a marked degree," he said to the author, and when I found myself in his presence, and remembered his career and the manner of man he was, I was silenced, much to my annoyance, and when I did speak it was to tell a deliberate untruth. Agassiz asked me if I had been long on the coast. In reply I said no, when in reality I was a forty-niner. Later when I met Mrs. Agassiz I told her how in my confusion, and I might say admiration for her husband, I had told him an untruth. She considered it an excellent joke, and later, in the full possession of my faculties I enjoyed a laugh over the occurrence with

Agassiz, who modestly disclaimed any intention of trying to impress me."

The condition of the great naturalist's health was such that he made no extended researches on the Pacific Coast, and returned to Cambridge in October, 1872. There is never a scientific gathering of the men of his time but he and his trip to the West are remembered. In Arizona a lofty peak bears his name. In Alaska one of the giant glaciers—a feeder of the Great Malaspina Glacier, is called the Agassiz, while over the divide, in the inter-continental region, the name Agassiz is given to an ancient glacial lake in Wyoming—all monuments of an enduring kind.

CHAPTER XX.

AT PENIKESE.

Growth of a New Idea—John Anderson's Gift—A Patron of Science—Realisation of Agassiz's Dream—Whittier's "Prayer of Agassiz"—A Distinguished Corps of Teachers—Sayings of the Great Teacher at Penikese—Last Days.

AGASSIZ had long felt the need of a laboratory upon a large scale, a school at the sea-side where students of natural history could meet and under competent instruction be brought face to face with natural objects. As with everything else he undertook, the idea grew upon him and rapidly took shape and form in his mind. He soon laid the plan before the public and it was discussed in the press from Maine to Florida and from ocean to ocean, exciting interest in every State. The subject was first brought to the attention

of the Massachusetts Legislature when they made their annual visit to the museum, Agassiz pressing the claim of the new scheme as a part of the educational development of the institution that they had so ably fathered. The appeal to the Legislature was published in the press and read by chance by John Anderson, of New York, who at once became interested in the plan and a few days later tendered Agassiz a site for the proposed school on the island of Penikese, one of the group in Buzzard's Bay, so well-known by the rhyme:

> "Naushon, Nonamesset,
> Uncatena, and Wepecket,
> Nashawena, Pesquinese,
> Cuttyhunk, and Penikese."

To the gift Mr. Anderson added $50,000 with which to fit out the school; and so the Anderson School of Natural History took form, and on the 4th of July Agassiz set sail for the island. He found everything in the crudest condition, but a strong appeal to carpenters and other workers brought order out of chaos, and soon the old stable, out of which the sheep had been turned to make way for medusæ, echinoderms, men and women, became habitable just in time for the steamer containing the visitors and students. In the old barn, still hung with festoons of silken make, through which the swallows darted and chirped a welcome, this grand old man, with bared head, opened the school in silent prayer. This incident was made the subject of the following poem by Whittier:

THE PRAYER OF AGASSIZ.

On the isle of Penikese,
Ringed about by sapphire seas,
Fanned by breezes salt and cool,
Stood the Master with his school.
Over sails that not in vain
Wooed the west-wind's steady strain,
Line of coast that low and far
Stretched its undulating bar,
Wings aslant along the rim
Of the waves they stooped to skim,
Rock and isle and glistening bay,
Fell the beautiful white day.
Said the Master to the youth :

" We have come in search of truth,
Trying with uncertain key
Door by door of mystery ;
We are reaching, through His laws,
To the garment-hem of Cause,
Him, the endless, unbegun,
The unnamable, the One
Light of all our light the Source,
Life of life, and Force of force.
As with fingers of the blind,
We are grouping here to find
What the hieroglyphics mean
Of the Unseen in the seen,
What the Thought which underlies
Nature's masking and disguise,
What it is that hides beneath
Blight and bloom and birth and death.
By past efforts unavailing,
Doubt and error, loss and failing,
Of our weakness made aware,
On the threshold of our task
Let us light and guidance ask,
Let us pause in silent prayer ! "

Then the Master in his place
Bowed his head a little space,
And the leaves by soft airs stirred,
Lapse of wave, and cry of bird
Left the solemn hush unbroken
Of that wordless prayer unspoken,
While its wish, on earth unsaid,
Rose to heaven interpreted.
As in life's best hours we hear
By the spirit's finer ear
His low voice within us, thus
The All-Father heareth us;
And His holy ear we pain
With our noisy words and vain.
Not for Him our violence
Storming at the gate of sense,
His the primal language, His
The eternal silence!

Even the careless heart was moved,
And the doubting gave assent,
With a gesture reverent,
To the Master well-beloved.
As thin mists are glorified
By the light they cannot hide,
All who gazed upon him saw,
Through its veil of tender awe,
How his face was still uplit
By the old sweet look of it,
Hopeful, trustful, full of cheer,
And the love that casts out fear.
Who the secret may declare
Of that brief, unuttered prayer?
Did the shade before him come
Of th' inevitable doom,
Of the end of earth so near,
And Eternity's new year?

In the lap of sheltering seas
Rests the isle of Penikese;

But the lord of the domain
Comes not to his own again :
When the eyes that follow fail,
On a vaster sea his sail
Drifts beyond our beck and hail.
Other lips within its bound
Shall the laws of life expound ;
Other eyes from rock and shell
Read the world's old riddles well :
But when breezes light and bland
Blow from Summer's blossomed land,
When the air is glad with wings.
And the blithe song-sparrow sings,
Many an eye with his still face
Shall the living ones displace,
Many an ear the word shall seek
He alone could fitly speak.
And one name forevermore
Shall be uttered o'er and o'er
By the waves that kiss the shore,
By the curlew's whistle sent
Down the cool, sea-scented air ;
In all voices known to her,
Nature owns her worshipper,
Half in triumph, half lament.
Thither Love shall tearful turn,
Friendship pause uncovered there,
And the wisest reverence learn
From the Master's silent prayer.

The school was carried on with unflagging interest. Agassiz lectured sometimes twice a day. Here were Dr. Burt G. Wilder of Cornell, Professor A. S. Packard, Count Pourtalès, Professor Guyot, E. S. Morse, Alfred Mayer, F. W. Putnam—all distinguished men in their various fields as instructors, whose lectures were listened to with close attention. Among the students were some of the leading naturalists of the

present day, who here obtained the inspiration perhaps which led to later successes. Among them were David Starr Jordan, now President of the Leland Stanford Junior University; Professor Fernald, of Maine; William K. Brooks, later author of a hand-book on *Invertebrate Zoölogy;* Dr. F. H. Snow, now Chancellor of the University of Kansas; Dr. W. O. Crosby, Walter Fewkes, Samuel Garman of the Museum of Comparative Zoölogy, Walter Faxon, Ernest Ingersoll, Professor Apgar, of Trenton, Miss Susan Hallowell, Miss Mary Beaman, Charles S. Minot, Professor Stowell, and many more.

The applications by students far exceeded the accommodations for them, and out of the several hundred, fifty of both sexes were finally selected. Referring to these days, David Starr Jordan says:

"None of us will ever forget his first sight of Agassiz. We had come down from New Bedford in a little tug-boat in the early morning, and Agassiz met us at the landing-place on the island. He was standing almost alone on the little wharf, and his great face beamed with pleasure. For this summer school, the thought of his old age, might be the crowning work of his lifetime. Who could foresee what might come of the efforts of fifty men and women, teachers of science, each striving to do his work in the best possible way? His thoughts and hopes rose to expectations higher than any of us then understood.

"His tall robust figure, broad shoulders bending a little under the weight of years, his cheery smile,

the enthusiastic tones of his voice,—all these entered into our first as well as our last impressions of Agassiz. He greeted us with great warmth as we landed. He looked into our faces to justify himself in making choice of us among the many whom he might have chosen. . . .

"And the summer went on with its succession of joyous mornings, beautiful days, and calm nights, with every charm of sea and sky, the master with us all day long, ever ready to speak words of help and encouragement, ever ready to give us from his own stock of learning. The boundless enthusiasm which surrounded him like an atmosphere, and which sometimes gave the appearance of great achievement to the commonest things, was never lacking.

"Essentially Latin in his nature, he was always picturesque in his words and his work. He delighted in the love and approbation of his students and his friends, and the influence of his personality sometimes gave his opinions weight beyond the value of the investigations on which they were based. With no other investigator have the work and the man been so identified as with Agassiz. No other of the great workers has been equally great as a teacher. His greatest work in science was his influence on other men."

Dr. Jordan, who was one of the pupils at Penikese, jotted down some of the talks given to teachers at this time by Agassiz, and through his courtesy I am able to reproduce them here: "Never try to teach what you yourself do not know and know well. If your school board insists on your teaching anything

and everything, decline firmly to do it. It is an imposition alike on pupils and teachers to teach that which he does not know. Those teachers who are strong enough should squarely refuse to do such work. This much-needed reform is already beginning in our colleges, and I hope it will continue. It is a relic of mediæval times, this idea of professing everything. When teachers begin to decline work which they cannot do well, improvements begin to come in. If one will be a successful teacher, he must firmly refuse work which he cannot do successfully.

"It is a false idea to suppose that anybody is competent to learn or to teach everything. Would our great artists have succeeded equally well in Greek or calculus? A smattering of everything is worth little. It is a fallacy to suppose that an encyclopædic knowledge is desirable. The mind is made strong not through much learning, but by the thorough possession of something."

"Lay aside all conceit. Learn to read the book of Nature for yourself. Those who have succeeded best have followed for years some slim thread which has once in a while broadened out and disclosed some treasure worth a life-long search."

"A man cannot be a professor of zoölogy on one day, and of chemistry on the next, and do good work in both. As in a concert all are musicians—one plays one instrument, and one another, but none all in perfection."

"You cannot do without one specialty; you must have some base-line to measure the work and attainments of others. For a general view of the subject

study the history of the sciences. Broad knowledge of all Nature has been the possession of no naturalist except Humboldt, and general relations constituted his specialty."

"Select such subjects that your pupils cannot walk without seeing them. Train your pupils to be observers, and have them provided with the specimens about which you speak. If you can find nothing better, take a horse-fly or a cricket, and let each hold a specimen and examine it as you talk."

"In 1847 I gave an address at Newton, Massachusetts, before a Teachers' Institute conducted by Horace Mann. My subject was grasshoppers. I passed around a large jar of these insects, and made every teacher take one and hold it while I was speaking. If any one dropped the insect, I stopped till he picked it up. This was at that time a great innovation, and excited much laughter and derision. There can be no true progress in the teaching of natural science until such methods become general."

"There is no part of the country where, in the summer, you can not get a sufficient supply of the best specimens. Teach your children to bring them in yourselves. Take the text from the book, not from the booksellers. It is better to have a few forms well known than to teach a little about many hundred species. Better a dozen specimens thoroughly studied as the result of the first year's work, than to have two thousand dollars' worth of shells and corals bought from a curiosity shop. The dozen animals would be your own."

"The study of Nature is an intercourse with the

highest mind. You should never trifle with Nature. At the lowest her works are the works of the highest powers, the highest something in whatever way we may look at it."

"A laboratory of natural history is a sanctuary where nothing profane should be tolerated. I feel less angry at improprieties in church than in a scientific laboratory."

"In Europe I have been accused of taking my scientific ideas from the Church. In America I have been called a heretic, because I would not let my church-going friends pat me on the head."

The Penikese school existed in Agassiz. It was his personality which made it a success, his great genius that made it possible; and as the students separated in the autumn, all felt that a fresh impetus had been given to biological study, a stimulus that has found expression in later years in the establishment of various marine laboratories in various parts of this country and Europe.

In the autumn Agassiz returned to the museum and the contemplation of new work, made possible by the grant of one hundred and twenty-five thousand dollars by the Legislature, one hundred thousand of which was considered as a birthday gift to the scientist, to be used as he willed in the cause of the museum, — a contrast indeed to his experience in former years when he pleaded and used all his eloquence to secure the necessary appropriations to insure the preservation of his growing collections.

It was very evident to the friends of the naturalist that his strength was failing, that he had overtaxed

nature. Yet he had plans outlined that would have required half the lifetime of an ordinary man to accomplish. As the winter came on he began a series of lectures on the type of Radiates. At this time he wrote and began the preparation of several articles on the theories advanced by Darwin, and on the 2d of December, 1873, he appeared before the people of Fitchburg at a meeting of the Massachusetts Board of Agriculture, lecturing on "The structural growth of domesticated animals." This was his last public effort, yet while the audience was impressed with his mental force and saw no lessening of the fires of his genius, those who knew him best felt that he was struggling against physical weakness.

He often almost broke down in these last days —the glint of the setting sun rested upon his face, the shadow of the unknown was upon him. At one time he said: "I want rest; I am ready to go; I am tired! but I will work while I live; while I have strength I will labour." He desired to die in the harness, and the end came when the great soul was filled with thoughts for the advancement of science and the intellectual elevation of mankind.

To the immediate loved ones he spoke of weariness, and finally on the 14th of December, 1873, laid down the burden in the full confidence of a life well spent, of a journey happily ended, leaving a memory and heritage as imperishable as the boulder from the glacier of the Aar, that marks his grave at Mount Auburn, or the great ice-river that bears his name in the Alaskan mountains above the Malaspina glacier.

The death of Agassiz, like that of Darwin, created

widespread comment and regret throughout the civilised world. The people, irrespective of sect or class, recognised the fact that one of the great figures, not only of the century, but of the age, had passed away.

"For a long time," wrote Professor Silliman, "have we dreaded the sad event which we now record. For many years the splendid physique of Agassiz manifested signs that his prodigious labours were overcoming his elasticity. His herculean strength, which made fatigue of body or mind unknown to him, yielded to the severer tax of the American climate and the incessant growing demands upon him from every source. His life and strength were renewed by his long voyage to San Francisco in the *Hassler;* but both he and his friends recognised the fact that to labour with his former activity was impossible and forbidden. Yet to live, was for him unavoidably to labour; and to die in the harness rather than to live after the power to serve his fellow-men was passed—his aspiration."

VEGETATION ON THE SHORES OF THE JANDIATUBA.
(VALLEY OF THE AMAZON.)

CHAPTER XXI.

RELIGIOUS BELIEF.

Friendship for Darwin—Opposition to his Theories—Letter to Dr. Wilder—Strong Religious Belief—Agassiz on Evolution—Last Literary Work in Opposition to Darwin's Theory—A Definition of Classification—Evidences of Religious Thoughts—Denounced as an Atheist—The Lectures at the Academy of Music.

AGASSIZ was the great theistic philosopher of the age in which he lived, and an account of his life would be incomplete without some reference to his opposition to the theories advanced by Charles Darwin, in which is outlined his strong religious belief. Between the two men existed the kindest of feeling. In 1871 Agassiz wrote to Professor Burt G. Wilder: "I have read both volumes of Darwin's *Descent of Man*, which he sent himself with some very pleasant words. You know that we are truly friends, much as we differ in views." Both men believed in a Creator; but Darwin rarely

if ever referred to religion in his works, directly or indirectly, while with Agassiz the reverse holds. He believed that the theories of Darwin were incompatible with a belief in an all-wise Creator, and he combated them with all his power, his attitude upon this question being one of the most interesting features of his career.

Agassiz always stood by the tenets of his religious belief. Everything in nature was suggestive of the bounty, the wisdom of a living God, and any theory, any belief that threw a shadow of doubt upon this was looked upon as a sacrilege. In brief, these two great minds, while working for a common object, were diametrically opposed on many points. Darwin's great theories, which aroused such fierce antagonism throughout the world, found no stronger antagonist and critic than Agassiz, who even to the last stood by his convictions. Both men were great; both possessed of a divine genius. They were born and equipped for great deeds and accomplishments, antagonistic to each other yet each imbued with highest respect for the attainments of the other.

"What a set of men you have at Harvard!" said Darwin to Longfellow. "Both our universities put together cannot furnish the like. Why, there is Agassiz,—he counts for three." And of Darwin personally Agassiz had none but good words, though he vigorously opposed the acceptance of his ideas.

Darwin believed that man is the result of development and the highest form of the animal kingdom of to-day, and that in all probability he was or is a descendant or rather an ascendant of a Simian

type; that all animals have developed from previous forms, the species and genera being produced by environment in vast eras of time. In a letter to Sir Philip de Grey Egerton, Agassiz wrote: "My recent studies have made me more adverse than ever to the new scientific doctrines which are flourishing now in England. This sensational zeal reminds me of what I experienced as a young man in Germany, when the physio-philosophy of Oken had invaded every centre of scientific activity; and yet, what is there left of it? I trust to outlive this mania also. As usual, I do not ask beforehand, what you think of it, and I may have put my hand into a hornet's nest; but you know your old friend Agass., and will forgive him if he hits a tender spot."

Agassiz's last literary work was upon an article for the *Atlantic Monthly*, on the "Evolution and Permanence of Type." "A physical fact is as sacred as a moral principle. Our own nature demands from us this double allegiance," was his text, his creed, and in the above-mentioned paper, in defining his plan for future articles, he said: "I hope in future articles to show, first, that, however broken the geological record may be, there is a complete sequence in many parts of it, from which the character of the succession may be ascertained; secondly, that, since the most exquisitely delicate structures, as well as embryonic phases of growth of the most perishable nature, have been preserved from very early deposits, we have no right to infer the disappearance of types because their absence disproves some favour-

ite theory; and, lastly, that there is no evidence of a direct descent of later from earlier species in the geological succession of animals."

In 1844 Agassiz completed a monograph on the fishes of the Old Red Sandstone, which was begun at the request of the British Association for the Advancement of Science, and was a supplement to the magnificent work in five volumes entitled *Recherches sur les Poissons Fossiles.* At this time, he made some observations that then and in later years attracted no little attention. He knew that there were certain living fishes, as the sturgeon, in which the upper lobe of the tail was formed by the continuance of the backbone, and he saw in these the descendants of a large group that swarmed the ancient Carboniferous and Devonian seas. Agassiz made the remarkable discovery that certain other fishes, not of the group of which the sturgeons may be taken as a representative, had in the embryo state tails that were heterocercal, which afterwards became homocercal. From this discovery, which at the time occasioned no little interest in the world of science, Agassiz deduced the famous law that the "embryo of the fish during its development, the present class of fishes with its numerous families, and the type of fish in its geological history, undergo strictly analogous phases," and in his introduction to a monograph of the fossil fishes of the Old Red Sandstone he applies this in a general way to vertebrates: "The successive creations have undergone phases of development analogous to those the embryo passes through during its growth, and similar

to the gradations the present creation shows us in its ascending series, considered as a whole. . . . The most incontestable result of modern palæontological research, in the examination of the question which at present occupies us, is the fact, now beyond controversy, of the simultaneous appearance of particular types of all classes of invertebrate animals from the earliest development of life upon the surface of the globe. The history of this successive development shows conclusively the impossibility of referring the first inhabitants of the earth to a small number of branches, differentiated from one parent stock by the influence of the modifications of exterior conditions of existence." This is the keynote of Agassiz's belief regarding the creation and origin of life which he held until the last.

His ideas on the much discussed subject of classification are well illustrated in the introduction of a work entitled *Contributions to the Natural History of the United States*, the plan of which was published in 1857. "In the beginning of this chapter," he says, "I have already stated that classification seems to me to rest upon too narrow a foundation when it is chiefly based upon structure. Animals are linked together as closely by their mode of development, by their relative standing in their respective classes, by the order in which they have made their appearance upon earth, by their geographical distribution, and generally by their connection with the world in which they live, as by their anatomy. All these relations should, therefore, be fully expressed in a natural classification; and though structure furnishes the

most direct indication of some of these relations, always appreciable under every circumstance, other considerations should not be neglected which may complete our insight into the general plan of creation."

With the types which he termed embryonic he recognises others which he called prophetic. He thus writes in his essay on *Classification :*

"I confess that this question as to the nature and foundation of our scientific classifications appears to me to have the deepest importance ; an importance far greater, indeed, than is usually attached to it. If it can be proved that man has not invented but only traced this systematic arrangement in nature ; that these relations and proportions which exist throughout the animal and vegetable world have an intellectual, an ideal, connection in the mind of the Creator ; that this plan of creation, which so commends itself to our highest wisdom, has not grown out of the necessary action of physical laws, but was the free conception of the Almighty Intellect, matured in His thought before it was manifested in tangible external forms ; if, in short, we can prove *premeditation* prior to the act of creation, we have done once and forever with the desolate theory which refers us to the laws of matter as accounting for all the wonders of the universe, and leaves us with no God but the monotonous unvarying action of physical forces, binding all things to their inevitable destiny. . . .

"To me it appears indisputable that this order and arrangement of our studies are based upon the

natural primitive relations of animal life; those systems to which we have given the names of the great leaders of our science who first proposed them, being in truth but translations into human language of the thoughts of the Creator. And if this is indeed so, do we not find in this adaptability of the human intellect to the facts of creation, by which we become instinctively and, as I have said, unconsciously the translators of the thoughts of God, the most conclusive proof of our affinity with the Divine mind? And is not this intellectual and spiritual connection with the Almighty worthy of our deepest consideration? If there is any truth in the belief that man is made in the image of God, it is surely not amiss for the philosopher to endeavour by the study of his own mental operations to comprehend the workings of the Divine Reason, learning from the nature of his own mind better to understand the Infinite Intellect from which it is derived."

Agassiz was first of all a believer in a Divine Ruler, in a Creator of all things. To him it was this Divine Intelligence that governed life. He was essentially religious; the teaching of his devoted and pious mother had taken so deep root that he never wandered. It was this in part that undoubtedly made Agassiz the successful teacher that he was. The simplest facts in nature gave him inspiration. Every leaf, the smallest animals were but the evidences of the Divine Creator whose existence he acknowledged. In his essay on *Classification* he says: "All the facts proclaim aloud the one God, whom we know, adore, and love; and Natural

History must in good time become the analysis of the thoughts of the creator of the universe, as manifested in the animal and vegetable kingdoms."

Agassiz's line of argument against the development theory is well illustrated in the following extract from a published article, *The Tertiary Age, and its Characteristic Animals:*

"One word more as to the relation of the Tertiary mammalia to the creation which preceded them. I can only repeat here the argument used before: the huge quadrupeds characteristic of these epochs make their appearance suddenly, and the deposits containing them follow as immediately upon those of the Cretaceous epoch, in which no trace of them occurs, as do those of the Cretaceous upon those of the Jurassic epoch. I would remind the reader that in the central basin of France, in which Cuvier found his first Palæotherium, and which afterwards proved to have been thickly settled by the early Mammalia, the deposits of the Jurassic, Cretaceous, and Tertiary epochs follow each other in immediate, direct, uninterrupted succession; that the same is true of other localities, in Germany, in Southern Europe, in England, where the most complete collections have been made from all these deposits; and there has never been brought to light a single fact leading us to suppose that any intermediate forms have ever existed through which more recent types have been developed out of older ones. For thirty years Geology has been gradually establishing, by evidence the fulness and accuracy of which are truly

amazing, the regularity in the sequence of the geological formations, and distinguishing, with ever-increasing precision, the specific differences of the animals and plants contained in these accumulations of past ages. These results bear living testimony to the wonderful progress of the kindred sciences of geology and palæontology in the last half-century; and the development theory has but an insecure foundation so long as it attempts to strengthen itself by belittling the geological record, the assumed imperfection of which, in default of positive facts, has now become the favourite argument of its beholders."

In 1863 Agassiz published a volume entitled, *Method of Study in Natural History*, the main object of which was to give hints and suggestions to young readers, yet in the introduction he says: "I have also wished to avail myself of this opportunity to enter my earnest protest against the transmutation theory, revived of late with so much ability, and so generally received. It is my belief that naturalists are chasing a phantom, in their search after some material gradation among created beings, by which the whole Animal Kingdom may have been derived by successive development from a single germ, or from a few germs. It would seem, from the frequency with which this notion is revived,—ever returning upon us with hydra-headed tenacity of life, and presenting itself under a new form as soon as the preceding one has been exploded and set aside,—that it has a certain fascination for the human mind. This arises, perhaps, from the desire to explain the secret of our own existence;

to have some simple and easy solution of the fact that we live.

"I confess that there seems to me to be a repulsive poverty in this material explanation, that is contradicted by the intellectual grandeur of the universe; the resources of the Deity cannot be so meagre, that, in order to create a human being endowed with reason, he must change a monkey into a man. This is, however, merely a personal opinion, and has no weight as an argument; nor am I so uncandid as to assume that another may not hold an opinion diametrically opposed to mine in a spirit quite as reverential as my own. But I nevertheless insist that this theory is opposed to the processes of nature, as far as we have been able to apprehend them; that it is contradicted by the facts of Embryology and Paleontology, the former showing us forms of development as distinct and persistent for each group as are the first types of each period revealed to us by the latter; and that the experiments upon domesticated animals and cultivated plants, on which its adherents base their views, are entirely foreign to the matter in hand, since the varieties thus brought about by the fostering care of man are of an entirely different character from those observed among wild species. And while their positive evidence is inapplicable, their negative evidence is equally unsatisfactory; since, however long and frequent the breaks in the geological series may be in which they would fain bury their transition types, there are many points in the succession where the connection is perfectly distinct and unbroken, and

it is just at these points that new organic groups are introduced without any intermediate forms to link them with the preceding ones. In another series of papers, I shall endeavour to show the futility of the argument so far as it is founded upon the imperfection of the geological record."

Everywhere in this and other papers we note the reverential feeling of the naturalist. The idea of a creative God, a Maker, a Divine Architect, never left him, and while Darwin was being attacked by the clergy for his belief, Agassiz received the sneers and scoffs of many for what they termed his bigoted views. He simply expounded his belief, never urging its adoption, and how liberal was his teaching, how little tinctured with the spirit of bigotry, is seen in the fact that to-day, with perhaps one exception, all of his pupils are believers in the modern theory of evolution as expounded by Darwin.

In referring to classification, Agassiz believed it meant "simply the creative plan of God as expressed by inorganic forms. Referring to man and his position and spiritual nature, he says: "Even in the lowest members of this highest group of the Vertebrates, at the head of which stands man himself, looking heavenward it is true, but nevertheless rooted deeply in the Animal Kingdom, we have the dawning of those family relations, those intimate ties between parents and children, on which the whole social organisation of the human race is based. Man is the crowning work of God on earth; but though so nobly endowed, we must not forget that we are the lofty children of a race whose lowest

forms lie prostrate within the water, having no higher aspiration than the desire for food; and we cannot understand the possible degradation and wretchedness of man, without knowing that his physical nature is rooted in all the material characteristics that belong to his type and link him even with the Fish. The moral and intellectual gifts that distinguish him from them are his to use or to abuse; he may, if he will, abjure his better nature and be Vertebrate more than man. He may sink as low as the lowest of his type, or he may rise to a spiritual height that will make that which distinguishes him from the rest far more the controlling element of his being than that which unites him with them."

In another place Agassiz says, in referring to Darwin's suggestion that man in breeding animals simply takes the place of certain happenings in nature: "Nature holds inviolable the stamp that God has set upon his creatures; and if man is able to influence their organisation in some slight degree, it is because the Creator has given to his relations with the animals he has intended for his companions the same plasticity which he has allowed to every other side of his life, in virtue of which he may in some sort mould and shape it to his own ends, and be held responsible also for its results.

"The common-sense of a civilised community has already pointed out the true distinction, in applying another word to the discrimination of the different kinds of domesticated animals. They are called Breeds, and Breeds among animals are the work of man: species were created by God."

In 1862 Agassiz delivered a series of six lectures in the Academy of Music, Brooklyn, N. Y., which were entitled "The Graham Lectures," on the "Power, Wisdom, and Goodness of God" as manifested in his works. In one of these lectures he announced what may possibly surprise the reader. He said:

"I know that I have been considered by many persons an infidel, because I have not taken for my guidance in the study of science the dictum of certain creeds. But science cannot submit to dictation, it must build up what it seeks upon the premises which it finds. Let us be content if the results lead to the same conclusion; we shall stand then in the position of one who, having been brought up in the religion of his parents, and having been led astray by doubts, has at length, under the influence of a better frame of mind and of sober thought, come to reconsider the basis of his doubts, and by laborious investigation has returned to the faith he had forsaken.

"Such is the position of science. It is the questioning, the doubting element in human progress: and when this has gone far enough, it begins the work of reconstruction in such a way as will never harm true religion, or cause any reasonable apprehension to the real and sincere Christian. Such is my conviction; and while I am considered on one side as an infidel, and decried on the other in scientific circles as a bigot, as one who follows the lead of a creed rather than that of science, I feel bound to say that I am neither."

Those who professed to believe Agassiz an infidel

could hardly have been posted as to his methods and belief, as the works of no naturalist of his time so ring with religious fervour and enthusiasm. In one of his lectures he says: "In presenting the order of succession of animals in past ages, my object was chiefly to show that there exists such a connection between them as bespeaks thought, plan, and deliberation, and that in their combination at different periods is clearly seen the intervention of an intelligent Creator." And again: "Even though we can make ourselves conscious that they (animals) are built by mind, and that it has pleased the Maker of all things to give us a spark of that life which makes us to be His children, formed in His image, that evidence is nowhere stronger than in the fact that our mind is capable of studying those works to a limit which approaches to a comprehension of their wonderful relation to one another."

Thus it will be seen, that Agassiz stands out strongly among the scientists and naturalists of his time as a defender of the faith, as one who never allowed the doubt of infidelity to creep into his mind. To him all nature spoke of the glory of God, and every living thing was an evidence of the creative mind in nature, the wisdom of a Divine Architect.

In referring to his religious nature Dr. Stebbins says: "He was eminently a religious and devout man. He was ever looking for the indications of thought and purpose in nature from monad to mastodon. He studied nature as the work of an intelligent mind, not of blind forces. The more he dis-

covered of order, the more he perceived of intellect. This vast display of animate and inanimate nature was to him the result and perpetual expression of the *divine thought*, *a revelation of God.* How I have seen his face glow as he described some of the most striking of the evidences of intellectual action in nature! He has been accused of weakness for yielding to such impressions, advancing such opinions. It was his great glory not to esteem the *thing* above the *thought*, the *product* above the *producer.* To see behind adapted forms a purposing mind is not a weakness, but a necessity for every comprehensive mind. The studies of Agassiz did not lead him into the mire of materialism nor the deserts of pantheism, nor the dreary solitudes of atheism, but to the sublime ideas of God and immortality.

"Yes; Agassiz was reverent. Said he to his class at Penikese: 'The study of nature is direct intercourse with the highest mind. It is unworthy an intelligent being to trifle with the works of the Creator. A laboratory of natural history is a *sanctuary*, in which nothing improper should be exhibited. I would tolerate improprieties in a church as soon as in a scientific laboratory,' and in this spirit he did his work."

To-day the students of Agassiz are among the most distinguished advocates of the doctrine of Darwin, and unquestionably the majority of naturalists of the world have accepted its deductions; yet there are many who still agree with the eminent Swiss. What the decree of future generations will be can but be surmised.

CHAPTER XXII.

THE AGASSIZ ASSOCIATION.

Agassiz the Teacher—Effect on American Science—Important Positions Held by Pupils—Methods of Study—The Disciple of Outdoor Studies—Methods of Teaching—The Agassiz Association—Work Accomplished.

UNQUESTIONABLY Agassiz was the greatest teacher of science the world has seen. The faculty of conveying information and enthusing the recipient with ardour was inborn. We have seen that he was successful in teaching even in boyhood and that during the days of the "Little Academy" he was the central figure among many bright lights.

He came to this country at a time when it was ripe for new methods. His views were novel, his individuality was recognised everywhere, and, as

MOUTH OF THE RIVER NAPO. (A TRIBUTARY OF THE AMAZON.)

a result, it was not long before he was the centre of scientific interest in America. He gathered about him a coterie of brilliant men from all parts of the country, and it is interesting to note that in almost every instance these students, graduates, as it were, of his system and methods of work, have taken positions of the highest rank. Putnam, now director of the Department of Ethnology at the World's Fair; Jordan, President of Leland Stanford Jr. University; Bickmore, the founder of the American Museum; Agassiz, his son, an eminent scientist, the head of the Cambridge Museum of Comparative Zoölogy; Whitman, of Clark University; Snow, Chancellor of the University of Kansas; Crosby, of the Boston Natural History Society, Garman, of the Museum of Comparative Zoölogy, Wilder, Morse, Mayer, Minot, Brooks, and Packard of Boston, and many more are distinguished naturalists of to-day. Agassiz's coming to America marked the beginning of a new epoch in American science. He introduced methods of study and investigation unknown.

Many of his pupils will remember their first days with him, and several have chronicled their experiences. To one, now a distinguished entomologist, who went to the great master to perfect himself, was given an echinoderm, with a request to be prepared to tell something about it. To be left alone with an echinoderm, especially if one has never seen the animal before, and expected to describe its characteristics, was, to say the least, puzzling, yet the student carefully made his observations and unwittingly learned the first great precept in the

Agassiz school of science teaching. He observed and investigated at first hand, and had the happy consciousness of having made his discoveries himself. This was Agassiz's method. He once entered a class with a bottle of grasshoppers, gravely distributing the kicking insects to the students, then began a lucid, even charming, discourse, which was followed by the students from thorax to eye, and antennæ to mouth parts and back again, after which the grasshoppers were allowed their liberty.

But it is to the after results of Agassiz's life that I would refer in the present chapter, and to the indirect influence of Agassiz upon young people.

Agassiz was a disciple of out-door studies. His classes observed while walking the moors and valleys and recited among the flowers or by the brookside, with the song of the birds and the hum of insects in their ears. This method of study is in vogue to-day and the name of Agassiz is synonomous with health-giving, soul-inspiring out-door studies, face to face with nature and the Divine Giver of all things.

In almost every town or city in the United States we find the Agassiz Association, and, happily, it is fast spreading to other lands. The idea of forming societies among young people to follow out the suggestions of study made by the great teacher, is due, in this country to Harlan H. Ballard of Lenox, Mass., a devoted admirer of the great naturalist, and an educator and lover of nature himself.

The Agassiz Association was founded in 1875, being the "outgrowth of a life-long love for nature,

and a belief that education is incomplete unless it includes some practical knowledge of the common objects that surround us." A similar association had flourished for some years in Switzerland, and the American society grew rapidly in interest. In 1880 it was taken up by the St. Nicholas, and so, from the little society in the Berkshire Hills, sprang the hundreds of chapters that bear the name of Agassiz from one end of North America to the other. The societies were formed in schools, in towns, villages, in fact wherever there were a few persons interested in natural history. While visiting an island in the Pacific, about thirty miles off the coast of California, the author was surprised and delighted to find that, though there were but few permanent inhabitants on the island, there was a chapter of the Agassiz Association. Even in this remote island the name of the great naturalist was revered, and gave inspiration to a few persons who gathered regularly to discuss the specimens that formed the stock in trade of a local curiosity dealer.

The Agassiz Association is a free school of natural history, to include any one old and young, and from schools it has spread so that, according to Mr. Ballard, about two thousand clubs have been enrolled since 1880, ranging from two or three members up to one hundred and fifty, which is the membership list of the Fitchburg, Mass., Chapter, No. 448. This chapter has accomplished much, has published a "Flora of Fitchburg and Vicinity," and issued many valuable papers on the fauna and flora of the locality. Mr. Ballard has received the co-operation of many scien-

tists all over the country, who have agreed to answer questions relating to their specialties, and in this way the dissemination of knowledge and facts has been pushed. The constitution of the Agassiz Association is as follows:

Art. 1. The name of this society shall be *The Agassiz Association.*

Art. 2. It shall be the object of this association to collect, study, and preserve natural objects and facts.

Art. 3. The officer of this association shall be a President, who shall perform the customary duties of such officer, and who may nominate his own successor, who may be elected by the votes of a majority of the chapters of the association.

Art. 4. New chapters may be added with the consent of the president, provided that no such chapter shall consist of less than four members. Chapters shall be named from the towns in which they exist, and if there be more than one chapter in a town, they shall further be distinguished by the letters of the alphabet.

Art. 5. Each chapter may choose its own officers and make its own by-laws.

Art. 6. *The Swiss Cross* shall be the official organ of the Agassiz Association.

Art. 7. This constitution may be amended by a three-fourths vote of the association or its representatives.

Under this constitution the good work has gone on. Hundreds of young people have been aided morally, physically, and mentally. They have been

taken out into the glad sunlight, made better and stronger by the association, and with the possession of new facts regarding simple things rendered more helpful and useful. "It was the dream of Louis Agassiz himself," writes Mr. Ballard, "to see American youth early led into the pleasant paths of natural science; to see them forsaking all foolish and wanton sport for the sake of a wise and loving study of the works of God."

The success of the Agassiz Association lies in in the fact that it appeals to all, old and young, big and little. In a letter to the author, Mr. Ballard, in referring to a new branch of the society, writes:

"This is a chapter composed not of members who live in the same town, but of persons living remote from one another, in places where not enough congenial spirits can be found to form a club, but who are united by a common interest in a common object of research. These are called corresponding chapters, and first among them was the Archæological Corresponding Chapter, which has for its president Mr. Hilberne T. Cressen, of Philadelphia; for vice-president, Dr. C. C. Abbott, of Trenton, N. J.; and for secretary, Mr. A. H. Leitch, of Dayton, Ohio. The members of this society are all adult, and propose, under the auspices and general direction of the Peabody Museum, to preserve valuable mounds from the spade of the vandal and the speculator, until they can be properly opened either by themselves or by some one else acting under scientific supervision. Two other corresponding

chapters have been added recently: the Gray Memorial Chapter of Botany, G. H. Hicks, president, and the Isaac Lee Memorial Chapter of Conchology, led by Dr. M. L. Leach, of Traverse City, Mich. Chapter No. 1, founded in a country school in Lenox, Mass., in 1875, still exists, and is in a stronger condition than ever, although it has recently been removed to Pittsfield, Mass., where it is about to undertake the study of local geology and mineralogy. Since the establishment of our society the girls and women have kept equal step with the boys and men, not only in patient and thorough work in the field and laboratory, but also in the less congenial but perhaps no less necessary work of organisation and direction. Many ladies are efficient secretaries, curators, and presidents of chapters, and one at least has held the office of president of a State assembly, and carried it off with honor."

One of the pleasant features of this Agassiz Association is the custom of celebrating in each chapter all over the land the birthday of Agassiz, May 28th. The chapters make the event an especial occasion, spending the day as Agassiz would were he with them, face to face with nature. Perhaps some paper is read, or *The Prayer of Agassiz*, by Whittier, or the lines by Longfellow on the naturalist's fiftieth birthday are recited.

Among those interested in the chapters are old students of Agassiz, who revere his name and memory, and appreciate the enthusiasm and delight with

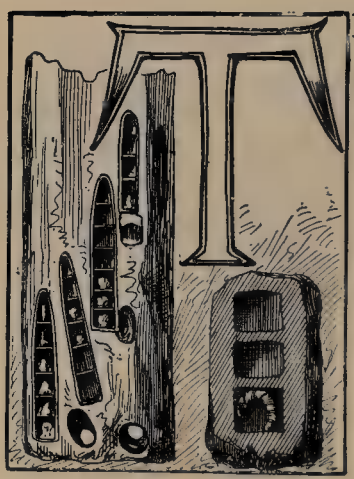
which he would have watched the progress and popularisation of science among the young.

The Agassiz Association is but one of the effects of the teaching of Agassiz upon the thought of the day.

CHAPTER XXIII.

AGASSIZ AND HIS WORKS.

Work on the Spix Collection of Fishes — *On Fresh-Water Fishes—Sur les Moules de Mollusques Vivans et Fossiles—Études sur les Glaciers*—The *Nomenclator Zoölogicus—Contributions to the Natural History of the United States—The Structure of Animal Life*, etc., etc.



HE published works, pamphlets, and monographs of Louis Agassiz have never been completely recorded, but even a casual review of the list known is suggestive of the phenomenal labours of the great thinker and investigator in the world of science. The published works of Agassiz, which were milestones in the development of his career, have been casually referred to in the previous pages, but they were so epoch-making, had so marked an effect upon the scientific thought of the time, that some special mention may add to the interest of the story.

FISHES OF THE UCAYALI AMAZON AND OF THE LAKES BORDERING ITS SHORES.

Authorship came to Agassiz by no slow evolution. He sprang at once into the arena of letters, and was at the early age of twenty-one given by Martius the work of describing the Spix collection of fishes. The work, when complete, was given the following title: *Selecta genera et species piscium quos collegit et pingendos curavit Dr. J. B. de Spix.* Digressit, descripsit, et observationibus illustravit Dr. L. Agassiz.

It was a high compliment to the young naturalist that he should be selected to complete this work, and it is remarkable that one of his age could write so elaborate a volume, and in the Latin language; it gave him a reputation that was something more than mere fame.

The story of his life and aspirations at this time is touching and interesting. His dream was to surprise his parents by the announcement of their son's authorship, and we have already seen how the secret was made public. All his young energies were poured into this work, his entire future seeming to depend upon this one effort, and when we remember that this youth of twenty-one was not only doing the work that was usually given to the oldest naturalists, but writing in the Latin language, we can realise what he had undertaken. His letters to his brother at this time teem with the pleasant anticipations of the results of his labours and the delight which he believed it would give his parents. In one letter, published in the work of Mrs. Agassiz on her husband, he refers to the fact that it will seem a singular thing that the largest book in their father's library will be the folio bearing his own name, "and

will it not," he asks, "be as good as to see his prescription at the apothecary's?"—a suggestion that is appreciated when we remember that Agassiz's father at this time was strenuously endeavouring to have him adopt the profession of medicine.

This work alluded to still stands as one of the most valuable on the subject to which it relates.

Agassiz's second venture, in which he was assisted by Cotta, the noted publisher, was a work on the natural history of the *Fresh-Water Fishes* of Europe, a portion of which was issued in 1839–40, but never entirely completed. He communicated the information of this great undertaking to his parents in a letter from Munich in 1829. He was then anxiously awaiting the reviews of his *Brazilian Fishes*, and for the verdict, though fairly sure of a welcome from the scientific press of the day. The work on fresh-water fishes he planned to issue in numbers, each to contain twelve coloured plates. The young author proposed to announce his new undertaking at the meeting of savants and naturalists which was to be held at Heidelberg, when he intended to distribute his circulars. Cuvier, to whom the *Brazilian Fishes* had been dedicated, and who was highly pleased with the work, promised to aid in its sale in every way. He also expressed great interest in the forthcoming work on fresh-water fishes, pointing out to Agassiz that there was room for such a work as the one he proposed, as the illustrations of those of Block, Marsigli, and others were not correct.

Between the publication of more important works came special papers, monographs, communications

A MONSTER OF THE AMAZON.

to the press, scientific and otherwise, which, if completely collected, would show the extraordinary enterprise and vigour of the young student. The fourteen years during which Agassiz held the chair of Natural History at Neuchâtel were especially prolific in published works, being the period during which he conducted the large lithographic establishment where were made and published many of the plates of the work on *Fossil Fishes*, those of *Poissons d'Eau Douce*, the illustrations of the *Embryology of the Coregonus*, those of the work on *Glaciers*, and the fine cuts of the work on *Echinoderms*.

The work on the fossil fishes, already referred to, was the finest thing of the kind ever published. It contained a thousand species, nearly every one then known to science, and was issued in a regal manner in five volumes with four hundred plates. The magnitude of the work can be realised when it is known that it was ten years in appearing from the press. This work is a monument to the industry, perseverance, and ambition of Agassiz.

His next most important book was that on *Glaciers* which gave him world-wide fame. This work was the result of the glacial rocket which he threw into the geological skies. Agassiz was at the time president of an aspiring scientific body, the Helvetic Society of Natural Sciences, and in his address at the opening of the meetings at Neuchâtel he announced his views and threw down the glove to the scientific world. That his views should take shape in a volume was to be expected, and we have as a result *Études sur les Glaciers*. This elaborate

work appeared in 1840 and 1841 in the German and French languages, and was illustrated by fine plates. This was followed by numerous short papers, lectures, monographs, and descriptions of visits to various glacial regions, and in 1847 appeared his *Système Glaciaire*, an elaborate effort, beautifully illustrated. This not only includes Agassiz's observations, but contains a *résumé* of all that had hitherto been observed regarding glaciers. The stray papers on this subject, which Agassiz wrote in these years, if collected, would form a volume in themselves. One especially is brought to mind for its interest and value. It appeared in the *Edinburgh New Philosophical Journal* in October, 1842, and was entitled "The Glacial Theory and its Recent Progress." It contained a map of the interesting region about Glen Roy. An example of Agassiz's description is found in the following from a paper on the formation of glaciers:

"The long summer was over. For ages a tropical climate had prevailed over a great part of the earth, and animals whose home is now beneath the equator roamed over the world from the far south to the very borders of the arctics. The gigantic quadrupeds, the mastodons, elephants, tigers, lions, hyenas, bears, whose remains are found in Europe from its southern promontories to the northernmost limits of Siberia and Scandinavia, and in America from the Southern States to Greenland and the Melville Islands, may indeed be said to have possessed the earth in those days. But their reign was over. A sudden intense winter, that was also to last

for ages, fell upon our globe; it spread over the very countries where these tropical animals had their homes, and so suddenly did it come upon them that they were embalmed beneath masses of snow and ice, without time even for the decay which follows death. The elephant, whose story was told at length in the preceding article, was by no means a solitary specimen; upon further investigation it was found that the disinterment of these large tropical animals in northern Russia and Asia was no unusual occurrence. Indeed, their frequent discoveries of this kind had given rise among the ignorant inhabitants to the singular superstition already alluded to, that gigantic moles lived under the earth, which crumbled away and turned to dust as soon as they came to the upper air. This tradition, no doubt, arose from the fact that, when in digging they came upon the bodies of these animals, they often found them perfectly preserved under the frozen ground, but the moment they were exposed to heat and light they decayed and fell to pieces at once. Admiral Wrangel, whose Arctic explorations have been so valuable to science, tells us that the remains of these animals are heaped up in such quantities in certain parts of Siberia that he and his men climbed over ridges and mounds consisting entirely of the bones of elephants, rhinoceroses, etc. From these facts it would seem that they roamed over all these northern regions in troops as large and numerous as the buffalo herds that wander over our western prairies now. We are indebted to Russian naturalists, and especially to Rathke, for the most minute

investigations of these remains, in which even the texture of the hair, the skin, and flesh has been subjected by him to microscopic examination as accurate as if made upon any living animal.

"We have as yet no clue to the source of this great and sudden change of climate. Various suggestions have been made,—among others, that formerly the inclination of the earth's axis was greater, or that a submersion of the continents under water might have produced a decided increase of cold; but none of these explanations are satisfactory, and science has yet to find any cause which accounts for all the phenomena connected with it. It seems, however, unquestionable that since the opening of the Tertiary age a cosmic summer and winter have succeeded each other, during which a Tropical heat and an Arctic cold have alternately prevailed over a great portion of the present Temperate Zone.

"At great heights there is never dampness enough to allow the fine snow-crystals to coalesce and form what are called 'snow-flakes.' I have even stood on the summit of the Jungfrau when a frozen cloud filled the air with ice-needles, while I could see the same cloud pouring down sheets of rain upon Lauterbrunnen below. I remember this spectacle as one of the most impressive I have witnessed in my long experience of Alpine scenery. The air immediately about me seemed filled with rainbow-dust, for the ice-needles glittered with a thousand hues under the decomposition of light upon them, while the dark storm in the valley below offered a strange contrast

to the brilliancy of the upper region in which I stood. One wonders where even so much vapour as may be transformed into the finest snow should come from at such heights. But the warm winds, creeping up the sides of the valleys, the walls of which become heated during the middle of the day, come laden with moisture, which is changed to a dry snow-like dust as soon as it comes into contact with the intense cold above."

While the works of Agassiz were well received by the public, they were enthusiastically praised by his friends, particularly Von Humboldt. "You are happy, my dear Agassiz," he said, "in the more simple and yet truly proud position which you have created for yourself. Your admirable work . . . draws to a close. The last number, so rich in discoveries, and the prospectus, explaining the true state of this vast publication, have soothed all irritation regarding it. It is because I am so attached to you that I rejoice in the calmer atmosphere you have thus established about you. The approaching completion of the work delivers me also from the fear that a too great ardour might cause you irreparable loss. You have shown not only what a talent like yours can accomplish, but also how a noble courage can triumph over seemingly insurmountable obstacles."

Referring to the work on *Fresh-Water Fishes*, Humboldt said: "In what words shall I tell you how greatly our admiration is increased by this new work on the *Fresh-Water Fishes?* Nothing has appeared more admirable, more perfect, in drawing and colour.

This chromatic lithography resembles nothing we have had thus far. What taste has directed the publication! Then the short descriptions accompanying each plate add singularly to the charm and enjoyment of this kind of study. . . . I not only delivered your letter and the copy with it to the King, but I added a short note on the merit of the undertaking. The counselor of the Royal Cabinet writes me officially that the King has ordered the same number of copies of the *Fresh-Water Fishes* as the *Fossil Fishes*—that is to say, ten copies."

Such words, coming from the greatest savant of the day to a young author, cannot have failed to give him renewed courage to fight the battle.

A feature of Agassiz's works is that they appeal to the layman as well as the scientist, the same grand idea of popularising science underlying all. This is well illustrated in some of his monographs and papers, of which may be mentioned *Sur les Moules de Mollusques Vivans et Fossiles.*

As early as 1834 Agassiz published an elaborate paper in the *Isis*, entitled "Über die Echinodermen," which attracted wide-spread attention. The curious "basket-fish," or Astrophyton—a starfish with bifurcating arms—was described in 1839, and so plain and simple is the description that it is delightful reading to those not especially interested in science or the wonders of the Echinodermata.

The echinoderms were always a favourite study with Agassiz, and he published many papers regarding them. In 1838 to 1842 he issued *Monographies d'Echinodermes Vivans et Fossiles*—a valuable contri-

SOME CURIOUS AMAZON FISHES.

bution to the subject, and one which added not a little to his fame and reputation.

Agassiz was now but thirty-five years of age, yet few scientists in Europe were as well known to the world. There was hardly a branch of science upon which he was not authority. The year 1846 saw the completion of what was to all intents and purposes a vast index of the genera of the animal kingdom, an extensive work in which he was assisted by twenty-two scientific friends, among whom the work was divided. The volume was issued under the title of *Nomenclator Zoölogicus.*

One of Agassiz's first works in the United States was an account of his investigations in the Lake Superior region, and it is interesting to note that in later years his son Alexander became the owner of valuable copper interests here, the proceeds of which have been used with a prodigal hand in the cause of science and upon the museum which Louis Agassiz founded.

Agassiz's notes upon his observations in America soon assumed large proportions. Among the first publications was a paper on the viviparous fishes of California, then recently discovered, while a still greater plan began to take form in his mind. This was an elaborate work, to be entitled *Contributions to the Natural History of the United States,* and to entail the publication of at least ten large volumes. It was to be a subscription work, and in a very short time twenty-five hundred names were secured, attesting to the popularity of the distinguished writer. This work was never fully completed, but four vol-

umes being issued, these remaining as monuments to his energy and fame. The titles are: *An Essay on Classification*, *North American Testudinata*, *The Embryology of Turtles*, and *The Acalephs*.

If we were to select any of Agassiz's books as representing his best work and happiest expression, this might well be the above-mentioned, as in the various essays are found some of his best thoughts, showing his rare intellectual development. Referring to this, Theodore Lyman says: "To properly appreciate this masterly disquisition, it must be remembered that Agassiz had always a metaphysical mind, and one in which the idea of intelligent power was a ground principle. Although he had not accepted the results of Oken, he heartily admired his spirit, and ever spoke of him with pleasure. Indeed, he may be said to have adopted the method of Cuvier and the inspiration of Oken. Advancing from this point Agassiz interprets the phenomena of Not-self by those of Self. The last paper that came from his hand, 'Evolution and Permanence of Type,' has this sentence: '*It cannot be too soon understood that science is one; and that, whether we investigate language, philosophy, theology, history, or physics, we are dealing with the same problem, culminating in the knowledge of ourselves.*' The human mind is for him an entity in accord with the creating spirit, and capable therefore of studying and appreciating creation. This study and this appreciation he considers science; and he finds in the animal kingdom the physical expression of various intellectual operations, some sharply defined and some shadowy, some

MATAMATA TURTLE.

simple and some hopelessly complex, just as are the familiar workings of the human mind. Not only is his erudition throughout remarkable, but his grasp of facts, intricate in their relations and numerous, is quite amazing. In nothing is this better exhibited than in his celebrated demonstration of the correspondence of embryological, geological, and zoölogical succession. He shows that, in many orders, the species which first appear in the older beds resemble the embryo of the highest species now living; and, moreover, that this fossil and this embryo have characters in common with the living species that stand lower in the zoölogical scale. Thus among Crustacea the living Brachyurans stand highest; but the embryo of the Brachyuran has a long tail like the Macrourans, which are characteristic of the middle geological periods, and among the living are zoölogically inferior to the Brachyurans.

Among the works of Agassiz that have been widely circulated and extremely popular, is his *Geological Sketches*, issued in 1866. This little volume was the result of notes made for extemporaneous lectures, and appeared finally as a series of articles in the *Atlantic Monthly*. There are ten chapters on topics of especial interest, as "The Growth of Continents," "The Formation of Glaciers," "Mountains and their Origin," and others.

Equally valuable is a work previously referred to, *The Structure of Animal Life*, which was issued in the same year, and comprised six lectures, delivered at the Brooklyn Academy of Music in 1862, under the title of "The Graham Lectures on the Power,

Wisdom, and Goodness of God as Manifested in his Works." This volume threw a flood of light upon subjects that had rarely been presented to the masses. The original lectures constituted a remarkable picture at that time. Few if any journals paid especial attention to science, yet these lectures upon a technical subject were so well attended that there was but "standing room only," showing the power of conveying information and of holding an audience possessed by Agassiz.

An extremely interesting work, one which ran through many editions and is still selling, is his *Methods of Study*, which he considered as a "complement or commentary" to the *Essay on Classification.* His view here was to present in "a more popular form the views first expressed," and to reach younger students. To any one to whom nature has a charm, this is a most delightful volume, the clear lucid style attracting the reader and holding his interest to the end. Agassiz had that immediate touch with nature that enabled him to surround any subject, no matter how technical, with an especial interest, and this is well illustrated in this volume in the chapters on "Homologies," "The Age of Coral Reefs," "Alternate Generations," "The Ovarian Egg," etc.

Agassiz was opposed to text-books, but one of his works published in this country was *Principles of Zoölogy*, written in collaboration with Augustus A. Gould, intended for use in schools and colleges.

The last important work of Agassiz was his *Journey in Brazil*, which comprises a delightful journal of

STUDY OF THE MATAMATA TURTLE: SHELL; HEAD, FRONT VIEW; FOOT, BACK VIEW.

Professor and Mrs. Agassiz, the book being chiefly the work of the latter, and suggestive of the delightful companionship that existed between the scientist and his wife. We have seen that Agassiz received much counsel and advice from his mother, and it may be said that his wife, who survives him, was his collaborator in every sense. She was his constant and appreciative companion, herself no less an enthusiast than her distinguished husband; living the same life, entering into all his joys, hopes, and ambitions, she was at once his counsellor, companion, friend, and worthy co-labourer. In the Preface of the Brazilian volume, Agassiz thus refers to the aid his wife gave: "One word as to the manner in which this volume has grown into its present shape, for it has been rather the natural growth of circumstances than the result of any preconceived design. Partly for the entertainment of her friends, partly with the idea that I might make use of it in knitting together the scientific reports of my journey by a thread of narrative, Mrs. Agassiz began this diary. I soon fell into the habit of giving her daily the more general results of my scientific observations, knowing that she would allow nothing to be lost which was worth preserving. In consequence of this mode of working, our separate contributions have become so closely interwoven that we should hardly know how to disconnect them, and our common journal is therefore published, with the exception of a few unimportant changes, almost as it was originally written."

It is the commingling of the expressions of these two earnest characters that adds greatly to the

charm of the volume—that gives a vivid and picturesque account of the entire voyage referred to in previous pages. This work, as might have been expected, had a large sale and is still in constant demand.

Professor Agassiz received much assistance from his son Alexander, who has followed in his footsteps,—a true Agassiz and devotee of science. The Cambridge Museum has been to him a sacred trust, and out of his fortune he has given nearly half a million dollars to science through the institution founded by his father.

Alexander is the only son of Louis Agassiz by his first wife and is ranked among the most distinguished scientists of the day. He came to Cambridge in 1849, receiving his final education at Harvard, from which he graduated in 1855. When fully equipped by special courses in various institutions of learning, he entered active life, going to California in 1859 in connection with the Coast Survey. He was an indefatigable collector, always having the museum at Cambridge in view, and in 1860 he was made assistant of Professor Agassiz, in 1865 becoming virtually its head during the latter's absence. In 1866 he interested himself in the copper mines of Lake Superior, which by his energy became famous throughout the world, and which through his generosity and love of science have been made to pay constant tribute to the great monument of Agassiz the elder—the Cambridge Museum. Professor Alexander Agassiz is a member of the National Academy his father founded and of almost every

scientific society of prominence in the world; his publications, monographs, and reports of various kinds, in connection with his father and individually, being among the valuable contributions to science of the day. With Mrs. Elizabeth C. Agassiz he is joint author of a delightful work, *Sea-Side Studies in Natural History*, while of his father's works he completed the fifth volume of *Contributions to the Natural History of the United States.*

In a single chapter it is impossible to give more than a suggestion of the works of Louis Agassiz, but a study of his bibliography shows him to have been one of the most exhaustive and comprehensive thinkers in the field of science that any age has produced

CHAPTER XXIV.

THE AGASSIZ MEMORIALS.

The Effect of His Death—The Memorial and Resolutions of the California Academy of Sciences: Addresses of Davidson, Gilman, Le Conte, Stearns, Stebbins, Scott, Edwards—Action of the Smithsonian Institution: Addresses of ex-President Garfield and Dr. Parker—Memorial of the Boston Natural History Society: Address by Rev. R. C. Waterson.

THE death of Agassiz was a shock not only to the scientific but to the world at large, and from every quarter came words expressive of the high appreciation in which he was held. Agassiz was an honorary or active member of almost every scientific society of any standing in this country and Europe, and the memorials issued by them, constituted a most interesting and impressive tribute, giving in many instances an insight into his character as seen from the standpoint of his fellow-

MOUTH OF THE RIVER NANAY. (A TRIBUTARY OF THE AMAZON.)

workers, the men of his time who laboured with him in the cause of science and truth.

Action of the California Academy of Sciences.

The memorials which emanated from the California Academy of Sciences are of exceeding interest, and have been introduced here in the belief that they will add materially to this brief estimate of the character of a well-beloved man of science.

AGASSIZ'S INFLUENCE ON SCIENCE.

By George Davidson.

In his own handwriting, upon a souvenir of his Pacific Coast visit, is the legend "L. Agassiz, born May 28, 1807." On the 14th of December, 1873, the telegraph flashed to the uttermost parts of the earth that he was no more; and we meet to-night to render homage to his memory.

After a few occasional meetings, from my first acquaintance with him twenty-seven years since, it happened to be my lot last season to introduce him to the Academy and its friends, after his voyage of twenty thousand miles, undertaken at a time of life when most of us look forward for rest from life-toiling. You saw that his old enthusiasm was still ablaze; you felt the peculiar charm of his presence and voice, and were happier and better in knowing that you had come into personal relations with one who commanded such influence and power for good. So it has been through a busy, earnest life, devoted

to but one object; to see him was to love him; to know him was to willingly promise service to science for all time, and to feel amply repaid in fulfilling that promise.

Learned men and statesmen, and educated, brilliant women had hung on his words, and had paid the same tribute: all mourn with the same sorrow. In our hearts he can never be forgotten; in the centuries hence, his influence and labours will assure students there were intellectual giants in these days.

To others, more intimate with his daily life and thoughts, must be left the analysis of that powerful hold which he maintained on all classes of men. Simplicity and purity of character, singleness of purpose, directness, and comprehensiveness of the highest order, were the bases for that subtle power which gathered facts from observation, combined and correlated them, thence deduced order, and placed them so lucidly and attractively before the learned and unlearned.

With the permission of the Academy, I make this the occasion to say a few words upon the impetus, direction, and steadily preserved influence which he exerted upon scientific study in the United States; not only in his particular lines of investigation, but upon every other branch of knowledge. In 1846, fresh from contact with the advanced scientific men of Europe, and endowed with the amplest powers of body and mind, he saw and was delighted with the broad and untrammelled field in the country of his adoption. One rule he at once established for him-

self — that the results of all his investigations should be given to American and not to foreign institutions; and to the day of his death he broke not the self-imposed obligation. He had cast his life and lot amongst us; and the communication of discoveries to others abroad — who, however, were no less his friends, admirers, and co-labourers — he deemed a special act of treason.

The many wants he discovered, upon assuming his professorship in Cambridge, would have disheartened and dismayed others less ardent and self-reliant. You recollect with what quaint and good humor he described the few dried fishes forming the collection of natural history, by which he was expected to illustrate his lectures and investigations. That want aroused in his mind the desire, and fixed the purpose, to found a museum of zoölogy which should surpass the most complete in Europe — not as a mere measure of vastness, but as the only proper means of affording the necessary material for the use of students, and for aiding the broader studies of the advanced naturalist. With constant thinking, the plan grew in scope and definiteness. Here men high in their special studies could thoroughly describe and classify every obtainable specimen, and designate their relation with each other; whilst the fossils of buried ages should reveal their story, and exhibit their correlation with the present epoch. From a critical discussion of such aggregated results, we may be assured that the law of development in the natural history of the world, whatever it may be, would be demonstrated.

He has not lived to see it. For a quarter of a century he has fought to obtain the means to perfect it, and has really succeeded as no other man upon this continent could have hoped for. But he has infused among our people the sentiment of more liberal assistance to science, and the full fruition of his labour will come to his successors.

It seems a marvel how much of the enthusiasm and industry of Agassiz has been developed among those who have studied or come in contact with him. If there were any that became weary with the heat and burthen of the day, they have dropped by the wayside. The young, the earnest, the ambitious, are scattered over the globe, searching, working, and studying to increase our knowledge. The men of mark who have been students under him are not few; although, perhaps, differing from many of his views, they are working with his indomitable ardour.

From him they have learned that their real student life but just commences when they quit the college halls for the broader and more suggestive fields where animal life exhibits itself in a thousand new relations, and suggests new methods and solutions.

In the last quarter of a century there has arisen in America a large body of the ablest naturalists, geologists, and palæontologists; and I attribute the thoroughness of their investigations, their enthusiasm and success, to the direct and reflected example of Agassiz.

But the impetus which he gave to the interesting study of natural history, to fossil ichthyology, to geology, and especially to glacial action, had its effect

upon all other branches of science. Remarkably well versed in every science, and intimate with the scientists in their specialties, he imparted to them, as the magnet to the steel, an equal amount of his force, directness, and thoroughness; he cheered the struggling, re-invigorated the diffident, and diffused a halo of attractiveness around each one's study.

He was especially earnest and forcible in expressing his views of scientific education. He contended for broader studies than those prescribed in the old, dogmatic curriculum; for something more than heavy, reiterated book-learning. He demanded original research, exhaustive observation, and rigorous comparison. And whilst garnering the treasures, he was peculiarly chary of propounding hypotheses and theories. To him the time had not come for laying down the law of development. He could not bear with superficial study: a man should give his whole life to the object he had undertaken to investigate. He felt that desultory, isolated, spasmodic working avails nothing, but curses with narrowness and mediocrity. Although strongly wedded to his particular objects and course, he fully realised and ably advocated the equal value and importance of the other special branches. He appreciated the fact that the tastes and peculiar mental fibre of others would lead them in other channels, and he looked forward to the time when their results should be brought into harmony with his own.

We hear so much of weak, inconsequent condemnation of specialists, that an erroneous but widespread misapprehension would appear to exist upon

the subject. In every-day life, who hesitates to measure out commendation to the blacksmith, the printer, the farmer, the jeweller, the artist, the merchant, for excellence in their specialties? The steamship, the mansion, the bridge, are but the carefully combined results of men's labours in many special trades; and the strength and beauty of every structure and work are great and pleasing just in proportion as the special workmen are skilled. The moulding of all their results into one harmonious body is the work of another specialist, who has the comprehension to properly adjust and aggregate them.

The case is not at all dissimilar with the specialists of science. Each is gathering and logically arranging all the details of his examinations and study; whilst others are endeavouring to blend and harmonise, so far as practicable with yet incomplete observations, the results in the different branches of science. So delicate have become the means and methods of examination, so extreme the range of subjects, so intimate their correlation, that we are perforce compelled to confine our special investigations to single and very narrow lines of research. The geologist, botanist, chemist, physiologist mathematician, subdivide their labours; cosmical physics attract one astronomer, observations of the planets another, spectrum analysis another. As the results in particular branches are announced, special discussions are entered upon to evolve the law which entwines and embraces them all. These discussions must conform to and be governed by mathematical

processes. No indeterminate solutions can be admitted; for their presence indicates the necessity for more tangible facts.

It was the realisation of this requirement for labour in specialties in natural history and its cognate branches, that impressed Agassiz with the necessity of a museum that should be complete in its absolutest sense; and to accomplish this he undertook his exploration on the Amazon, his voyage round Cape Horn, and had projected a voyage this coming May though the labyrinth of waters extending from Puget Sound to the Chilkaht River in Alaska.

On the Pacific Coast we are full of faith that such a museum will be gathered by the Academy, and that, from the ample means of her benefactors, original researches in special branches of science will be systematically carried on, and the results be regularly made known in series of lectures. For general information, this method has had no abler exponent than Agassiz; in fact, he was the father of the method of popularising science by lectures of the highest order by the investigators themselves. In the present flush of scientific lecturers we are too apt to forget that when he, many years since, commenced giving his series of lectures on natural history, fossil fishes, the glaciers, etc., freed from the usual flood of cold technicalities, he was looked upon as an innovator, and as degrading science. Fortunately, his conception of its value was the true one. A deep and abiding yearning for fresh, living information has been diffused, and, one by one, even the learned men of Europe have yielded to the pressure, and given of

their abundant stores of knowledge to the humble as to the rich.

We cannot yet measure the full value of this new means of diffusing the results and methods of scientific investigations. It humanises and expands the minds of men of power whose business, habits, and pursuits have kept them apart from study since their school-boy days; it quickens the memory of the student and reader; and from the humbler walks of life it will call out the latent talent of many a gifted but timid youth, whose instincts and aspirations would have been chilled by the esoteric system of the old formal school.

In the introduction of this method of popularising science, it was peculiarly fortunate that Agassiz had the rare power of stating so clearly and so logically, and of illustrating so rapidly and cleverly, the processes and deductions of his investigations. It was all new knowledge—not gleaned from encyclopædias or composed of the unverified statements of others. It was mental food for the acutest thinker; it was comprehended by the youngest student. In his lectures his diction was a model of English; no straining for effect, no struggling for words, but the right word always in the right place. "I never think of the words I am to use," said he. "I arrange the matter, order, and method of statement and illustration clearly in my mind before I begin, and then the words come of themselves."

It was fortunate, also, that he had that charm of manner—modesty, simplicity, manliness, and kindness for others—which attracted and captivated his

audience. In fact, it was fortunate for popular science that he was—Agassiz; for men with such a rare combination of good qualities, and such a position, come but seldom in a century.

One of the branches of scientific investigation to which he gave much actual examination and earnest thought, and by which he will be known as the great expounder, was the extent of glacial action during the period when the greater part of the northern and southern continents was under an ice-sheet of immense thickness. He first grasped the full force of the problem, and enunciated it; and his demonstrations have made clear many existing conditions on the surface of the earth, which had baffled the skill of others. Perplexities melted before it, and from chaos are emerging order and consecutiveness. In his visit to this coast, he was particularly gratified and excited with the evidences of glacial action which mark our Sierras, and which I have shown to mark our coast-line. These, the existence of the great living glaciers of British Columbia and Alaska, and the evidences of glacial action through the thousand miles of ocean Yosemites stretching from latitude forty-seven to sixty, were some of the inducements that led him to acquiesce in the projected trip of this season. He had studied the glacial action through similar geological formations from Cape Horn northward, and, from his comprehensive knowledge and grasp of the subject, was peculiarly fitted for the discussion. Even among those who may be capable of seizing the minutiæ of evidence and realising the magnitude of the powers which performed that work,

it may be many years before any one can command the means and the time for their examination and elucidation. It requires a rare combination of qualifications for its solution, particularly that of the mechanical faculty; and we can but hope that from among our young students of California will come those who can demonstrate it successfully.

I close with a few words of a power which he possessed, so unusual among scientific men, yet so absolutely necessary for the development of science as understood by the specialists, and of knowledge as taught by the colleges, that we can but pray without ceasing his mantle may fall and cover many shoulders. Others possess it—perhaps only differing in degree—or the magnificent endowments which have been made to our higher seats of learning would have been devoted to other purposes. Yet he first made the claims of science a demand upon the affluent who had grown wealthy through the practical applications of scientific investigations and discoveries. He would admit of no compromise measures—science had taken a back seat too long; her votaries had been sneered at as particularly deserving reprobation for lack of the money-making faculty; and he repudiated the supposed eleemosynary character of the gifts grudgingly made to her. He boldly stood forth as the champion of the self-sacrificing devotees of science. For the benefit of human knowledge he had given, with unsparing prodigality, the mental and physical activity of a life noted for its remarkable vigour, endurance, and consecutiveness; and his sense of justice was aroused to appeal for help to

those who could so easily and so largely endow our colleges and universities, our museums and academies of science. You have listened to these appeals, and know that even in our midst they have not been in vain. Throughout our country the leaven has reached the treasures of large-minded men who, during their lifetime, wish to see the fruition of their nobler instincts. In the last ten years, millions of dollars have been devoted to learning and science; but many more millions are needed, and the apostles of science must cease not urging and proving her claims. Our university alone needs its millions for buildings, apparatus, and museum; and another million for the endowment of professorships. Our academy needs as much for buildings, collections, and for foundations for original research. And in our midst we need an amply endowed institute of technology.

The interest which he imparted to science on this coast, in one short visit, has steadily increased. The cheering words which he spoke in our behalf have fallen upon the hearts of our people, and awakened their sympathy. The academy certainly has cause to rejoice in its benefactions; but we need still more freely the helping hand of endowment, to realise what he prophesied.

We can listen no more to the magic of his voice; but his example is ever before us. Words of praise can add nothing to his glory; but we can honour his memory by imitating his fervid devotion to science, and its diffusion among mankind. It never faltered; it pervaded his being.

He was the incarnation of Science; and greater love hath no man than this—he laid his life down for it.

He has gone; but his name will be a landmark in human knowledge through the long roll of centuries.

AGASSIZ AS A TEACHER.

By Professor D. C. Gilman.

The name of Agassiz does not belong to the learned alone, though it is honoured most by the wise and the profound; it likewise belongs to the common people, for it is a household word throughout the land.

Few men, while they live, attain renown among the multitude, and also retain their eminence among philosophers; but he wore fitly this double crown—"the praise of praised men," which is gold, and the applause of the unlearned, which is silver. How few of those whom we call distinguished, whether writers, teachers, statesmen, merchants, scholars, or leaders in arms, are equally known and honoured with this college professor, this comparative zoölogist, this interpreter of nature! The news of his decease has brought to learned societies and to common schools, to universities and to fishermen's cottages, the sense of a personal bereavement, for it tells of the loss of a guide, the death of a friend.

To these twofold aspects of his character, your attention will now be directed; the speaker who follows,* by our mutual understanding, rehearsing

* Prof. Joseph Le Conte.

the claims of Agassiz to scientific renown, while I am to dwell upon his claims to popular regard, or rather upon his character, as a teacher, and the influence he has exerted upon American Education.

It will be generally admitted that, among all the teachers of the land, he has held the foremost place. Notwithstanding that ours was to him a foreign tongue, that he grew up to the prime of life under European institutions, and that the subjects which he taught were quite remote from what are called the "practical" wants of the Americans, he always spoke among us with that extraordinary power of adaptation, that easy self-possession, that rare adjustment of thoughts and words to the occasion, which constitutes true eloquence—which attracts, enlightens, delights, and persuades. Before the Legislature of Massachusetts or the National Academy of Sciences, in the college lecture-room or in the teachers' institute, on the public platform or in the private parlor, in the open field or on the vessel's deck, he was always the same—ready, graceful, enthusiastic, earnest, suggestive, and instructive. He delighted to learn, that he might teach; to teach, that he might learn.

When such a man departs, old, honoured, unsullied, and beloved, it is well to inquire into the antecedents of his character, the elements of his renown.

It is not every teacher who is endowed with a good constitution, neither too nervous, nor too phlegmatic. Agassiz was fortunate in his physical character, his noble figure, his beaming countenance, his elastic

step, his excellent health. He was not of that type of scholars whose shrivelled faces and whose withered forms declare the neglect of exercise, and the misuse of food; nor was he one who gained by stimulants extraordinary force. He possessed what might be called a commanding presence, a favourable personal equation, a magnetic influence, a manly beauty, or an easy dignity—a quality not to be defined, but everywhere appreciated, which may be in-bred, yet must be first in-born. He came of good descent, having a mother of rare intellectual qualities, and on his father's side an ancestry of six generations of Protestant ministers, going back to the Huguenot refugees. But his was not the parentage of wealth or fashion, and the narrow circumstances of his early life quickened his industry, his patience, and fitted him forever after to sympathise with and encourage those who have high aims and shallow purses.

His early culture was most liberal. In many countries, and though many years, his studies were prolonged. Four years, the record runs, in the gymnasium at Bienne, two years in college at Lausanne, two years in the medical school at Zurich, five years in the universities of Heidelberg, Munich, and Erlangen, that is, thirteen years, at least, of preparation in the period of youth.

Thus he came in contact with some of the most renowned naturalists in Europe—Cuvier, Humboldt, Martius, Spix, and a host besides—and received that intellectual impress from superior minds which is far more influential than a library full of books, or a city full of museums.

Hence he laid a broad basis for his scholarship. Ancient and modern languages, philosophy, human anatomy and physiology, botany, mineralogy, geology, and zoölogy, were all pursued with such enthusiasm, that in any of these departments he might have been distinguished.

So was he qualified to teach—by natural endowments, personal presence, honourable ancestry, narrow circumstances, prolonged culture, and broad foundations. What, now, were the consequents of such antecedents — the superstructure on such a foundation?

There was supreme kindliness or self-control in his disposition, which led him to be patient with ignorance, and what is harder yet, with arrogance; which made him generous in bestowing his time, his learning, and his letters upon others; which made him accessible to the most timid student, or the most humble discoverer of a curious bug.

To this was added a charming enthusiasm, which gushed forth in no spasmodic intermittence, but bubbled up perpetually with refreshing effervescence. He captivated all whom he met. He made them believe that his work was his play; that they might engage in it with a surety of reward. He seemed to say perpetually to his associates, as Faraday said to Tyndall, under untoward circumstances: "Our subjects are so glorious, that to work at them rejoices and encourages the feeblest; delights and enchants the strongest."

Genuine gratitude was also conspicuous in all he did. The school-boy who brought him an uncommon

fish, or the farmer who sent him a nest of turtle's eggs, or the woodsman who favoured him with a family of little rattlesnakes, was as sure of his hearty acknowledgments as the millionaire of Boston who endowed his museum, or the tobacconist of New York who bought for him Penikese Island, or the officers of the Government who placed at his command the resources of the Coast Survey. No emperor or king ever received such homage, voluntarily bestowed by high and low alike, or such tributes from the united realms of earth, and air, and sea; none returned such gratitude. This gratitude was marked by unmistakable sincerity. His looks, and tones, and the pressure of his hand, all confirmed the utterance of his lips. No one need fear that when the private letters of Agassiz are made public there will be anything to regret, as there was in the posthumous revelations of one of his most illustrious contemporaries.

There was, moreover, a hearty co-operation with other workers, and in other spheres — a friendly indorsement of their efforts which was free from the tone of patronage or of interference. The members of this Academy must well remember the generous words which he uttered on the evening when he first set foot in San Francisco — his congratulations at the success of the Academy, his words of encouragement for the University, and his eulogy of the Geological Survey, the pride of all the science of the State.

Still more remarkable in Agassiz was his readiness to aid in the diffusion of knowledge. Devoted as he

was to scientific researches—to the advancement of learning by investigations of the most profound sort, extending down to the lowest organisms at the bottom of the sea, and back to the remotest æons of geological history—he was always ready to come before the public and bring the newest and the best of his acquisitions. There are such men as intellectual misers, but he was not of that race. There are also those who are deaf and dumb, but he used all his faculties. He did not wait for costly diagrams or extraordinary specimens. A blackboard and a piece of chalk were all the apparatus which he required for a lecture on natural history. At the oldest University in Cambridge, or at the newest in Ithaca, through the *Atlantic Monthly* or the extra *Tribune*, in the National Academy, or on Penikese Island, in the State house at Boston, or in Pacific Hall at San Francisco, he was ready to teach all who wished to be taught. The wisest would enjoy the clearness, the liveliness, and the method with which he told his tale; and the uninformed would think they were growing wise, because they could follow so agreeably and intelligently the utterance of a master. He believed in the Public Schools; and the newspapers say that one of the last acts of his public life was to give a lecture at a teachers' meeting.

As a popular teacher, Agassiz was undoubtedly aided by his devout reverence, which saw in Nature something more than a force or law, or rather, which believed all law and force to emanate from a Law-giver and a Ruler. He did not obtrude these

opinions. He was not more fortunate than other men of science in escaping the attacks of bigotry and superstition; but now and then, like a church-bell tolling on a Sabbath morning, deep utterances would come forth expressive of his faith. For example, at the close of his essay on "Classification," occurs this passage: "All the facts proclaim aloud the one God, whom man may know, adore, and love; and Natural History must in good time become the analysis of the thoughts of the Creator of the universe, as manifested in the animal and vegetable kingdoms." *(Contributions to Natural History of the United States.)*

Thus we see that the supreme kindliness, charming enthusiasm, genuine gratitude, unmistakable sincerity, uniform co-operation, incessant desire to diffuse as well as to advance knowledge, and devout reverence, were among his most conspicuous qualities as a teacher. I do not dwell upon his love of truth, for that is fundamental with all real men of science; nor on his abstinence from money-making, for all legitimate university life precludes the professor from wild speculations on the one hand, or from regular business responsibilities on the other; nor do I dwell upon his love of studies remote from their practical bearings, for the student of Nature never knows what profound benefits to mankind may proceed from the most abstract research. In these respects I do not know that Agassiz differed much from other naturalists, but in native gifts, and in the acquisitions of varied culture, there are but few to be compared with him.

Hence he has exerted a powerful influence upon American education. It is true that he was fortunate in colleagues and in circumstances. Guyot came with him to this country from Switzerland, and in a different sphere, and with different intellectual endowments, has shown many of the qualities which distinguish his life-long associate. Their united work among the teachers of Massachusetts will always be gratefully remembered by the friends of popular education. Dana, when Agassiz arrived, had recently returned from his voyage around the globe, laden with rich treasure of thought and observation, and in his enlightened and impartial conduct of the *American Journal of Science*, was a powerful ally in the promotion of all departments of scientific education and research. Bache and Henry, at the head of two great departments of the Government, the Coast Survey and the Smithsonian Institution, were able to turn the national resources toward the same great purposes. Torrey and Gray had already given world-wide reputation to American Botany, and Peirce had advanced the science of Mathematics. The gifts of Lawrence, and Sheffield, and Peabody, successively brought new and advantageous impulses to the study of Natural History. The explorations of the Western States and Territories, the settlement of California, and the surveys of the Pacific Railroad route, created a demand for trained geologists and naturalists. Young men were attracted to Cambridge by the renown of the Swiss professor, and, after learning wisdom in his laboratories, went off to found and develop new institutions in Salem,

Boston, New Haven, Ithaca, and Oakland, or offered themselves to the service of the State or nation. Teachers in the common schools, especially in New England, learned how to awaken interest in the study of Nature. Congress, in 1862, made a generous provision for scientific schools; and now, a quarter of a century from the coming of Agassiz, scientific courses run parallel with classical courses in most of the colleges of the country. I am far from attributing all this progress to any individual. It is the movement of science, in a new country, and in the nineteenth century; but I do not hesitate to say that among all the great and serviceable men who have helped on this spirit of research and of investigation, none is more worthy of grateful homage than Louis Agassiz. Especially was he noteworthy for his opposition to the rote-teaching in scientific text-books; for his encouragement of local studies—researches about home; and for his persistent employment and recommendation of the art of drawing as an indispensable aid in scientific research.

If I may be allowed to make an allusion to my own relations with Professor Agassiz, I will say that the greeting which you gave him, and the greeting which he gave me in the halls of the Academy, fifteen months ago, filled me with assurance and courage. It was not long afterward, before his visit here bore fruits, and the liberality of Edward Tompkins, of Oakland, endowed in the University of California a professorship which is to bear in all time the name of Agassiz. Scarcely two months ago I sat in his study at Cambridge, and answered his

inquiries about California, and the friends whom he met here. I congratulated him on the recovery of his health, and heard his declaration that he had at his command all the funds which he could well employ for two years to come. Scarcely ten days have passed since I received from an Eastern society a request, which was made at the suggestion of Agassiz, that I would prepare, or cause to be prepared, a paper on the commerce of the Pacific in its relations to San Francisco. Then came the telegram that he was gone.

Agassiz is gone! His name is henceforth enrolled among the immortals. Whatever personal deficiencies he may have had, whatever of the imperfections or weaknesses which belong to humanity, will soon be forgotten, and his worth will be more apparent as the years roll on. Hereafter he will be remembered with Linnæus, and Cuvier, and Humboldt, and others, whom the world delights to honor for their scientific researches; with Franklin, and Rumford, and Faraday, who have made popular the sciences which they have likewise advanced. So we lay upon his tomb our perishable garland, and say, Farewell, philosopher and philanthropist! Farewell, our teacher and our friend.

AGASSIZ'S WORK AND METHOD.

PROFESSOR JOSEPH LE CONTE.

MR. PRESIDENT AND GENTLEMEN, MEMBERS OF THE ACADEMY OF SCIENCES: — I respond the more willingly to your invitation to say something in

honour of Professor Agassiz, because I owe personally so deep a debt of gratitude to him as my teacher. For some fifteen months in the years 1850–51, as his private pupil, I spent the whole working hours of nearly every day by his side, either in the laboratory or else in excursions along the shores of Massachusetts, or over the mountains of New York, or on the reefs and keys of Florida. The result of this long intimate association was, on my part, a great and ever-increasing love, admiration, and reverence for him, both as a scientist and as a man, and on his part, I am sure, a very strong and affectionate regard. It would be very pleasant to me to linger here a moment—to speak of him as a man and a teacher; the contagiousness of his enthusiasm, the abundance and suggestiveness of his thoughts, the greatness of his intellect, far greater even than his work, and, therefore, contrary to what we find in little great men, the increase of his intellectual stature as you approached him nearer and nearer. It would be pleasing to me to linger here, but I have a higher duty to perform, and one which I am sure would be more pleasing to him. In speaking of a man of science, before a scientific body, it seems to me peculiarly appropriate that I should try to show the *true grounds of his great reputation, and the reasons for believing that it will be permanent.*

In the noble army of science—that army so compactly organised for the conquest of darkness and the extension of the empire of light—there are many valiant fighters, but there can be but few *leaders.* In the construction of the great temple of science—

that eternal temple made without hands—the only temple ever erected by man worthy to be dedicated to the great Author of nature—there are many busy, eager, joyous workmen, but there can be but few *master-builders.* Now, I wish to show that in the construction of the temple of science, Agassiz was not only an indefatigable worker in all the lowest details, with chisel and hammer and trowel, in brick and stone and mortar, but also a great *master-mason;* that in the army of science he was not only a valiant fighter in the very front rank, but also a *great leader.* In a word, I wish to show that he was not only an indefatigable, enthusiastic worker in all the lowest details of his chosen science, observing, collecting, arranging, analysing, classifying, but also a *great philosophic thinker*—that his life and work form an epoch in science—that in looking back over the track of time, his gigantic stature will remain for many ages to come a conspicuous landmark.

As we look back over the history of science, we see, at long intervals, certain men who seem to tower far above their fellows. In what consists their greatness? They are men who have introduced *great ideas* or *new methods* into science—ideas which extend the domain of human thought, or methods which increase our power over nature, facilitate the progress of discovery, and thus open the way to the conquest of new fields. Such men were Copernicus, and Galileo, and Kepler, and Newton, and Herschell, in astronomy: such were Linnæus, and Buffon, and Cuvier and Agassiz, in organic science.

Let me illustrate the effect of the introduction of great ideas into science. I will select one example from astronomy, and one from geology.

Before the time of Copernicus and Galileo, this, our earth, was *all of space* for us. Sun, moon, and stars were but little satellites revolving about us at inconsiderable distance. Astronomy then was but the *geometry* of the heavens, the geometry of the curious lines traced by these wandering fires on the concave board of heaven. But with the first glance through the telescope, the phases of Venus and the satellites of Jupiter revealed the existence of other worlds beside our own. In that moment the fundamental idea of modern astronomy, the idea of infinite space filled with worlds like our own, was fully born in the mind of Galileo. In that moment the intellectual vision of man was infinitely extended.

Again, before the time of Buffon and Cuvier, this, our human epoch, the history of our race, was *all of time* for us. Shells and other remains of marine animals had, indeed, been found far in the interior of the continents, and high up the slopes of mountains, and there had been much speculation as to the origin of these. Some may have thought by means of these to extend the limits of our epoch, but none dreamed of other epochs. Some may have thought they were discovering new coast islands along the shores of time; but none dreamed that these were the evidences of new worlds in the infinite abyss of time. It was reserved for Buffon and Cuvier first to recognise the entire difference between fossil and living species. In that moment was born the funda-

mental idea of geology, the idea of infinite time containing many successive epochs, or time-worlds like our own. In that moment the intellectual horizon of man was again infinitely extended.

These two are the grandest moments in the history of science; yea, in the intellectual history of our race. The one opened the gates of infinite space, and showed us many space-worlds; the other opened up the gates of infinite time, and showed us as many successive creations or time-worlds.

We see, then, the intellectual impulse communicated by a great new idea. The introduction of a new method, though less striking to the imagination, is perhaps even more important. We will illustrate it presently. Now, I wish to show that Agassiz, too, was the originator of new ideas, and the introducer, or at least the perfecter, of new methods in science. Yes, Agassiz was the originator of a great new idea in geology, and the introducer or perfecter of a new method in organic science.

For nearly a century past, glaciers, their structure, their mysterious motion, and their effects, have been the subject of the intensest interest to scientists; an interest which is deepened by the splendours of mountain scenery and the perils of mountain travel. The most eminent men have successively expended their energies upon these problems: De Saussure, and Charpentier, and Huger, and Agassiz, and Guyot, and Forbes, and Tyndall. To the physicist, the two points of greatest interest are, the *law* of glacier motion and the *theory* of glacier motion. Now, in the din and confusion of discussion, as to whether

Agassiz or Forbes first discovered the true *law* of glacial motion, and as to whether Forbes or Tyndall advanced the true *theory* of glacial motion, it seems to have been almost forgotten that to Agassiz and Guyot is due the credit of something far greater than either the law or the theory of glacial motion. I put aside with bare mention the immense mass of accurate observations accumulated by Agassiz, and embodied in his great works—the *Études des Glaciers* and the *Système Glacière*, a treasury from which all subsequent writers have drawn. I put aside also all questions as to the laws and the theories of glacial motion, important as they are, as trifling in comparison. I desire to fix your attention on only one great idea introduced by him, *viz.:* the idea that glaciers are now, and have been to a much greater extent in a previous epoch, *a great geological agent*, sculpturing our mountains and determining the forms of our continents.

Let me trace the history of this great idea. Agassiz and Guyot had studied minutely the evidences of the former extension of the glaciers of Switzerland. Guyot had even traced the outlines of these ancient glaciers, and thus established the existence of a glacial epoch in that country. With these results still fresh in his mind, Agassiz visited England in 1844 or 1845 (I know not the exact date, nor is it important), and quickly recognised the footprints of glaciers all over the mountains of Wales and Scotland, and astonished the world by announcing that these regions were moulded beneath an ice-sheet. In 1846 he came to this country,

and again tracked the steps of glaciers all over the surface of New England, and again astonished the world by announcing that all the northern portions of the United States were also moulded beneath an ice-sheet. It is unnecessary to trace the extension of this idea from country to country; suffice it to say, that it was soon recognised that there was a glacial epoch not for Switzerland only, but for the whole earth. Before Agassiz, the study of glaciers was the study of nice questions in physics, and of interest principally to special physicists. Agassiz transferred the whole subject into the broad domain of geology, and gave it a far deeper, broader, and more general interest. The result was not only a powerful impulse to the study of glaciers, but a flood of light shed upon the whole later geological history of our earth, and thus an enormous impulse to geology also.

But I said that Agassiz was a great reformer in zoölogy also—that he was also, if not the first introducer, at least the perfecter of the great method of organic science. This must ever remain the chiefest glory of Agassiz. Yes, far greater than all his great works in zoölogy—as great as these are, a monument of industry and genius—far greater than these is the *method* which underlies them, and which has impregnated all modern zoölogy.

Let me pause a moment, in deference to the intelligent but unscientific of this audience, to explain the meaning and show the power of scientific methods. Scientific methods bear the same relation to *intellectual* progress which machines, instruments,

tools, do to *material* progress. The civilised man is not superior to the savage in physical strength. The wonderful mechanical results achieved by civilised man are possible only by the use of *mechanical contrivances.* So, also, the scientists differ from the unscientific not by any superior intellectual power. The astounding intellectual results achieved by science have been attained wholly by the use of *intellectual contrivances*, called methods. As in the lower sphere of material progress, the greatest benefactors of our race are the inventors or perfecters of new mechanical contrivances or machines; so in the higher sphere of intellectual progress the greatest benefactors of our race are the inventors or perfecters of new intellectual contrivances, or methods.

To illustrate the necessity and power of method, take, for example, the method of *notation*, characteristic of mathematics. How simple the contrivance, and yet how powerful! Nine numeral figures, having each a value of its own, and also a value depending upon its position: a few letters—*a* and *b*, *x* and *y*, connected by the symbols + and −: that is all. And yet by the use of this simple contrivance the dullest boy in your public schools may accomplish intellectual results which the greatest philosophic genius could not otherwise attain. As soon as we leave the field of abstract thought and rise into the field of phenomena, *observation* commences. But as in the field of pure thought, thought can accomplish little without method; so in the field of phenomena, observation can accomplish little without the assistance of method. The phenomena of the external

world are so complex, so affected by disturbing forces and conditions, that in order to be understood, they must first be simplified. The scientist, therefore, by *experiment*, removes one condition after another, and one disturbing force after another, until the true cause and necessary condition is perceived. This is the great *method of experiment*, upon which rests the whole fabric of physics and chemistry. But when we rise still higher into the field of organised bodies, the phenomena become infinitely more complex and infinitely more difficult to understand without the assistance of method, and yet, just here, the method of experiment fails us, or, at least, can be used only to a very limited extent. The conditions of life are so complex, so nicely adjusted, so delicately balanced, that when we attempt to introduce our rude hands in the way of experiment, we overthrow the equilibrium, we destroy the very conditions of our experiment, *viz.:* life. In this dilemma what shall we do? Fortunately, nature herself prepares for us a most elaborate series of experiments. The phenomena of life in the higher animals and plants are indeed far too complex to be understood; but if commencing with these we go down the scale, we find these phenomena becoming simpler and simpler until they reach the simplest expression in the microscopic cell or microscopic spherule of protoplasm. The equation of life is reduced to its simplest terms, and then, only, we begin to find the value of the unknown quantity. This series I will call *the natural history series.* Again, nature prepares for us another series of ex-

periments. Commencing with the *mature* condition of the higher animals, and going backwards along the line of individual history through the stages of embryo, egg, and germ, we find again the phenomena of life become simpler and simpler, until we again reach the simplest condition in the microscopic cell. This, I will call the *embryonic series.* Again, that there might be no excuse for man's ignorance of the laws of life, nature prepares still another series of experiments. Commencing with the fauna and flora of the present time, and going back along the track of geological history, through Tertiary, Secondary, Palæozoic and Eozoic, to the very *dawn* of life, we find a series of organic forms becoming simpler and simpler, until we again reach the simplest term in the lowest conceivable forms of life. This I will call the *geological* or palæontological, or evolution series.

Now it has been by extensive comparison in each of these series up and down, and by extensive comparison of the three series with each other, that our knowledge of organisms has gradually become scientific; that mere accumulation of facts and phenomena has grown with science; that a mere heap of useless rubbish has been changed into a beautiful edifice. This is what is called the *method of comparison*—the great method used in the science of life. Yes, anatomy only becomes scientific through *comparative* anatomy. Physiology only becomes scientific through *comparative* physiology; and I may add, psychology will never become scientific except through *comparative* psychology.

So much I have said to show you the nature and power of scientific methods and especially of that method—the method of comparison—upon which rests the whole fabric of the science of organisms. Now what has Agassiz done in perfecting this method? I will attempt to explain.

We have seen that this method consists of *three subordinate* methods which lead to similar results, *viz.:* comparison in the three series, the natural history series, the embryonic series, and the geological series. Now Cuvier and his co-labourers introduced and perfected comparison in the natural history series and thus laid the foundation of scientific zoölogy; but Agassiz and Von Baer and their co-labourers extended the method of comparison into the embryonic and geological series, and also into the relation of the three series to each other; and thus greatly perfected the method and increased its power. Others, no doubt many others, assisted in the great work, but Agassiz was unquestionably the leader in the movement. For forty years Agassiz worked incessantly, enthusiastically — even to the breaking down of his strong physical constitution and the sacrifice of his life—on the ideas and the methods conceived in his youth. *Is not this a great life?*

Finally, let us glance at some of the results of Agassiz's method. The *direct* result is too familiar and obvious to dwell on. We see it in the amazing impulse given to biology and its consequent great and ever-increasing progress in recent times. I will only very briefly draw your attention to the *indirect*

results, *i. e.*, results which were not in the mind of Agassiz nor aimed at by him.

1. Agassiz's work and Agassiz's method prepared the whole ground and laid the whole foundation for the modern doctrine of evolution. The idea of the *similarity* of the three series mentioned above—the natural history, the embryonic, and the palæontological—and therefore *the light which each sheds on the others*, a view so long insisted on by Agassiz and so tardily and grudgingly accepted by zoölogists, forms the whole scientific basis, and comparison in these three series, the whole scientific method, of the theory of evolution. Evolution is development. Evolution of the organic kingdom is development of the organic kingdom through geologic times. No one insisted so long and so strongly on development of the organic kingdom through geologic times, as did Agassiz. All that is grandest and most certain in evolution, *viz.:* development from lower to higher, from simpler to more complex, from general to special by a process of successive differentiation, has always been insisted on by Agassiz, and until recently only grudgingly accepted by English zoölogists and geologists. In this sense, therefore, Agassiz is the great apostle of evolution. It was only the *present theories* of evolution, or *evolution by transmutation*, which he rejected. His was an evolution not by *organic forces within*, but according to an *intelligent plan without*—an evolution not by *transmutation* of species, but by *substitution* of one species for another. In the true spirit of inductive caution, perhaps of excessive caution, he confined

himself strictly to the *formal laws* of evolution, and no man has done so much in establishing these as he; but he regarded the *cause* of evolution as beyond the domain of science, and all attempts at a *causal* theory as at least premature if not altogether vain.

2. Agassiz's work and Agassiz's method has laid the only foundation of a possible scientific sociology. Society also is an organised body, and therefore subject to the laws of organisms. Society, too, passes by evolution from lower to higher, from simpler to more complex, from general to special, by a process of successive differentiation. Society *progresses, develops.* This is the most glorious doctrine of modern times. The phenomena of society, however, are even more complex than those of organisms, and therefore still more in want of a method. But we have already seen that phenomena which are too complex to be analysed by experiment can only be brought into subjection by the method of comparison. If, then, there shall ever be a scientific sociology, it must be by the use of the same methods which are used in biology; it must be by the comparison of social institutions, governments, civilisations, etc., in all stages of development; it must be by extensive comparison of social phenomena in *three series*, first, as exhibited in *different races and nations* in various stages, as now existing in different places, corresponding to the natural history series; second, as exhibited in various stages of advance of the *same nation* from barbarism to civilisation, corresponding to the embryonic series; third, as exhibited in the slow onward progress of the *whole*

race through rude Stone age, polished Stone age, Bronze age and Iron age, corresponding to the palæontological series. It is by comparisons of this kind that Herbert Spencer is now attempting to lay the foundations of a scientific sociology. I repeat it: if sociology ever becomes a science it will owe much to the genius and the method of Louis Agassiz.

POPULARITY OF LOUIS AGASSIZ.

By Robert E. C. Stearns.

Mr. President.—It has pleased you to insist that I should add something to the general expression of sorrow and of eulogy. It is in no spirit of reluctance that I hesitate to bear testimony to the merits of him to whose voice it was so pleasant to listen, and in whose presence it was a pleasure to be; but rather from the fear of my inability to render an even measure of justice to the dead.

Without enlarging upon those exterior characteristics by which he was known, and which, ennobled by a generous nature, gave grace and dignity to his person, we find with and above these attractions a moral and intellectual greatness and simplicity, which endeared him to his fellow-men.

I cannot recall the name of any other scientific man, which has been so often spoken, and with so much respect and affection, in the homes and families of our people, as that of Agassiz.

This respect and affection arose, not alone from his intellectual achievements or from the popularity

of his lectures and writings, but from that large-heartedness which made him accessible to all.

In his intercourse with his fellow-men, he graduated his speech not by the rank or station of the person, for each and all were received with unmeasured courtesy and kindness.

Such intellectual breadth, moral excellence, and estimable qualities as he possessed, are seldom found in the same person; and these made him not only an impressive and attractive teacher, but, combined with enthusiasm, inspired all with the desire to serve and assist him; hence, in part, that vast aggregation of materialat Cambridge,beyond the capacity of the present building for its proper arrangement and display.

What wonderful progress has been made in our country since the arrival of Agassiz, in 1846! Its material wealth how enormously increased, broad areas peopled, new States established, and the march of empire pushed westward to the sea. At that time, for the year of his arrival may be regarded as a notable and important event in the history of the country, within a few rods of this spot, the waters of the Bay rippled along an almost untrodden beach. Do you remember his concluding remarks at the Academy's rooms, on that September evening, a little more than a year ago? He said: "When I saw to-day, for the first time, San Francisco through the Golden Gate, I was amazed. I looked upon it as one of the marvels of modern times that there should be a city standing upon these shores, so grand, so prosperous, so rich, and so young." Great and manifold as are the changes we have noticed, great

also has been the progress of science and intellectual advancement in the nation. The increased and constantly increasing interest in scientific study and literature is most marked and astonishing.

I cannot but remember, and with regret, that when a boy some thirty years ago, when first I became interested in the study of natural history, there were neither books nor teachers. How often have those early disadvantages been brought to mind, from time to time, as in after years I added to the muster roll of friends, the names of younger men who were privileged to sit under the teachings of the great master.

As some good mother, by the fireside's glow, spreads the new book upon her lap, and, calling her children near, points out the pictures and explains their meaning; so he, with radiant face and winning voice, gathered around him those nature-loving boys, and, opening wide the book of the greater mother, page by page, pointed to its living illustrations—explained their history and their relations, their beauty and their use.

How shall we estimate the value of early training under such a teacher?

Of the earlier students, Stimpson has passed away. He had accumulated, though but forty years of age, the ample store of more than twenty years' investigation. His manuscripts and plates were destroyed by the great fire in Chicago. Of this sad event and its effect upon him he wrote: "My own books, collections, manuscripts, and drawings—twenty years' work—all gone." What a pang must have shot

through his heart as he wrote that line! "His old teacher offered him all the resources of the museum at Cambridge, but, with all his old love for the work, his strength was gone."

We may speak freely of the dead, if no evil is in our speech; but delicacy suggests that we should cautiously praise the living.

Other members of the earlier classes are professors and teachers in various colleges and schools throughout the country, or faithfully toiling in some field of investigation. I may not call their names. Many have already acquired distinguished reputation, and all are contributing to "the sum of human knowledge." Some of them are borne upon the roll of this Academy, and share with us the duties of this occasion.

A few days more than eighteen months have gone since Stimpson died; and now the illustrious teacher has followed his old-time pupil, on the same inevitable path.

Shall we not pause, before we say farewell, and review the labours and services of the master, since the day when he made our country his own?

How much, what part of our intellectual growth and material advancement, with its resulting higher and expanding civilisation, is due to him?

Of those lofty qualities which lift man above the merely imitative and sensual animal, and place him nearer the divine—in all which makes a people wise and virtuous and a nation great—who has done more to disseminate the seed and encourage the growth than Louis Agassiz?

And now we say, good-bye! The form we knew and called by his name will soon fade away; but the effacing fingers of decay can never mar the record of his noble life.

At the conclusion of this paper, which, owing to the absence of Mr. Stearns, was read by Dr. E. S. Carr, the latter remarked as follows:

"Yes, Mr. President, Agassiz is not dead. He has gone to sit with Humboldt and Cuvier, with Plato and Aristotle, among the stars; the voice of humanity, echoing down the corridors of time, and gathering fulness, through the coming ages, will ever proclaim as long as a love of knowledge endures—*Agassiz still lives.*"

AGASSIZ'S PLACE IN SCIENCE.

Rev. Dr. Horatio Stebbins.

Mr. President, Ladies and Gentlemen:—It would not be appropriate to me in this presence, and after what has been said by those who have preceded me, to undertake to give a *résumé* of Agassiz's scientific thought, or to sketch his career as one of the great interpreters of nature's law; but while I have been sitting here listening to the words of others, and looking into your faces, I have been impressed anew by that cheerful, harmonious accord of reason, intelligence, and all magnanimous sentiments with which we acknowledge human greatness. With what refreshing admiration—with what proud, grateful, sympathising joy do we stand on these level

plains of existence and look up to those vast mountain ranges whose solitary summits attest man's intellectual and moral grandeur, and the permanence of truth! It is the felicity of the scientific man, that the truth he seeks is cosmopolitan. It knows not state or nation, tribe or race, but is world-truth and world-law. The distinguished representatives of that truth have a clear atmosphere, and if their moral nature is strong enough to sustain itself in those rarified heights, they lead a life of singular dignity and freedom, their minds dashed with no colour of prejudice or passion—seeking what is. To know what is in the world of things, is the vocation of the man of science. His reputation is the reputation of truth, strong and still as the sun; and his name is the property of mankind. In the enthusiasm of admiring grief, we accord to our late illustrious fellow-citizen and cosmopolite such a place and such a name.

Far back, ascending the centuries, in the very horizon of man's intellectual history, is Aristotle, in whose mind the seeds of the universe were planted, who compassed all the knowledge of his time, and gave the hint to future ages. Two thousand years later is Humboldt, who, with matchless wonder of comprehension and penetration—with a persistency of purpose and idea, pursued, without a parallel in the life of man, through a period of nearly seventy years of original research—constructed a "Cosmos," the science of the relation of things, which is perhaps the source of more of the knowledge of the modern time than has come from any other single mind. In

our own time, and in the near distance of the present, is Agassiz, who, coming forward at a period when science was so complex as to render universality impossible, devoted himself to the investigation of the living forms upon the surface of our globe, and to finding the thread of order and law running through all organised beings. His mind was at once incisive and comprehensive, analytic and synthetic; while a fine glow of poetic insight and feeling suffused his whole intellectual and moral frame. It was this poetic nature, expressed in elevated, restrained enthusiasm of purpose and idea, that enabled him to give such an impulse to scientific studies in America. He had the rare ability of pursuing original research and of transforming it into popular knowledge—a hazardous undertaking for some, inasmuch as the popularisation of science is accomplished through dense and refracting media, which impair intellectual rectitude and degrade the scientific standards of truth to practical and economical relations. To extend the domain of science is one thing, to diffuse science is another thing; and the two are rarely united.

Agassiz claims my admiration for the firmness and simplicity with which he maintained the right of science to pursue its own investigations in its own domain, without controversy, and without reference to any prejudices or opinions that might be held in any other department of knowledge or experience. With the old conflict between science and religion he had nothing to do. He had frankness and truth enough to confess that there is as much dogmatism

in science as in religion; but he knew that essentially there is no conflict between them, and never can be. Their boundaries are undefined, as the boundaries between the known and the unknown, the apprehended and the comprehended, always will be. It is one of the infirmities of the human mind to become provincial in its conceptions of truth, and to judge the universe of things by the standards of its own village experience. Agassiz did much to enlarge and enlighten the mind, by teaching that the outward world is an expression of the thought of God, and that man's science is the discovery of God's law.

He was indeed a light and a life! That life has finished its earthly course, and that light is extinguished from our earthly horizon. It must be considered a happy event to us here, that he visited once these western shores. It is a privilege to have seen him; as it is a profound satisfaction to feel that the distinguished expressions of human nature are of kindred blood with ourselves. As I looked on him and called to mind the recollections of former days, admonished of the malady that was destroying him, I grieved for living men; but I did not grieve for him—there was so little of him that could die.

REMARKS BY REV. DR. W. A. SCOTT.

MR. PRESIDENT, LADIES AND GENTLEMEN:—I did not know till I entered the hall this evening, that I was expected to have the honour of saying a word to you on this interesting occasion, but being urged

to appear on the platform I could not absolutely refuse, because as a citizen it was in my heart to honour, as far as in me lay, this memorial meeting, and as a member of this Society to aid in tendering our respects to the memory of our illustrious dead. Another reason for opening my lips is to endorse the sentiments of Rev. Dr. Stebbins, just uttered in regard to the alleged or supposed antagonism of science to revealed religion. Believing as I do, as intimated in the reference made to the opinions of the late Louis Agassiz, that there is as much *dogma* in science, or even more than in religion, I am ready to say and boldly maintain that there is not, and cannot be, any real antagonism or controversy between true science and true religion. All truth is of God and is a unit. Science and religion are twin sisters from the throne of the Eternal Lawgiver. There is no real controversy between them—no strife but as to which branch of knowledge can do most for mankind. Properly interpreted, they come from the same glorious hand and tend to the same result—the happiness of mankind and the glory of the Creator. I honour science, and heartily bid God-speed to every honest investigator of the laws of the universe. As a theologian I have never had the slightest fear concerning the advance of true science. Our natural philosophers cannot travel so far but they will find the Creator has been there before them; and as they climb through space and journey among planets and systems unnumbered, they will all find that the ladder by which they have ascended to the very outposts of the universe was built for

them by the hand of an all-wise Lawgiver possessed of supreme intelligence, will, and power. No, ladies and gentlemen, there is no real controversy between true science and religion. Their mission is one—the progress of mankind to a higher degree of knowledge and sincere purity. I have ever believed in free thought, free speech, and a free press—not *toleration*, but absolute freedom. It is thought that governs the world.

But he must be a braver man than I claim to be, who would undertake to entertain such a presence as this at such a late hour, and especially after the learned and eloquent remarks that have been made by the gentlemen who have preceded me, even if I had an address prepared, which I have not. All I can venture to say is, that in doing honour to our distinguished fellow-citizen, we honour ourselves. Some nations honour their dead in one way, some in another. Some build monuments or found institutions to perpetuate their names to coming generations. The eloquent addresses already delivered have told us of the exalted character of our great scientist as a man, a citizen in all the walks of life, of the magnetism of his presence and speech, and of his wonderful abilities as a teacher, and of the results or net gains to the scientific world, as the perfecter, if not the original proclaimer, of a *new thought* and of a *new method* of scientific experiments, which are revolutionising many of the departments of scientific philosophy. We need not then offer a hecatomb at his tomb. It may be true, in a limited sense, as the heathen sages have said, "Those whom the gods

love die early," and for us, too early has *Louis Agassiz* passed from us through glory's morning gate to the *great majority* gathering on the shores of "the beautiful river," where the flowers never fade. But not too early for himself, nor for the cause of science to which his whole nature was consecrated. You have been told that the telegraph wires flashed to us the sad intelligence "Agassiz is no more." This is a popular but an erroneous announcement. True, he is no longer on earth, to be seen in the high places he so long honoured. We shall look no more here upon his noble form, nor hear his eloquent and burning words, but *he still lives.* He is one of those men who possess two immortalities—one, his own individuality, which he has carried with him to the future state, and the other remains with us in our hearts and in the annals of science to the end of time.

Reference has been made to personal acquaintance with the deceased. I was not as highly favoured as some of the gentlemen who have spoken, but happily not altogether without being able to record with gratitude my knowledge of him, and the benefits derived from his lectures. As a disciple, I once enjoyed two full courses of his lectures, on Fishes and Geology, and then sat at the feet of Professor Mitchell, of the Cincinnati Observatory, and afterwards at the feet of Professor Guyot, of Princeton College, so honourably mentioned in your presence. And from these masters of scientific lectures I derived views of the laws of Nature and the works of

God, for which I desire to acknowledge my deepest gratitude.

Let us then thank our Heavenly Father for the advance of Science, and for the life, character, labours, and contributions to true science of Louis Agassiz. And as it is a true saying, "They mourn the dead aright who live as they would wish us to live," so let us in our several spheres endeavour to imitate the noble deeds of our illustrious dead; remembering that he said "he had no time to make money." And he was right. Thank God he gave his time, strength, genius, and heart to a far nobler purpose. To make money requires time, skill, and talent. It is a trade—a business—and in its place all right; but it is not the highest calling of man. It is not in itself the greatest good. What is gold, gold to thought, to the enjoyments of a cultivated mind? Like him, then, let us go forth from this memorial meeting to give more of our time, and strength, and substance, to the enlightenment, mental culture, and advancement of our fellow-men, in the knowledge of all truth.

EULOGY BY HENRY EDWARDS.

"O! what a noble heart was here undone,
When Science self destroyed her favourite son."

From a seat of learning in the North has gone forth a wail of sorrow, a wail which echoes not only through the length and breadth of our own land, but in every place in which refinement and culture have found a home, and which will thrill for years to

come in many a heart at the mention of the name of the departed. Agassiz is dead. The mighty brain in which grand thoughts were kindled, is, as far as our earth is concerned, at rest for ever; the smile which ever shone on modest merit beams for us no more; the kind and gentle voice which spoke in earnest sympathy with even the meanest endeavour, is hushed and still, and memory is all that is left us of one so loved. To speak in praise of his vast acquirements would be but

"To guard a title that was rich before."

The history of his adopted country will inscribe them on its brightest pages, and his works will be forever cherished amid the records of the nation. But apart from the homage which the worshippers of his genius will surely lay before its shrine—apart from the consideration of the labours which have rendered him immortal, and enrolled his name among the deathless few—there steals into the thought the recollection of that tender and gentle nature which was so magnetic in its association, and which shed so pleasing an influence upon all which came within its contact. Involved in his own cherished pursuits, he scorned the mean pretences of the world, and being, as he himself declared, "Too busy to make money," he was utterly free from the taint of selfishness, and lived less for his own advancement than for the good of others, preferring the calm enjoyment of a studious and retiring life to the tinsel glories of wealth and display. Mindful of the difficulties which beset the student of Science, and well

knowing how willingly the world will sneer at what it cannot comprehend, his hand was ever extended to help the seeker after truth, and to place his feet upon a firm foundation. A father among the young, a brother among the mature, and a kind and gentle friend to all, the name of Agassiz will be loved as his genius is honoured, and his childlike nature cherished as his mental powers are valued and esteemed. Above the earth which covers his remains will be mingled the bitter regrets for the loss of one so gifted, and the sighs of sympathy for those who will miss the communion of a loving heart. As on and on we journey towards the end, the pathway of our life is strewn with sorrowing memories; but the blossoms of existence diffuse their fragrance by the wayside, and teach us that all is not sad for those who mourn. The incense of good deeds ascends to Heaven, and the place which so glorious a soul as his filled on earth, becomes a monument for after time, and points to the generations which follow, the shining remembrance of his power. For over fourteen years the writer has held pleasant intercourse with him; has profited by the varied store of knowledge he was ever so ready to impart; and with a saddened soul would add this poor tributary leaf to the garlands which will deck his tomb. He is but one among the many who have felt the friendly interest which Agassiz was wont to display to all who needed the help of such a teacher, and who, in the years to come, will sigh

> "For the touch of a vanished hand,
> And the sound of a voice that is still."

RESOLUTIONS OF THE CALIFORNIA ACADEMY OF SCIENCES.

WHEREAS, we, the members and associates of the California Academy of Sciences, have learned that it has pleased Divine Providence to call our friend and fellow-member, Professor Louis Agassiz, away from his earthly labours; Therefore be it

Resolved, That in the death of Professor Agassiz we recognise the loss of one whose life was passed in earnest devotion to the advancement of Science and the cause of liberal education; whose labours in this field have won for him an enduring fame throughout both hemispheres; whose efforts in this his adopted country have, more than those of any other individual, contributed to a wide popular appreciation of the dignity, value, and importance of scientific research, and to the necessity of incorporating in our schemes of education, instruction in those laws which form the foundations of the Natural Sciences and are inseparably connected with our material and intellectual prosperity; whose geniality and enthusiasm in the pursuit of his favourite studies, and whose unequalled power of presenting the results of those studies to the public in a simple and attractive form, have endeared to the hearts of this nation, and especially to us and others, who are more or less individually concerned in the pursuit of scientific truth.

Resolved, That we believe that to Professor Agassiz and the pupils whom he influenced by his teachings and example, we largely owe the adoption of that

wise liberality, exhibited by the government and by many private individuals, in matters relating to scientific exploration and research, which is so justly the pride of American citizens.

Resolved, That the visit of Professor Agassiz to this community, his genial presence, and his address before the Academy and its friends, will always be held by us in grateful remembrance.

Resolved, That we deeply regret the bereavement of Professor Agassiz's family and would offer them our sincere and respectful sympathy.

Resolved, That these resolutions be printed in the Academy's Proceedings, and that the Secretary be directed to forward an engrossed copy to the family of the deceased.

Action of the Smithsonian Institution.

Soon after the death of Agassiz, the Regents of the Smithsonian Institution held a meeting and the following remarks were made on the dead scientist, by ex-President James A. Garfield :

GARFIELD ON AGASSIZ.

Never before in a single year has the Board of Regents suffered so severe a loss. It would be difficult to find, in any organisation, two men more eminent, and representing a wider range of culture, than the two regents, Chief Justice Chase and Professor Agassiz, who have fallen since the last meeting of this board.

In Professor Agassiz we have lost a man of kindred powers, whose life was spent in a different though hardly less conspicuous field of action.

Few lives were ever so sincerely and entirely devoted to the highest and best aims of science. I was led to appreciate this by a remark which Professor Agassiz made to me several years ago, which is, I believe, the key to his own career, and deserves to be remembered by all who would follow in his footsteps. His remark was that he had *made it the rule of his life to abandon any intellectual pursuit the moment it became commercially valuable.*

He knew that others would utilise what he discovered; that when he brought down the great truths of science to the level of commercial values, a thousand hands would be ready to take them and make them valuable in the markets of the world. Since then I have thought of him as one of that small but elect company of men who dwell on the upper heights, above the plane of commercial values, and who love and seek truth for its own sake. Such men are indeed the prophets, the priests, the interpreters of nature. Few of their number have learned more, at first hands, than Professor Agassiz; and few, if any, have submitted their theories to severer tests.

It was a great risk for the astronomer to announce that the perturbations of the solar system could only be accounted for by a planet as yet unknown, and to predict its size and place in the solar system, trusting to the telescope to confirm or explode his theory. But perhaps Professor Agassiz took even a

greater risk than this. Who does not remember the letter he addressed to Professor Peirce, of the Coast Survey, just before he set out on the Hassler expedition, predicting in detail what evidences of glacial action he expected to find on the continent of South America, and what species of marine animals he expected to discover in the deep-sea soundings along that coast? He risked his own reputation as a scientific man on the predictions then committed to writing.

What member of this board will forget the lecture he delivered here after his return, detailing the discoveries he had made, and showing how completely his predictions had been verified?

While he was the prince of scholars, and a recognised teacher of mankind, yet he always preserved that childlike spirit which made him the most amiable of men. He studied nature with a reverence born of his undoubting faith. He believed that the universe was a cosmos, not a chaos; and that throughout all its vast domains there were indubitable evidences of creative power and supreme wisdom.

We have special cause for regret that his early death has deprived this community and the world of a series of lectures which were to have been delivered here this winter, on subjects of the deepest interest to science. His death will be deplored in whatever quarter of the globe genius is admired and science is cherished. He has left behind him as a legacy to mankind a name and a fame which will abide as an everlasting possession.

RESOLUTIONS OF THE SMITHSONIAN INSTITUTION.

Resolved, That the Board of Regents of the Smithsonian Institution record on the minutes of their proceedings their high appreciation of the character and labours of their lamented associate, Louis Agassiz, and the expression of their profound sorrow on account of his unexpected death, in the full exercise of his power, and amidst his unparalleled usefulness.

Resolved, That Professor Agassiz, by the attraction which he exerted on all who came under the magical influence of his genial temperament and generous sympathies, nobly advocated the claims of Science to high popular estimation, private endowments, and liberal public patronage.

Resolved, That as an instructor in his adopted country, he introduced methods of study, and directed attention to fields of research in natural history, far more elevated than those which had been previously in use; that as an original investigator he made additions to human knowledge which do honour to the science of the nineteenth century, and associate his name with those of the prominent benefactors of his race.

Resolved, That in the death of Professor Agassiz, the Smithsonian Institution has lost a wise adviser in its scientific operations, a powerful supporter of its policy in regard to original research, and an influential friend, ready at all times to advocate its claims on Congress for the independent support of a national museum.

Resolved, That the Board of Regents deeply sympathise with the family of the deceased, on account of their sad bereavement, and that a copy of these resolutions be transmitted to them.

DR. PARKER'S OPINION OF AGASSIZ.

MR. CHANCELLOR:—It may seem presumptuous in me to rise to move the adoption of the resolutions submitted.

To calculate the distance and magnitude of the sun, requires an astronomer, and to analyse its chemical properties is the province of the spectroscopist, but multitudes who are neither astronomers nor spectroscopists can delight in the revelations which are made in regard to that luminary.

I am not a scientist; still, I can appreciate, in some degree, the labours of one who shone *a star of the first magnitude* in the firmament of science!

It is sixteen years since I first met Professor Agassiz, whose death the Board of Regents so deeply lament. It was at commencement at Harvard University, in 1858, the first year after my return from a long residence in China. The Emperor Napoleon had made tempting offers in the way of high position to Professor Agassiz to go to Paris. Intense solicitude on the part of his friends in Cambridge and the country generally, was felt as to his decision. It was on this occasion that their anxious suspense was relieved, as Professor Agassiz, after dinner, rose and announced his determination

henceforth to be an American citizen. This declaration was received with most enthusiastic demonstrations of rejoicing.

I am happy the resolutions now submitted recognise his adopted citizenship. An incident that has come to my knowledge within the last hour has given me great pleasure, as illustrating the patriotism of the man. A mutual friend said, "Professor Agassiz, it fills me with gratitude every time I think of your declining the very flattering proposition that was made to you from the court of France." To which he replied: "Yes, and do you know, that proposition was renewed to me after the war began, and I replied with *more earnestness* than before, if I loved my adopted country too much to leave it when all was peace, I certainly shall not leave it now, when a shadow has come over its prospects."

In the resolutions adopted by different scientific and literary institutions throughout the country, much prominence is given, and rightly, too, to the irreparable loss sustained by the decease of this pre-eminent man of science.

While we sympathise most fully with that sentiment, there is another consideration that should not be overlooked. I refer to the kind Providence that has given to the world such a man, preserved his life to mature years, and enabled him to accomplish so much as he has done for the science, not only of the day and of this country, but of the age and world.

To Louis Agassiz belongs the distinction of having awakened, in a remarkable degree, a spirit of scientific inquiry, and of having discovered changes our planet has undergone, through the influence of laws he was the first to demonstrate, arriving at such a knowledge of their operations that it may be truly said of him that the remote consequences of these laws, *first predicted by his theory, were, in repeated instances, most signally verified upon two continents by his observations.*

In the circumstances of his departure from this life, there were peculiar mercies that call for grateful recognition. Fears were at one time entertained, and not without cause, lest he might linger through years of suffering, deprived of reason; but he and his loving family have been spared that affliction, and he has been, as it were, translated, to resume, or rather to continue, on a higher plane, his advance in the knowledge of the works of the Creator, with devout and endlessly increasing adoration of their Divine Author.

On motion of Dr. Parker, the resolutions were unanimously adopted.

Memorial of the Boston Natural History Society.

The Memorial of the Boston Natural History Society, of which Agassiz was a prominent member, is especially interesting, as it gives many facts relating to the Humboldt Celebration. The address was

delivered by the Rev. R. C. Waterson and is as follows:

ADDRESS BY REV. R. C. WATERSON.

At a meeting of the Boston Society of Natural History, June, 1869, it was moved and voted that a celebration of the Centennial Anniversary of the birth of Alexander von Humboldt, by this Society, is highly desirable. It was also suggested that Professor Agassiz be invited to deliver an address upon the occasion. The invitation was extended to Professor Agassiz and accepted. Various circumstances connected with that memorable occasion, at a time like the present, come to the mind with peculiar power.

In Professor Agassiz's public address, his introductory remarks were, "I am invited to an unwonted task. Thus far I have appeared before the public only as a teacher of Natural History. To-day, for the first time in my life, I leave a field in which I am at home, to take upon myself the duties of a biographer."

Thus this Society had the privilege of inviting Professor Agassiz to a duty (most nobly fulfilled), which without this invitation in all probability he would never have entered upon. That being, as he himself expressed it, the first time in his life he had undertaken such a task; it was also, as we now know, destined to be the last. This event which, on every account, had great interest, for these reasons possesses a solemn and sacred import. That anniversary we would keep in grateful remem-

brance, forming as it does, in connection with many reminiscences, an added and, may we not say, an indissoluble tie between us and him.

At the time when the invitation was extended to Professor Agassiz, he was overwhelmed with work; while, by previous labour, both body and mind had already been overtaxed. Under such circumstances it would have appeared next to impossible for him to comply with the request of the Society, yet so desirous was he to meet their wishes that he undertook the task.

On the 8th of June Mrs. Agassiz wrote:

"Though your letter touched and gratified me deeply, it made me very anxious, too. I could almost have wished the occasion had not arisen, for it alarms me to see the way in which work accumulates upon Mr. Agassiz, whose health is no longer so good as it used to be.

"It seems as if it would be easy for him to talk of Humboldt, and so, out of the fulness of his heart, it would; but on such an occasion, the address must include a very careful review of all the facts of his life, of his relation to science through three quarters of a century; it must be accurate as well as comprehensive, and even Humboldt's most intimate friend could not prepare it without a good deal of care and research. I do not say this because I would dissuade Mr. Agassiz from it; on the contrary, it seems to me a duty, which, since it arises, he cannot avoid; and I think he fully intends to undertake it, though not without many fears lest he should not rise to the grandeur of the occasion.

"Mr. Agassiz begs me to say that he has the greatest desire to further the project to the utmost of his power, and only fears, as I have said, to fall short of his own wishes, and the expectations of those who are willing to entrust him with such a responsibility."

On the 3d of July Professor Agassiz wrote as follows:

"For weeks past I have intended every day to write you, but the fact is that just now I have scarcely time to breathe, and with the sincere desire of accepting the invitation tendered to me through you, I have been trying to free myself in some degree of the tasks before me. It is not so easy to do this as it seems.

"However, I write now to say that I will do my best so far as it depends upon me, to make the anniversary of Humboldt worthy of his memory, and serviceable to science in the country. The task will be a difficult, and in some respects a painful one to me, none the less because of my personal relations with him. But I will do my best, and I beg you to believe that the confidence placed in me by those who wish to make this occasion a marked day, has gratified and touched me deeply.

"I wish you would express this sentiment in my behalf, and add that my great cause of hesitation has been the fear that I might not satisfy the expectations of those who have thus honoured me.

"Believe me,

"Ever truly yours,

"LOUIS AGASSIZ."

In a note, dated July 21st, he says: "I have been completely prostrated this week."

Yet notwithstanding this exhaustion (doubtless far beyond what was imagined by his most intimate friends, and, added to this, serious illness among the members of his own family, his son leaving for Europe, on account of his health, the very day upon which the address was delivered), Professor Agassiz most conscientiously devoted himself through the sultriness of an intensely hot midsummer, to the work of preparation. Few are probably aware what a mind like his would, under such circumstances, consider requisite. Nothing was to be taken for granted; not even the memory of former investigations would be accepted without passing through the process of examination. Every step was to be measured, with critical exactness, through the long progress of Humboldt's scientific career.

Is there not exemplified in this fact, one of the marked characteristics of Professor Agassiz's mind? Absolute thoroughness; sifting every question and principle down to its first elements; tracing every thought, from its earliest germ through each successive development, until the final result is reached.

In order to secure freedom from all interruption during these researches, he asked for a room at the City Library, which was readily granted. Here he could gather about him papers and books which during his absence would remain undisturbed. Mr. Winsor, the efficient and obliging Superintendent, tells me that for more than a month Professor Agassiz passed there at least three or four days of each week,

from nine o'clock in the morning until generally three o'clock in the afternoon, and that during this time he called for more than two hundred volumes in different languages, always desiring to read each work as it originally came from the mind of the author. Thus every work which Alexander von Humboldt ever wrote passed under careful review; not only every volume, but every pamphlet, with the exception of one, which could not be found in this country.

On the 4th of September he wrote me:

"I have only yesterday finished gathering my materials, and have not yet begun preparing my address."

He adds: "My friends will never know what anxieties I have to go through on this occasion."

Six days after this I received the following:

"NAHANT, SEPT. 10TH, 1869.

"MY DEAR SIR:

"I have succeeded this evening in bringing to a close my draft of an address; not exactly as I would like to deliver it, but such as I may be compelled to read should the occurrences of the day unfit me for an extemporised discourse which I believe might be more effective."

It would thus appear that even after the address was written, he hoped to give, not what he had embodied in manuscript, but the result of which that would be the basis, in the form of an extemporised discourse, for which, as all know from his

constant habit of speaking without notes, he possessed the very highest qualifications.

However, to meet every contingency, he adds:

"As I go to-morrow to Cambridge, I will try to have my illegible manuscript set in type, that I may myself be able to read it. At the same time I shall see how my diagrams are progressing, and if satisfactory, forward them at once to the Music Hall.

"Very truly yours,

"L. AGASSIZ."

On the 13th of September he wrote:

"DEAR SIR: —

"I hope I may have a proof of my address for your reporters by the time I reach Boston to-morrow, which I shall hand to you. My diagrams went to the Music Hall Saturday afternoon, with the palm-branch worn on Humboldt's funeral.

"The pen taken from his desk the day he died, and sent to me, I shall bring myself, fearing it might be lost if left with bulkier objects.

"Very truly yours,

"L. AGASSIZ."

Such were some of the preparatory labours connected with the address which was to be heard on that Centennial Anniversary by literary and scientific men from every part of the country. Seldom has there been an occasion in the history of New England, which has brought together so brilliant an assemblage of able scholars and prominent men in every department of thought.

At the evening reception, Mr. Ralph Waldo Emerson, in speaking of what he termed the "delightful address in praise of Humboldt," concentrated his estimate in this characteristic declaration, "Our eminent professor never delivered a discourse more wise, more happy, or of more varied power."

These words expressed the universal feeling. And the address, so cordially welcomed by those who heard it, was received when published with equal favour on both sides of the Atlantic.

This very day, I was reading a letter by Sir John Herschel expressing his commendation; and in the *Life of Alexander von Humboldt*, edited by Professor Karl Bruhns, director of the Observatory at Leipzig, the address of Agassiz is referred to, both in the preface, and in the body of the book. In the latter, a lengthy extract is introduced. [See Vol. II., pp. 179, 180, and 181.]

There were several occasions upon which Alexander von Humboldt extended such attention and kindness to Agassiz, at a time when encouragement was most needed, that it seems but an act of justice and gratitude to recall them here. The first was related by Agassiz some fifteen years ago, at a meeting of the American Academy of Art and Science, soon after Humboldt's death.

"May I be permitted," he said "to tell a circumstance personal to me? I was only twenty-four years of age when in Paris, whither I had gone with means given me by a friend, but I was at last about to resign my studies from want of ability to meet my expenses. Professor Mitscherlich was then on a visit

in Paris, and I had seen him in the morning, when he had asked me what was the cause of my depressed feelings, and I told him I had to go, for I had nothing left. The next morning as I was seated at breakfast, in front of the yard of the Hotel, where I lived, I saw the servant of Humboldt approach; he handed me a note, saying there was no answer and disappeared. I opened the note, and I see it now as distinctly as if I held the paper in my hand. It said:

"'My Friend:

"'I hear that you intend leaving Paris in consequence of some embarrassments. This shall not be. I wish you to remain here as long as the object for which you came is not accomplished. I enclose you a check of £50. It is a loan which you may repay when you can.'"

That one act of Humboldt, at the turning-point in the life of Agassiz, may have affected the whole course of his after-career. If Sir Humphrey Davy could say "My best discovery was Michael Faraday," what shall we say of this discriminating instance of generous encouragement, which perhaps gave to us Agassiz as a man of science.

In the address upon Humboldt, Agassiz speaks of his studies at Munich, whose University had opened under the most brilliant auspices, and where nearly every professor was prominent in some department of science or literature. "These men," he says, "were not only our teachers but our friends. We were the companions of their walks, and often present at their discussions." "My room," he adds, "was

our meeting-place, bedroom, study, museum, library, lecture-room, fencing-room, all in one. Students and professors used to call it the little Academy."

It was at this time that Humboldt was preparing for his Asiatic journey. Agassiz was anxious to accompany him, and asked that he might join the expedition as an assistant. This was the beginning of his personal acquaintanceship with Humboldt.

A graphic picture is presented of the student's life in Paris, in the days of Louis Philippe, when Cuvier, just the age of Humboldt himself, was active and ardent in research, his *salon* frequented by statesmen, scholars, and artists.

Cuvier was then giving a course of lectures in the College of France, on the History of Science. "Humboldt," says Agassiz, "attended these lectures regularly; I had frequently the pleasure of sitting by his side, and being the recipient of his passing criticism." At this period, Humboldt had his working-room at the Rue de la Harpe. "There," continues Agassiz, "it was my privilege to visit him frequently. There he gave me leave to come, to talk with him about my work, and consult him in my difficulties."

At this time Agassiz was twenty-four years of age, and Humboldt sixty-two.

"I had recently," says Agassiz, "taken my degree as Doctor of Medicine, and was struggling, not only for a scientific position, but for the means of existence also. I have said that he gave me permission to come as often as I pleased to his room, opening to me freely the inestimable advantages which inter-

course with such a man gave to a young investigator like myself. But he did far more than this, occupied and surrounded as he was, he sought me out in my lodging."

Here he gives a most interesting account of a visit from Humboldt, at Agassiz's narrow quarters, in the Hôtel du Jardin des Plantes. After which is an invitation from Humboldt, to meet him at the Palais Royal—where they dine—"a rare indulgence," says Agassiz, "for a young man, who could allow himself few luxuries." "Here" he adds, "for three hours, which passed like a dream, I had him all to myself. How he examined me, and how much I learned in that short time! How to work, what to do, and what to avoid; how to live, how to distribute my time; what methods of study to pursue; these were the things of which he talked to me, on that delightful evening."

When we reflect upon the extended reputation acquired by Agassiz before he left Europe; of that visit to this country which led him gladly to adopt it as his home, and of the untiring zeal with which he devoted to it the best years of his life; shall we not hold in grateful remembrance the man who gave to him, at the most critical moment, the cordial hand of friendship, and who by his cheering words, inspired fresh ardour, and a hope which no after trial could extinguish?

It is more than a pleasant picture, it is a lesson for all time, and should awaken, through generations, the desire generously to encourage and wisely to aid.

THE HUMBOLDT SCHOLARSHIP.

It was in this spirit that a "Humboldt Scholarship" became associated with the Humboldt Anniversary. Through personal solicitation on the part of the committee the sum of seven thousand dollars was subscribed to form a permanent fund, the income of which, under the direction of the Faculty, was to be solely applied to the aid of young and needy students, while pursuing their preparatory studies at the Museum of Comparative Zoölogy, in Cambridge. The founding of this scholarship was the voluntary proposition of this Society as a token of sympathy and hearty good-will.

The gratification of Professor Agassiz was at once expressed. In a note written July 3d, he says:

"Your proposition to connect a scholarship with the Museum of Comparative Zoölogy, in commemoration of this occasion, has had great weight with me. I believe that such an arrangement will not only be an ever-returning memento of the solemnities of this 14th of September, but, if properly conducted, will contribute to the real advancement of Natural History among us."

The origin of this scholarship was by some misapprehended. It was supposed to have been suggested, directly or indirectly, by Professor Agassiz. This is an entire mistake. No one could feel more sensitive than he himself did upon this subject. His feelings are frankly expressed in a note which I received

from him, after he had read a paragraph in the daily papers, referring this movement to him.

"MY DEAR SIR:

"In a paper to-day, giving an account of the proposed celebration, 'a plan' is alluded to 'of Mr. Agassiz for founding a Humboldt Scholarship in the institution of which he is the head.'

"This is no doubt a simple error of the press, but I should be very sorry to have it stand. It would have been very ungracious in me, and would have shown, to say the least, a great want of delicacy, had I suggested an endowment for the Museum in which I am personally interested. It was, as you know, a proposition made spontaneously without any reference to me. And though I rejoice in it and feel doubly unwilling, on account of this offer, to shrink from the responsibility connected with the invitation of your committee, yet the suggestion coming from me, under the circumstances, instead of being appropriate, would be wholly unbecoming. You will excuse me for troubling you about this, but I am sure you will see that it places me in an awkward position."

If in any mind there should exist even the shadow of a misapprehension upon this subject, these words will serve to explain fully both the feelings of Professor Agassiz and the exact facts of the case.

At the close of his public address of the 14th of September, he says:

"I have appeared before you as the representative of the Boston Natural History Society. It was their proposition to celebrate this memorable anniversary. I feel grateful for their invitation, for the honour they have done me. I feel still more grateful for the generous impulse which has prompted them to connect a Humboldt Scholarship, as a memorial of this occasion, with the Museum of Comparative Zoölogy at Cambridge."

Thus, Mr. President and gentlemen, while we cannot but deeply mourn the vast loss which this community and the whole country has sustained by this bereavement, we rejoice in that friendly relationship which so long existed between us, and are thankful that one of the last great public utterances of his life was given under the auspices of this Society.

And now that his life, so beneficently crowded with activity and usefulness, has closed to us in this sphere of being, we are grateful that our mutual efforts established what will not only be a perpetual bond of union between this Society and the institution of which he was the honoured head, but which, we trust, through successive years may prove a source of practical help and encouragement to numberless students, who, by their future efforts, may extend the boundaries of knowledge, thus aiding in the work of human progress, while they carry forward to yet further completion those investigations and discoveries which, in our own day, have given immortality to the names of Humboldt and Agassiz.

BIBLIOGRAPHY OF LOUIS AGASSIZ.

CONTENTS.

Note :—An asterisk placed before a title signifies that the book has not been seen by the compiler.

1.—Principal Works.

Bibliographia Zoölogiæ et Geologiæ. A general catalogue of all books, tracts, and memoirs on zoölogy and geology. Corr., enl., and ed. by H. E. Strickland. 4 vols., 8vo. Lond. *(Royal Society)*, 1848–54.

Caractères Zoölogiques et Anatomiques des Sauroïdes Vivans et Fossiles. 4to. Neuchâtel, 1842.

Catalogus Systematicus Ectyporum Echinodermatum Fossilium Musei Neocomensis, secundum Ordinem Zoölogicum Dispositus, Adjectis Synonymis Recentioribus nec non Stratis et Locis in

quibus Reperiuntur. Sequunter *characteres diagnostici* generum novorum vel minus cognitorum. Necomi Helvet., 1840.

Contributions to the Natural History of the United States of America. Illus. Plates. 4 vols., 4to. Bost., 1857–62.

Contents : v. i.—Essay on Classification—North American Testudinata. v. ii.—Embryology of the Turtle. v. iii.—Acalephs in General—Ctenophoræ. v. iv.—Discophoræ—Hydroidæ—Homologies of the Radiata.

Dents et les Rayons des Placoïdes. 4to. Neuchâtel, 1844.

Description des Echinodermes Fossiles de la Suisse. 2 T., 25 planches. 4to. Neuchâtel, 1839–40.

Note:—Extraits des Tomes iii. et iv. des "Nouveaux Mémoires de la Société Helvetique des Sciences Naturelles."

Discours d'Overture des Séances de la Société Helvétique des Sciences Naturelles à Neuchatel, le 24 Juillet, 1837. 8vo, Neuchâtel, 1837.

Dissertatio Inauguralis : De Taxi et Syntaxi Morphomatum Telæ Corneæ Dictæ. 4to. Monachii, 1839.

Essai sur la Classification des Poissons. 4to. Neuchatel, 1844.

Essay on Classification. 8vo. Lond., 1859.

Études Critiques sur les Mollusques Fossiles. [With Atlas.] 100 planches. 5 T., 4to. Neuchâtel, 1840–45.

Études sur les Glaciers. [With Atlas.] Dessinés d'après nature et lithographies par J. Bettanier. 2 T., 4to and f°. Neuchâtel, 1840.

Geological Sketches. First and second series. Illus. 2 vols., 12mo. Bost., 1866, 1876.

Histoire Naturelle des Poissons d'Eau Douce de l'Europe Centrale. Planches [colored, with descriptions in French, German, and English.] Obl. 4to. Neuchâtel, 1839.

Iconographie des Coquilles Tertiaires, Reputées Identiques avec les Espèces Vivantes ou dans Différens Terrains de l'Époque Tertiaire, Accompagnée de la Description des Espèces Nouvelles. 15 planches. 4to. Neuchâtel, 1845.

Note :—From "Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften," Bd. vii., 1845.

Journey to Switzerland and Pedestrian Tours in that Country. Including a Sketch of its History and of the Manners and Customs of its Inhabitants. 8vo. Lond., 1833.

Lake Superior: Its Physical Character, Vegetation, and Animals Compared with those of Other and Similar Regions. With a narrative of the tour and contributions by other scientific gentlemen. Illus. 8vo. Bost., 1850.

Matériaux pour une Bibliothèque Zoölogique et Paléontologique. Neuchâtel, 1842.

Mémoire sur les Moules de Mollusques Vivants et Fossiles. 4to. Neuchatel, 1839.

Note :—Extrait de T. ii., 1839, des "Mémoires de la Société des Sciences Naturelles de Neuchatel."

Methods of Study in Natural History. 12mo. Bost., 1863.

Note :—Appeared first in serial form in volumes ix. and x. of the *Atlantic Monthly.*

Monographie des Poissons Fossiles du Vieux Grès Rouge, ou Système Dévonien (old red sandstone) des Îles Britanniques et de Russie . . . Ouvrage redigé à la demande de l'Association Britannique pour l'Avancement des Sciences et présenté par extraits à sa réunion à Manchester en 1842. 2 T. ; T. ii., planches. 4to and obl. f°. Neuchâtel, 1844–45.

Monographies d'Échinodermes Vivants et Fossiles. 57 planches. 4 T., 4to. Neuchâtel, 1838–42.

Nomenclator Zoölogicus, Continens Nomina Systematica Generum Animalium tam Viventium quam Fossilium, secundum Ordinem Alphabeticum Deposita, Adjectis Auctoribus, Libris, in Quibus Reperiunter. 4to. Soloduri, 1842–46.

—— *Same.* Index Universalis. 8vo. Soloduri, 1848.

Nouvelles Études et Expériences sur les Glaciers Actuels: leur Structure, leur Progression, et leur Influence sur le Sol. 2 T. ; T. ii., Atlas. 8vo & f°. Paris, 1847.

Poissons Fossiles et l'Ostéologie du Genre Brochet. 4to. Neuchâtel, 1842.

Rapport sur les Poissons Fossiles, Présenté à l'Association Britannique pour l'Avancement des Sciences en 1842. 8vo. Neuchâtel, 1842.

Recherches sur les Poissons Fossiles, Comprenant la Description de 500 Espèces qui n'Existent plus, l'Exposition de Lois de la Succession et du Développement Organique des Poissons durant toutes les Métamorphoses du Globe Terrestre, une Nouvelle Classification de ces Animaux . . . enfin, des Considérations Géologiques Générales Tirées le l'Étude des Fossiles. 10 Tom. (5 T., planches.) 4to. Neuchâtel, 1833–43.

Selecta Genera et Species Piscium quos in Initere per Brasilian Annis 1817–1820. . . . Collegit et pingendos curavit J. B. des Spix. . . . digessit, descripsit et observationibus anatomicis illustravit Dr. L. Agassiz. Præfatus est et edidit itineris socius F. C. P. de Martius. f°. Monachii, 1829.

Structure of Animal Life: Six lectures delivered at the Brooklyn Academy of Music, January and February, 1862. 8vo. New York, 1862.

Succession et du Développement des Êtres Organisés à la Surface du Globe Terrestre, dans la Différents Âges de la Nature. Discours Prononcé à l'Inauguration de l'Académie de Neuchatel, le 18 Nov., 1841. 8vo. Neuchâtel, 1842.

—— *Same.* Aufeinander-Folge und Entwickelung der Organisirten Wesen auf der Oberfläche der Erde in den verschiedenen Zeitaltern. Rede . . . [delivered] am 18 Nov., 1841. Aus dem Französischen von Dr. N. Gräger. 8vo. Halle a S., Görlitz, 1843.

Système Glaciaire. Nouvelles Études et Expériences sur les Glaciers Actuels. 2 T. T. ii., planches. 8vo and f°. Paris, 1847.

Tableau Général des Poissons Fossiles Rangés par Terrains. 16 pp. 1844.

Tableau Synoptique des Principales Familles Naturelles des Plantes. 12mo. Neuchâtel, 1833.

Twelve Lectures on Comparative Embryology. Delivered before the Lowell Institute in Boston. 8vo. Bost., 1849.

Untersuchungen über die Gletscher. . . . Nebst einen Atlas von 32 Steindrucktafeln (nach der Natur gezeichnet und lithographirt von J. Bettanier.) 2 Bde. 4to and f°. Solothurn and Neuchâtel, 1840, 1841.

Agassiz, Louis, *and Mrs.* **Elizabeth C. A Journey in Brazil.** Illus. 8vo. Bost., 1868.

—— *Same.* [In French.] Tr. . . . par. F. Vogeli. 8vo. Paris, 1869.

Agassiz, Louis, *and* **Gould, A. A. Principles of Zoölogy,** Touching the Structure, Development Distribution, and Natural Arrangement of the Races of Animals, Living and Extinct. Pt. i.; Comparative Physiology. 12mo. Bost., 1848.

—— *Same.* [In German.] . . . Mit einen vorwort von Professor Bronn. 8vo. Stuttgart, 1851.

Agassiz, Louis, *Tr.* **Conchologie, Minéralogique,** par James Sowerby, Tr. Française, corr. et aug., par L. Agassiz. 2 T.; T. ii., planches.

Agassiz, Louis, *Tr.* **Geologie und Mineralogie in Beziehung** zur natürlichen Theologie von W. Buckland. Aus dem Englischen . . . mit Anmerkungen und Zusätzen versehen von Dr. L. Agassiz. 2 Bde. 8vo. Neuchâtel, 1838–39.

2.—Articles in Publications of Learned Societies and Periodicals.

Abgerissene Bemerkungen über Fossile Fische. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie, und Petrefaktenkunde*, 1834, pp. 379–390.)

Additions to Mr. Wood's Catalogue of Crag Radiaria. (*Annals and Mag. of Nat. Hist.*, v. vi., 1841, p. 343.)

Address Delivered on the Centennial Anniversary of the Birth of Alexander von Humboldt, under the auspices of the Bost. Soc. of Nat. Hist., Sept. 14, 1869. 58 pp., 8vo. Bost., 1869.

—— *Same.* Humboldt Library, No. 43, 20 pp.

—— *Same.* [Abridged.] (*Amer. Jl. of Sci. and Arts*, 2d ser., v. 28, July, 1859, pp. 96–107.

Address to the California Academy of Sciences, in Response to an Introduction, Sept. 2, 1872. (Cal. Acad. of Sci. *Proceedings*, v. iv., 1868–72, p. 253.)

—— *Same.* (*Mining and Scientific Press.* San Fr., v. xxv., Sept. 7, 1872, pp. 152, 153.)

Affinities and Distribution of the Cyprinidæ. (Zoölogical Soc. of Lond. *Proceedings*, 1835, pt. 3, pp. 149–151.)

Alte Morainen bei Baden-Baden. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1841, pp. 566, 567.)

Alter der Glarner Schiefer-Formation, nach ihren Fische-Resten. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1834, pp. 301–306.)

America the Old World. (*Atlantic Monthly*, v. xi., Mar., 1863. pp. 373–382.)

***Anatomy of Freshwater Bivalves.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 356, 357.)

Anatomy of the Genus Lepidosteus, with Descriptions of Two New Species. (Zoölogical Soc. of Lond. *Proceedings*, 1834, pt. 2, pp. 119, 120.)

*—— *Same.* In French. (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. iii., 1835, p. 199.)

Animal Morphology. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 411–423.)

Animals Found in Red Snow. (British Assoc. Adv. of Sci. *Report*, 1840, pt. 2, p. 143.)

Animals of Millepora are Hydroid Acalephs and not Polyps. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xxvi., 1858, pp. 140, 141.)

—— *Same.* In French. (*Archives des Sciences Physiques et Naturelles*, nouv. sér., T. v., 1859, pp. 80, 81.)

***Animaux de la Neige Rouge.** (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. ix., 1841, p. 94.)

***Annelides, Studies on.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 190, 191.)

Antiquity of Man. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xi., 1866–68, pp. 304, 305.)

***Arrangement and Geology of Fishes.** (*Edinburgh New Phil. Jl.*, v. xix., 1835, pp. 331–346.)

***Bassin de l'Amazone.** (Société de Géographie, Genève. *Mémoires et Bulletins*, T. vii., 1868, pp. 159–196.)

Belemniten. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1835, p. 168.)

***Beschreibung einer neuen Species aus dem Genus** Cyprinus, *Linn.* (*Isis. Encyclopädische Zeitschrift*, 1828, col. 1046-1049; 1829, col. 414, 415.)

*—— *Same.* In French. (*Bulletin des Sciences Naturelles et de Géologie, par le Baron de Férussac*, T. xix., 1829, pp. 117, 118.)

Black-Banded Cyprynidæ. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1848, p. 70.)

Blind Fish of the Mammoth Cave. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xi., 1851, pp. 127, 128.)

—— *Same.* (*Edinburgh New Phil. Jl.*, v. li., 1851, pp. 254-256.)

*—— *Same.* In German. (*Tagsberichte über die Fortschritte der Natur- und Heilkunde, Abtheilung für Zoölogie*, Bd. ii., 1851, pp. 45-47.)

Blocs Erratiques du Jura. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, T. v., 1837, pp. 506–508.)

*—— *Same.* (*Bibliothèque Universelle de Genève*, nouv. sér., T. xi., 1837, pp. 416–418.)

*—— *Same.* (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. xi., 1837, pp. 417, 418.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxiv., 1838, pp. 176–179.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. iv., 1838, col. 117.)

*** Catalogus Echinodermatum Fossilium Musei Neocomiensis.** (Société Impériale des Naturalistes de Moskou. *Bulletin*, 1839, pp. 422–430.)

*** Cervus Alces and Tarandus Auct** (Lobatus and Hastalis). (Bost. Soc. of Nat. Hist. *Proceedings*, v. ii., 1847, pp. 187, 188.)

Circulation and Digestion in the Lower Animals. (*Amer. Jl. of Sci. and Arts.*, 2d ser., vol. x., 1850, pp, 123, 124.)

*—— *Same.* In German. (*Tagsberichte über die Fortschritte der Natur- und Heilkunde. Abtheilung für Zoölogie*, Bd. ii., 1851, p. 135.)

Circulation of the Fluids in Insects. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 140–143.)

—— *Same.* In French. (Annales des Sci. Naturelles. *Zoölogie*, 3e sér., T. xv., 1851, pp. 358—362.)

***Circulation of the Lower Animals.** (Bost, Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 206, 207.)

***Classification des Animaux dans ses Rapports avec leur** Développement Embryonnaire et avec leur Histoire Paléontologique. (*Bibliothèque Universelle de Genève*, 4e sér., T. xv., 1850, pp. 190–204.)

Classification in Zoölogy. (Amer. Acad. of Arts and Sci. *Proceedings*, v. 3, 1852–57, p. 221.)

***Classification of Fishes.** (*Edinburgh New Phil. Jl.*, v. xxxvii., 1844, pp. 132–143.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. xxxi., 1844, col. 225–230; 241–245.)

Classification of Insects from Embryological Data. Illus. Plates. (*Smithsonian Contributions to Knowledge*, v. ii., No. 6, 1851, 28 pp.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. liv., 1853, pp. 101–110.)

***Classification of Mammalia, Birds, Reptiles, and Fishes** from Embryonic and Paleozoïc Data. (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 395–398.)

Classification of Polyps. (Amer. Acad. of Arts and Sci. *Proceedings*, v. iii., 1852–57, p. 187.)

Classification of the Siluroïds. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xi., 1866–68, p. 354.)

Coloration of Animals, New Views Respecting. (Amer. Acad. of Sci. *Proceedings*, v. ii., 1848–52, p. 234.)

Comparison of the Skulls of the American Bison and European Aurochs. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xi., 1866–68, pp. 317, 318.)

***Considérations sur la Distribution Géographique des** Animaux et de l'Homme. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844-46, pp. 162–166.)

Contemplation of God in the Cosmos. (*Christian Examiner*, v. l., Jan., 1851, pp. 1-17.)

Contributions to the Natural History of the Acalephæ of North America. Part 1: On the Naked-Eyed Medusæ of the Shores of Massachusetts in their Perfect State of Development. Part 2: On the Beroid Medusæ of the Shores of Massachusetts in

their Perfect State of Development. (Amer. Acad. of Arts and Sci. *Memoirs*, N, S., v. iv., Pt. 2, 1850, pp. 221-367.)

—— *Same.* Part I. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. x., Sept., 1850, p. 272-276.)

"Contributions to the Natural History of the United States," Announcement of. (*Harper's Mag.*, v. xi., Aug., 1855, pp. 414, 415.)

"Contributions to the Natural History of the United States." [Prospectus of the Publication of.] (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xx., July, 1855, pp. 149-151.)

***Coup d'Œil Synoptique des Ganoïdes Fossiles.** (Société Imperiale des Naturalistes de Moskou. *Bulletin*, T. viii., 1835, pp. 202–3 18.)

Cours de l'Amazone. (Société de Géographie, Paris. *Bulletin*, 5e sér., T. xii., 1866, pp. 433–457.)

Darwinian Theory, The. [Facsimile of a letter sent to James A. Parsons in reply to an inquiry as to A's views.] (*Scientific American*, v. xxx., Feb. 7, 1874, p. 85.)

Deep-Sea Dredgings in the Gulf Stream during the Third Cruise of the U. S. Steamer *Bibb*. (Harvard College. Museum of Comparative Zoölogy. *Bulletin*, v. i., 1863–69, pp. 363–386.)

Deep-Sea Dredging, Letter concerning addressed to Prof. Peirce. (Harvard College. Museum of Comparative Zoölogy. *Bulletin*, v. iii., 1872–73, pp. 49–53.)

—— *Same.* (*Annals and Mag. of Nat. Hist.*, 4th ser., v. ix., 1872, pp. 169–174.)

Deep-Sea Explorations. More about the Trilobites. (*Canadian Naturalist and Geologist*, v. vi., 1872, pp. 358–361.)

***Descriptio Speciei Novæ e Genere Cycnocephalus**, *Briss.* (*Isis. Encyclopädische Zeitschrift*, Bd. xxi., 1828, col. 861–863.)

—— *Same.* In French. (*Bulletin des Sciences Naturelles et de Géologie, par le Baron de Férussac*, T. xix., 1829, pp. 345, 346.)

***Description de quelques Espèces de Cyprins du Lac de** Neuchâtel. (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. iv., 1836, pp. 419, 420.)

***Description de quelques Espèces de Cyprinus du Lac de** Neuchatel, qui sont encore inconnues aux Naturalistes. (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. i., 1835, pp. 33–48.)

*—— *Same.* In German. (*Archiv für Naturgeschichte*, Bd. iv., 1838, pp. 73–82.)

***Description des Échinodermes Fossiles de la Suisse** 1re Partie. (*Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften*, Bd. iii., 1839; Bd. iv., 1840.)

Détermination Exacte de la Limite des Neiges Eternelles en un Point Donné. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, T. xvi., 1843, pp. 752–756.)

—— *Same.* In German. (*Annalen der Physik und Chemie. Von J. C. Poggendorff*, Bd. lix., 1843, pp. 342–348.)

***Development of Lepidopterous Insects.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 199–200.)

***Développement des Actinies.** (Société Philomatique, Paris, *Extraits des Procès-Verbaux des Séances de la.* 1847, pp. 96-98.)

*—— (*L'Institut. Journal Général des Sociétés Travaux e. Scientifiques*, T. xv., 1847, pp. 388-389.)

***Développement des Êtres.** (Société Géologique de France. *Bulletin*, T. xii., 1854–55, pp. 353–355.)

Differences between Progressive, Embryonic, and Pro- phetic Types in the Succession of Organized Beings through the Whole Range of Geological Times. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 432–438.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 160–165.)

Different Species of the Genus Salmo which Frequent the Various Rivers and Lakes of Europe. (British Assoc. for the Advanc. of Sci. *Report*, 1834, pp. 617–623.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. xvii., 1834, pp. 380–385.)

*—— *Same.* In French. (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. iii., 1835, pp. 72, 73.)

Discovery of Viviparous Fish in Louisiana by D. Dowler. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xix., 1855, pp. 133–136.)

* **Distribution des Anciennes Maraines de l'Allée Blanche** et du Val Ferret. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, p. 171.)

* **Distribution Géographique des Animaux.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 58–60 ; 63–66.

* **Distribution Géographique des Cheiroptères.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 63–65.)

* **Distribution Géographique des Êtres Organisés.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 357–362.)

***Distribution Géographique des Quadrumanes Animaux.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, p. 58.)

***Distribution of Fossils in Formations.** (*Edinburgh New Phil. Jl.*, v. xxxii., 1842, pp. 9, 10.)

***Diverses Familles de l'Ordre des Crinoïdes.** (Société Helvétique des Sciences Naturelles. *Actes*, 1845, pp. 91–93.)

Diversity of Origin of the Human Races. (*Christian Examiner*, v. xlix., July, 1850, pp. 110–145.)

***Echinodermen.** (*Isis. Encyclopädische Zeitschrift*, 1834, col. 254–257.)

—— *Same.* **Growth and Bilateral Symmetry of the** Echinodermata. (*Lond. and Edinb. New Phil. Mag.*, v. v., 1834, pp. 369–373.)

***Einleitung zu einer Monographie der Radiarien oder** Echinodermen. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. v., 1838, pp. 305–311, 321–326.)

***Embryology, Lectures on.** Illus. (*American Traveller* and *Daily Evening Traveller*, 1848–49.)

Embryology of Ascidia and the Characteristics of New Species from the Shores of Massachusetts. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 157–159.)

Embryology of the Turtle, Recapitulation of, as Given in "Contributions to the Natural History of the U. S.", v. ii., pt. 3.

By H. J. Clark. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xxv., May, 1858, pp. 342–357.)

***Entwickelung eines Seesterns.** (*Archiv für Anatomie, Physiologie, und Wissenschaftliche Medicin. Von J. Müller*, Bd. xvii., 1851, pp. 122–124.)

***Enumeration des Poissons Fossiles d'Italie.** (*Nuovi Annali Scienze Naturali*, Bologna, T. iv., 1840, pp. 244–252; 325–332.)

Erratic Phenomena about Lake Superior. [Extract from *Lake Superior*, etc.] (*Amer. Jl. of Sci. and Arts*, 2d ser., v. x., 1850, pp. 83–101.)

—— *Same.* In French. (*Bibliothèque Universelle de Genève*, 4e sér., T. xvi., 1851, pp. 5–34.)

***Étude Çomparative du Cerveau des Poissons.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 147, 148.)

Eulogy on Dr. J. E. Holbrook. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xiv., 1870–71, pp. 347–351.)

Evolution and Permanence of Type. (*Atlantic Monthly*, v. xxxiii., Jan., 1874, pp. 92–101.)

Examination of the Florida Reefs, Keys, and Coast. (U. S. Coast Survey. *Ann. Rep. of Sup't.*, 1851, pp. 145–160.

—— *Same.* (U. S. Pub. Docs., 32d Cong., 1st Sess., 1851–52. *Senate Ex. Docs.*, v. v., No. 3, pp. 145–160.)

—— *Same.* (U. S. Coast Survey. *Ann. Rep. of Sup't.*, 1866, pp. 120–130.)

Exploration of the Coral Reefs of Florida. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 5th meeting, 1851, pp. 81–85.)

External Appearance of Glaciers. (*Atlantic Monthly*, v. xiii., Jan., 1864, pp. 56–65.)

Extraordinary Fishes from California, constituting a new family [Holconoti]. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xvi., 1853, pp. 380–390; v. xvii., pp. 365–369.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. lvii., 1854, pp. 214–228.)

*—— *Same.* In German. (*Archiv für Naturgeschichte.* Von Wiegmann, Bd. xx., 1854, pp. 149–162; Bd. xxi., 1854, pp. 30–34.)

***Faites en étudiant les Nageoires des Poissons.** (Société Helvétique des Sciences Naturelles. *Actes*, 1845, pp. 49–52.)

***Familie der Karpfen.** (*Archiv für Naturgeschichte*, Von Wiegmann, 1838, pp. 73–81.)

Färbende Infusorien in rothem Schnee. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1840, p. 93.)

Faune Ichthyologique de l'Amazone, Lettres Relatives à la. (Annales des Sciences Naturelles. *Zoölogie*, 5e sér., T. iv., 1865, pp. 382, 383; T. v., 1866, pp. 226–228, 309–311.)

Fern Forests of the Carboniferous Period. (*Atlantic Monthly*, v. xi., May, 1863, pp. 615–625.)

Fish-nest [of Chironectes Pictus] in the Sea-weed of the Sargasso Sea. (*Amer. Jl. of Sci. and Arts*, 3d ser., v. iii., 1872, pp. 154–156.)

*—— *Same.* (*Annals and Mag. of Nat. Hist.*, 4th ser., v. ix., 1872, pp. 243–245.)

*—— *Same.* (*Canadian Naturalist and Geologist*, v. vi., 1872, pp. 354–356.)

*—— *Same.* (*Monthly Microscopical Jl.*, v. vii, 1872, pp. 129, 130.)

*—— *Same.* In French. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. ix., 1873, pp. 165–169.)

Fishes from the Southern Bend of the Tennessee River in Alabama, Collection of. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xvii., 1854, pp. 297–308; 353–365.)

Fishes of Lake Superior. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1848, pp. 30–32.)

Florida Reefs, Report on the. Illus. 23 plates. 61 pp. (Harvard College, Museum of Comparative Zoölogy. *Memoirs*, v. vii., No. 1, 1880.)

Formation of Glaciers. (*Atlantic Monthly*, v. xii., Nov., 1863, pp. 568–576.)

Former Existence of Local Glaciers in the White Mountains. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, v. xix., 1870, pp. 161–167.)

—— *Same.* (*American Naturalist*, v. iv., 1871, pp. 550–558.)

***Fossil Fishes.** (*Edinburgh New Phil. Jl.*, v. xxxvii., 1844, pp. 331–334.)

***Fossil Fishes Found by Mr. Gardner in the Province of** Ceara, in the North of Brazil. (*Edinburgh New Phil. Jl.*, v. xxx., 1841, pp. 82–84.)

Fossil Fishes of Scotland. (British Assoc. for the Advanc. of Sci. *Report*, 1834, pp. 646–649.)

***——** *Same.* In French. (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. iii., 1835, pp. 65, 66.)

Fossil Fishes of the Devonian System, or Old Red Sandstone. (British Assoc. for the Advanc. of Sci. *Report*, 1842, pp. 80–88.)

***——** *Same.* In French. (*Bibliothèque Universelle de Genève*, T. xliii., 1843, pp. 353–369.)

Fossil Fishes, Particularly Those of the London Clay. (*Edinburgh New Phil. Jl.*, v. xxxix., 1845, pp. 321–327; v. xl., 1846, pp. 121-125.)

Fossil Remains of an Elephant Found in Vermont. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 100, 101.)

***Fossiles du Terrain Crétacé du Jura Neuchâtelois.** (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. i., 1835, pp. 126–145.)

***——** *Same.* (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. iv., 1836, pp. 420, 421.)

Fossilien Fische die Liasformation. (*Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1832, pp. 139–149.)

Fossilien Süsswasser-Fische der Tertiären Formationen. (*Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1832, pp. 129–138.)

Freshwater Fishes of Central Europe. (*Amer. Jl. of Sci. and Arts*, vol. xlv., 1843, pp. 211–214.)

***Gattungen Unterden Nordamerikanischen Najaden.** (*Archiv für Naturgeschichte.* Von Wiegmann, T. xviii., 1852, pp. 41–52.)

Gegen Wissmann's Ansicht vom Ursprung Erratischer Blöcke. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1840, pp. 575, 576.)

***Genus Dorudon of Gibbs.** (Phila. Acad. of Nat. Sci. *Proceedings*, vol. iv., 1848, pp. 4, 5.)

Genus Trigonia. Charakter von Art überhaupt, Gletscher. (*Neues Jahrbruch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1841, pp. 356, 357.)

***Geographical Distribution of Animals.** (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 1–23.)

*—— *Same.* In German. (*Verhandlungen des Naturhistorischen Vereins der Preussischen Rheinlande und Westphalens*, Bd. 7, 1850, pp. 228–254.)

***Geographische Verbreitung der Fische.** (Tagsberichte, über die Fortschritte der Natur- und Heilkunde. *Abtheilung für Zoölogie*, Bd. i., 1850, pp. 244–247.)

Geological Middle Age, The. (*Atlantic Monthly*, v. xii., Aug., 1863, pp. 212–224.)

***Géologie de la Vallée de l'Amazone.** (Société Géologique de France. *Bulletin*, T. xxiv., 1867, pp. 109–111.)

***Gills of Crustacea.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 225, 226.)

Glacial Period, The. (*Atlantic Monthly*, v. xiii., Feb. 1864, pp. 224–232.)

Glacial Phenomena in Maine. (*Atlantic Monthly*, v. xix., Feb.–Mar., 1867, pp. 211–220; 281–287.)

—— *Same.* In French. (*Archives des Sciences Physique et Naturelles*, T. xxviii., 1867, pp. 319–352.)

***Glacial Theory of the Erratics and Drift of the New** and Old Worlds. (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 97–117.)

Glacier de l'Aar, Observation sur le. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences.* Paris, T. xv., 1842, pp. 284–288.)

—— *Same.* (*Annales de Chimie*, n. sér., T. vi., 1842, pp. 465–484.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxxiii., 1842, pp. 399–402.)

*—— *Same.* In German. (*Verhandlungen der Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften*, 1842, pp. 81-91.)

***Glaciers.** (Société Géologique de France. *Bulletin*, T. ix., 1837–38, pp. 407, 408, 443, 450.)

—— *Same.* (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences.* Paris, T. xv., 1842, pp. 435–446.)

*—— *Same.* (Société Helvétique des Sciences Naturelles. *Actes*, 1843, pp. 72–74.)

*—— In English. (*Edinburgh New Phil. Jl.*, v. xxvii., 1839, pp. 383–391.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. xi., 1839, cols. 65–70.)

*—— *Same.* In German. (*Zeitschrift für Erdkunde als Vergleichende Wissenschaft*, Bd. iv., 1845, pp. 376–382.)

Glaciers and Boulders in Switzerland. (British Assoc. for the Advanc. of Sci. *Report*, 1840, pt. 2, pp. 113, 114.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. xvi., 1840, cols. 337–344.)

***Glaciers and the Evidence of their having once Existed in** Scotland, Ireland, and England. (Geol. Soc. of Lond. *Proceedings*, v. iii., 1842, pp. 327–332.)

—— *Same.* (*Lond. and Edinb. Phil. Mag. and Jl. of Sci.*, v. xviii., 1841, pp. 569–574.)

—— *Same.* (*Annals and Mag. of Nat. Hist.*, v. vi., 1841, pp. 396–398.)

***Glaciers, des Moraines et des Blocs Erratiques.** (*Bibliothèque Universelle de Genève*, nouv. sér., T. xii., 1837, pp. 369–394.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxiv., 1838, pp. 364–383.)

Glanis of Aristotle, The. (Amer. Acad. of Arts and Sci. *Proceedings*, v. iii., 1852–57, pp. 325–334.)

Gletscher-Studien mit Studer. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1840, pp. 92, 93.)

Growth of Continents. (*Atlantic Monthly*, v. xii., July, 1863, pp. 72–81.)

Growth of Coral Reefs. (A Lecture. *Scientific American*, N. S., v. vi., Feb. 15, 1862, p. 101.)

Growth of the Egg, Prior to the Development of the Embryo. Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 4th meeting, 1850, pp. 18, 19.)

Hassler Expedition, Remarks on Results of. Sept. 2, 1872. (Calif. Acad. of Sci. *Proceedings*, v. iv., 1868–72, pp. 257, 258.)

—— *Same.* (*Mining and Scientific Press*, San. Fr., v. xxv., Sept. 7, 1872, p. 153.)

Homologies of Echinoderms. (Bost. Soc. of Nat. Hist. *Proceedings*, v. viii., 1861–62, pp. 235–238.)

Homologies of Radiata. (Bost. Soc. of Nat. Hist. *Proceedings*, v. viii., 1861–62, pp. 226–232.)

Ice Period in America. (*Atlantic Monthly.*, v. xiv., July, 1864, pp. 86–93.)

***Ichthyological Fossil Fauna of the Old Red Sandstone.** *Edinburgh New Phil. Jl.*, v. xli., 1846, pp. 17–49.)

***Iconographie des Coquilles Tertiaires Reputées Identiques** avec les Espèces Vivantes ou dans Différens Terrains de l'Époque Tertiaire Accompagnée de la Description des Espèces Nouvelles. (*Neue Denkschriften der Allgemeinen Schweizerischen Gesellschaft für die Gesammten Naturwissenschaften.* Bd. vii., 1845.)

***Identité, L', des Coquilles Tertiaires et des Coquilles** Vivantes. (Société Géologique de France. *Bulletin*, 2e sér., T. i., 1844, pp. 744, 745.)

***Influence de l'Inclinaison du Sol sur le Mouvement de la** Glace. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 4, 5.)

***Infusoires Fossiles du Tripoli d'Oran.** (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques.* Paris, T. v., 1837, pp. 330, 331.)

***Infusoria.** The Earliest Larval State of Intestinal Worms. *Edinburgh New Phil. Jl.*, v. liii., 1852, pp. 314, 315.)

Internal Structure and Progression of the Glacier. (*Atlantic Monthly*, v. xii., Dec., 1863, pp. 751–767.)

Investigations upon Medusæ. (Amer. Acad. of Sci. *Proceedings*, v. ii., 1848–52, pp. 148, 149.)

***Isard, L', des Pyrénées Comparé ■■ Chamois des Alpes.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 57, 58.)

Kritische Revision der in der Ittiolitologia Veronese Abgebildeten Fossilen Fische. (*Neues Jahrbruch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1835, pp. 290–316.)

Künstliche Steinkerme von Konchylien; Fische. (*Neues Jahrbruch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1838, pp. 49–51.)

***Letters to Louis Coulon.** (Société de Physique et d'Histoire Naturelle de Genève. *Mèmoires*, T. xxiii., 1874, pp. 72– .)

Lettre [addressée de Boston à M. de Humboldt) **sur quelques** Points de l'Organisation des Animaux Rayonnés et sur la Parité Bilaterale dans les Actinies. (*Comptes Rendus. Hebdomadaires des Séances l'Académie des Sciences.* Paris, T. xxv., 1847, pp. 677–682.)

Lössbildungen im Thale des Amazonenstroms. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, Bd. xxxviii., 1867, pp. 180, 181.)

***Manatee is a Pachyderm, The.** (Bost. Soc. of Nat. Hist. *Proceedings*, vol. iii., 1850, p. 209.)

Marcou's "Geology of North America." [Review of.] (*Amer. Jl. of Sci. and Arts*, 2d ser., vol. xxvii., Jan., 1859, pp. 134–137.)

***Mémoire sur les Moules de Mollusques Vivantes et Fossiles.** (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. ii., 1839.)

Métamorphoses des Poissons. (Annales des Sciences Naturelles. *Zoölogie*, 5e sér., T. iii., 1865, pp. 55–58.)

***Métamorphoses que Subissent les Animaux des Classes** Inférieures. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 156–158.)

Métamorphoses Subies par Certains Poissons avant de Prendre la Forme Propre à l'Adulte. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences.* Paris, T. lx., 1865, pp. 152, 153.)

—— *Same.* In English. (*Annals and Mag. of Nat. Hist.*, 3d ser., vol. xvi., 1865, pp. 69, 70.)

Methods of Study in Natural History. (*Atlantic Monthly*, v. ix., 1861, pp. 1–13; 214–222; 327–337; 446–460; 570–578; 754–762; v. x., 1862, pp. 87–98; 325–336; 571–580.)

Mode of Copulation among the Selachians. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xiv., 1872, pp. 339–341.)

Monograph of Garpikes. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1848, p. 70.)

Morphology of the Medusæ. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 3d meeting, 1850, pp. 119–122.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. l., 1851, pp. 85–89.)

Moules du Musée de Neuchatel. (Société Imperiale des Naturalistes de Moscou. *Bulletin*, 1839, pp. 415–430.)

Mountains and their Origin. (*Atlantic Monthly*, v. xi., Jun., 1863, pp. 747–756.)

***Mouvement du Glacier de l'Aar.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 1–4.)

—— *Same.* In German. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1844, p. 620.)

***Mya Alba, Espèce Nouvelle de de Porto-Rico.** (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. ii., 1839.)

Narrative of an Expedition through the Straits of Magellan to San Francisco in the Steamer *Hassler*. (Smithsonian Institution. *Report*, 1872, pp. 87–92.)

—— *Same.* (Smithsonian Inst. *Misc. Coll.*, v. xviii., pp. 394–400.)

—— *Same.* (U. S. Pub. Docs., 42d Cong., 3d Sess., 1873–74. *House Misc. Doc.*, No. 107.)

Natural History of the Animal Kingdom. A Lecture. Illus. (*Mining and Scientific Press*, San Fr., v. xxv., Oct. 26, 1872, pp. 262, 265.

—— *Same.* (*Overland Monthly*, v. ix., Nov., 1872, pp. 461–466.)

Natural Provinces of the Animal World and Their Relation to the different Types of Mankind. [From Nott, J. C., and Gliddon, G. R., "Types of Mankind."] (*Edinburgh New Phil. Jl.*, v. lvii., 1854, pp. 347–363.)

Natural Relations between Animals and the Elements in which they Live. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. ix., 1850, pp. 369–394.)

—— *Same.* *Annals and Mag. of Nat. Hist.*, 2d ser., v. vi., 1850, pp. 153–179.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 193–227.)

—— *Same.* In French. (*Bibliothèque Universelle de Genève*, 4e sér., T. xix., 1852, pp. 15–31.)

***Nature et Définition des Espèces.** (*Revue des Cours Scientifiques*, T. vi., 1869, pp. 166–169.)

Neue Beobachtungen auf den Gletschern; Myacen; Struktur der Gletscher; Desor über Fossile Nucleolitem; Fossil-Arten der Molasse. (*Neues Jahrbuch für Mineralogie Geognosie, Geologie und Petrefaktenkunde*, 1843, pp. 84–89.)

Neue Entdeckungen über Fossile Fische. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1833, pp. 675–677.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxxvii., 1844, pp. 331–347.)

***New Classification of Fishes and on the Geological Dis**tribution of Fossil Fishes. (*Edinburgh New Phil. Jl.*, v. xviii., 1835, pp. 175–178.)

—— *Same.* (*Lond. and Edinb. Phil. Mag.*, v. v., 1834, pp. 459–462.)

*—— *Same.* Geological Soc. of Lond. *Proceedings.* Part ii., 1838, pp. 99–102.)

New Species of Fish from Lake Superior. (From "Lake Superior," etc., by A.) (*Amer. Jl. of Sci. and Arts*, 2d ser., v. x., 1850, pp. 125–127.)

***Nouvelle Espèce d'Esoce du Lac Ontario.** (*L'Institut. Journal Général des Sociétés Scientifiques de la France et de l'Etranger*, T. xxv., 1857, p. 128.)

***Nouvelles Études sur les Prétendues Identités que l'on** Admet Généralement entre les Espèces Vivantes et les Fossiles de Certains Terrains. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 108–109.)

***Nouvelles Observations Faites en Étudiant les Nageoires** des Poissons. (Société Helvétique des Sciences Naturelles. *Actes*, 1845, pp. 49–52.)

***Numerous Minute Tubes in Fishes, Opening Externally.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1848, pp. 27, 28.)

Observations de M. Durocher Relatives aux Phénomènes Erratiques de la Scandinavie, Remarques sur les. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, Paris, T. xxii., Pt. 2, 1845, pp. 1331–1333.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xl., 1845, p. 237.)

Observations Géologiques faites dans la Vallée de l'Amazone. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, Paris, T. lxiv., 1867, pp. 1269, 1270.)

***Ordre d'Apparition des Caractères Zoölogiques pendant** la Vie Embryonnaire. (*Revue des Cours Scientifiques*, T. vi., 1869, pp. 169–171.)

Origin of Species. [From "Contributions to the Nat. Hist. of the U. S.," v. iii.] (*Amer. Jl. of Sci. and Arts*, 2d ser., vol. xxx., July, 1860, pp. 142–155.)

Parallel Roads of Glen Roy in Scotland. (*Atlantic Monthly*, v. xiii., June, 1864, pp. 723–736.)

***Parasite Little Bodies of Hydra.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 354, 355.)

***Period in the History of our Planet, A.** (*Edinburgh New Phil. Jl.*, v. xxxv., 1843, pp. 1–29.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. xxvii., 1843, cols. 241–248; 257–264; 273–280; 289–292.)

***Petromyzontidæ and Their Embryonic Development and** Place in the Natural History System. (*Edinburgh New Phil. Jl.*, v. xlix., 1850, pp. 242–246.)

Phonetic Apparatus of the Cricket. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1848, p. 41.)

Physical History of the Valley of the Amazons. (*Atlantic Monthly*, v. xviii., July–Aug., 1866, pp. 49–60, 159–169.)

***Pictet's "Treatise on Palæontology, Remarks on."** (*Edinburgh New Phil. Jl.*, v. xxxix., 1845, pp. 295–302.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, 2te ser., Bd. xxxvi., 1845, cols. 209–213.)

***Points de l'Organisation des Euryales, Accompagnée de** la Description Detailée de l'Espèce de la Méditerranée. (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. ii., 1839.)

Poissons des États-Unis. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, Paris, T. xxxvii., 1853, p. 184.)

*—— *Same.* (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, 1853, p. 287.)

***Poissons des Terrains Paléozoïques.** (Société Philomatique, Paris. *Extraits des procès-verbaux des Séances*, 1846, pp. 61, 62.)

*—— *Same.* (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, Paris, T. xiv., 1846, p. 163.)

***Poissons Fossiles.** (Société Impériale des Naturalistes de Moscou. *Bulletin*, T. viii., 1835, pp. 180–201.)

***Poissons Fossiles de l'Angleterre.** (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, Paris, T. iv., 1836, pp. 85, 86.)

Poissons Fossiles de l'Argile de Londres. [In French and English.] (British Assoc. for the Advanc. of Sci. *Report*, 1844, pp. 279–310.)

—— *Same.* In French. (Annales des Sciences Naturelles. *Zoologie*, 3e sér., 1845, pp. 21–48.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxxix., 1845, pp. 321–327.)

Poissons Fossiles de la Formation Houillère. (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, Paris, T. iii., 1835, pp. 253, 254.)

Poissons Fossiles du Brésil. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, Paris, T. xviii., 1844, pp. 1007–1015.)

*—— *Same.* (*L'Institut. Journal Général des Sociétés et Travaux Scientifiques*, T. x., 1844, pp. 187, 188.)

***Poissons Vivipares.** (*L'Institut. Journal Général des Sociétés Scientifiques de la France*, T. xxiv., 1856, p. 164.)

***Polished and Striated Surfaces of the Rocks which Form** the Beds of the Glaciers of the Alps. (Geological Soc. of Lond. *Proceedings*, v. iii., 1842, pp. 321, 322.)

—— *Same.* (*Lond. and Edinb. Phil. Mag. and Jl. of Sci.*, v. xviii., 1841, pp. 565, 566.)

—— *Same.* (*Annals and Mag. of Nat. Hist.*, v. vi., 1841, pp. 392, 393.)

***Pores in the Disc of Echinoderms.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 348, 349.)

Primitive Diversity and Number of Animals in Geological Times. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xvii., 1854, pp. 309–324.)

—— *Same.* (*Annals and Mag. of Nat. Hist.*, 2d ser., v. xiv., 1854, pp. 350–366.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. lvii., 1854, pp. 271–292.)

*—— *Same.* In French. (*Bibliothèque Universelle de Genève.* 4e sér., T. xxx., 1855, pp. 27–50.)

***Principes Rationnels de la Classification Zoölogique.** (*Revue des Cours Scientifique*, T. vi., 1869, pp. 146, 165.)

Principles of Classification [of the Animal Kingdom.] (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 3d meeting, 1850, pp. 89–96.)

Principles of Classification of the Animal Kingdom in General, and among the Mammalia in Particular. (British Assoc. for the Advanc. of Sci. *Report*, 1835, Pt. 2, pp. 67, 68.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. l., 1851, pp. 227–235.)

—— *Same.* (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xi., 1851, pp. 127, 128.)

***Prodrome d'Une Monographie des Radiaires ou Echino-** dermes. (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. i., 1835, pp. 168–199.)

—— *Same.* (*Annales des Sciences Naturelles Zoölogie*, T. vii., 1837, pp. 257–296.)

—— *Same.* In English. (*Annals of Nat. Hist.*, v. i., 1838, pp. 30–43, 297–307, 440–449.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. v., 1838, cols. 305–311, 321–326.)

Progress Recently Made in the Natural History of the Echinodermata. [From *Monographies d'Échinodermes.* By A.] (*Annals and Mag. of Nat. Hist.*, v. ix., 1842, pp. 189–197, 296–302.)

***Rapports Existant entre la Répartition des Glaciers et le** Relief Général des Alpes. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, p. 172.

***Rapports qui Existent entre les Faits Relatifs à l'Apparition** Successive des Êtres Organisés à la Surface du globe et la Distribution Géographique des Différens Types Actuels d'Animaux. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 366–369 ; T. ii., pp. 347–350.)

***Recherches sur le Genre de Mollusques auquel Lamarck** a Donné de Nom de Pyrula. (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 69, 70.)

Reise-Projekt nach dem Aar Gletscher; Hügi über Gletscher ; Myaceen. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1842, pp. 313–317.)

Relation between Coloration and Structure in the Higher Animals. (Amer. Assoc. for the Advanc. of Sci. *Proceedings.* 4th meeting, 1850, p. 194.)

Relations Naturelles qui Existent entre les Animaux et les Milieux dans lesquels ils Vivent. (*Archives des Sciences Physiques et Naturelles*, T. xix., 1852, pp. 15–31.)

Remarques à l'Occasion d'une Note de M. Mandl, sur la Structure des Écailles des Poissons. (*Comptes Rendus. Hebdomadaires des Séances de l'Académie des Sciences*, Paris, T. x., 1840, pp. 191–194.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, Bd. xiv., 1840, cols. 179–182 ; Bd. xviii., 1841, cols. 33–41.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxviii., 1840, pp. 287–291.)

Résumé d'une Travail d'Ensemble sur l'Organisation, la Classification, et le Développement Progressif des Echinodermes dans la Série des Terrains. (*Comptes Rendus. Hebdomadaires des*

Séances de l'Académie des Sciences, Paris, T. xxiii., 1846, pp. 276–295.)

***Revue des Différéntes Époques Géologiques.** (Société des Sciences Naturelles de Neuchatel. *Bulletin*, T. i., 1844–46, pp. 50–52.)

***Rhacostoma Atlanticum.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1850, pp. 342, 343.)

***Roches Striées de Suisse.** (Société Géologique de France. *Bulletin*, nouv. sér., T. ii., 1844–45, pp. 274–277.)

***Salmonidæ.** (*Tagsberichte über die Fortschritte der Natur- und Heilkunde, Abtheilung für Zoölogie*, Bd. i., 1850, pp. 241–244.)

***Salmonidæ of Lake Superior.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1848, pp. 61, 62.)

Silurian Beach, The. (*Atlantic Monthly*, v. xi., Apr., 1863, pp. 460–471.)

Smithsonian Institution. Formation of a Museum; Communication from A. relative to. (Smithsonian Inst. *Report*, 1849, pp. 24–26.)

—— *Same.* (U. S. Pub. Docs, 31st Cong., 1st Sess., 1849–50. *House Misc. Docs.*, No. 50, pp. 24–26.)

—— *Same.* (*Senate Misc. Docs.*, v. ii., No. 120, pp. 24–26.)

Smithsonian Institution, Letter on, addressed to C. W. Upham. (*Amer. Jl. of Sci. and Arts.*, 2d ser., v. xix., 1855, pp. 284–287.)

Smithsonian Institution. Report on use of a new hall in Smithson. Bldg. (Smithsonian Inst. *Report*, 1867, pp. 109–111.)

—— *Same.* (U. S. Pub. Docs., 40th Cong., 2d Sess., 1867–68. *Senate Misc. Docs.*, v. iii., No. 86, pp. 109–111.)

Structure and Growth of Domesticated Animals. (*Amer. Naturalist*, v. vii., 1873, pp. 641–657.)

Structure and Homologies of Radiated Animals, with reference to the Systematic Position of the Hydroid Polypi. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 389–396.)

Structure des Écailles des Poissons. (Annales des Sciences Naturelles. *Zoölogie*, 2e sér., T. xiii., 1840, pp. 58–61.)

Structure et de Mode d'Accroissement des Écailles des Poissons et Réfutation des Objections de M. Mandl. (Annales des Sciences Naturelles. *Zoölogie*, 2e sér., T. xiv., 1840, pp. 97–110.)

Structure of Coral Animals. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 68–77.)

Structure of the Foot in Embryo Birds. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. vi., 1848, pp. 432, 433.)

Structure of the Halcyonoid Polypi. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 3d meeting, 1850, pp. 207–213.)

Structure of the Mouth in Crustacea. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 4th meeting, 1850, pp. 122, 123.)

***Succession and Development of Organized Beings on the** Surface of the Terrestrial Globe. (*Edinburgh New Phil. Jl.*, v. xxxii, 1842, pp. 97–99; v. xxxiii, 1842, pp. 388–399.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde.* Bd. xxiv., 1842, cols. 193–201.)

Succession des Poissons Fossiles dans la Série des Formations Géologiques. (Annales des Sciences Naturelles. *Zoölogie*, 3e sér., T. ii., 1844, pp. 251–271.)

Synopsis of the Ichthyological Fauna of the Pacific Slope of North Amer., chiefly from the Collections Made by the U. S. Exped. under Capt. Wilkes, with Recent Additions and Comparisons with Eastern Types. (*Amer. Jl. of Sci. and Arts.* 2d ser., v. xix., 1855, pp. 71–99; 215–231.)

Synoptical Table of British Fossil Fishes, Arranged in the Order of the Geological Formations. (British Assoc. for the Advanc. of Sci. *Report*, 1843, pp. 194–207.)

*—— *Same.* (*Edinburgh New Phil. Jl.*, v. xxxvii., 1844, pp. 331–347.)

—— *Same.* In French. (Annales des Sciences Naturelles. *Zoölogie*, 3e sér., 1844, pp. 251–271.)

Terraces and Ancient River Bars, Drift, Boulders, and Polished Surfaces of Lake Superior. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1848, pp. 68–70.)

Tertiary Age, The, and Its Characteristic Animals. (*Atlantic Monthly*, v. xii., Sept., 1863, pp. 333–342.)

Theorie der Erratischen Blöcke in den Alpen. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1838, pp. 303, 304.)

Three Different Modes of Teething among Selachians. (*Amer. Naturalist*, v. viii., Mar., 1874, pp. 129–135.)

Unconformability of the Palæozoic Formations of the United States. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1851, pp. 254–256.)

Ursprung des Loess. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1867, pp. 676–680.)

Vegetable Character of Xanthidium. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 89–91.)

Verbal Sketch of Prof. Johannes Müller. (Bost. Soc. of Nat. Hist. *Proceedings*, v. vi., 1856–59, pp. 382, 383.)

Vertebrate Fossiles Exhibited to the Association. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 5th meeting, 1851, pp. 178–180.)

***Voyage d'Exploration Scientifique dans l'Atlantique et** l'Amérique du Sud. (*Revue des Cours Scientifique*, 2e sér., T. iv., 1873, pp. 1077–1093.)

Wassergefäss-System der Mollusken. (*Zeitschrift für Wissenschaftliche Zoölogie*, Leipzig, 1856, p. 176.)

***Water-tubes in Fishes.** (Bost. Soc. of Nat. Hist. *Proceedings*, v. iii., 1848, pp. 27, 28.)

—— *Same.* (*Amer. Jl. of Sci. and Arts*, 2d ser., v. vi., 1848, pp. 431, 432.)

Young Garpipes from Lake Ontario. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xxiii., 1857, p. 284.)

Zoölogical Character of Young Mammalia. (Amer. Assoc. for the Advanc. of Sci. *Proceedings*, 1849, pp. 85–89.)

Zoölogical Notes. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xiii., 1852, pp. 425, 426.)

***Zoölogical Researches.** (*Edinburgh New Phil. Jl.*, v. xliv., 1848, pp. 316–319.)

*—— *Same.* In German. (*Neue Notizen aus dem Gebiete der Natur- und Heilkunde*, 3te ser., Bd. v., 1848, col. 145–148; Bd. vii., cols. 293, 294.)

3.—Books Containing Contributions by Agassiz.

Agassiz, L., *and* Buckland, W. Fossil Beaks of Four Extinct Species of Fishes, Referable to the Genus Chimæra that occur in the Oolitic and Cretaceous Formations of England. [With note by Prof. A.] (*Lond. and Edinb. Phil. Mag. and Jl. of Sci.*, v. viii., 1836, pp. 4–7.)

***Agassiz, L., *et* Couthino, *Dr.* J. M.** Géologie de l'Amazone. (Société Géologique de France. *Bulletin*, T. xxv., 1868, pp. 685–691.)

Agassiz, L., *et* Desor, E. Catalogue Raisonné des Familles, des Genres, et des Espèces de la Classe des Echinodermes ; Précédé d'une Introduction sur l'Organisation, la Classification, et le Développement Progressif des Types dans la Série des Terrains. (Annales des Sciences Naturelles. *Zoölogie*, 3e sér., T. vi., 1846, pp. 305–374 ; T. vii., pp. 129–168 ; T. viii., pp. 5–35, 355–381.)

***Agassiz, L., *et* Vogt, C.** Anatomie des Salmones. (Société des Sciences Naturelles de Neuchatel. *Mémoires*, T. iii., 1845.)

Conrad, T. A. Synopsis of the Invertebrate Fossiles of the Cretaceous Formations of New Jersey. [Synopsis of the Naiades of North America, by A.] 8vo. Newark, 1868.

Costa, O. G. Ittiologia Fossile Italiana. Opera da servire di supplimento alle ricerche su i pesci fossili di L. Agassiz. 4to. Naples, 1853.

Desor, E. Journal d'une Course Faite aux Glaciers du Mont Rose et du Mont Cervin. [Renfermant une Notice sur les Glaciers, par. M. Agassiz.] 8vo. Geneva, 1840.

—— Nouvelles Excursions et Séjours dans les Glaciers et les Hautes Régions des Alpes, de M. Agassiz et de ses Compagnons de Voyage. Accompagnées d'une Notice sur les Glaciers de l'Allée Blanche et du Val-Ferret. 8vo. Neuchatel et Paris, 1846.

Guyot, A. The Earth and the Man ; or, Comparative Physical Geography in its Relation to the History of Mankind. Assisted by Professors Agassiz, Peirce, and Gray. New ed. [Tr. from the French, by C. C. Felton.] 8vo. Lond., 1875.

Maury, L. F. A. Indigenous Races of the Earth ; or, New Chapters of Ethnological Inquiry. . . . With communications from J. Leidy and L. Agassiz. 4to. Phila., 1857.

Miller, H. Footprints of the Creator. With memoir of M., by Louis Agassiz. 8vo. Bost., 1857.

Nott, J. C., *and* **Gliddon, G. R.** Types of Mankind. [Natural Provinces of the Animal World and their Relation to the Different Types of Mankind, by A. Illus. 21 pp.] 8vo. Phila., 1854.

—— Indigenous Races of the Earth, including Monographs by Prof. Agassiz, etc. 8vo. Phila., 1857.

Murchison, *Sir* **R. I.** The Silurian System. [*Pterygotus Problematicus*, n. sp. *Onchus Murchisoni*, n. sp. By A. Illus. pp. 606.] 4to. Lond., 1839.

Pourtalés, L. F. de. Contributions to the Fauna of the Gulf-Stream. [Communicated (and with a note) by Agassiz.] 8vo. 1868.

Williamson, *Lieut.* **R. S.** Reports of Explorations in California for Railroad Routes. 1855. [Fossil Fishes of Williamson's Explorations, by Agassiz, v. v., pp. 313–316.]

4.—Biographies of Agassiz.

Louis Agassiz: His Life and Correspondence. Ed. by Mrs. Elizabeth Cary Agassiz. Port. Illus. 2 vols., 12mo. Bost., 1885.

—— *Same.* Louis Agassiz: sa Vie et sa Correspondance. Tr. de l'Anglaise par Auguste Mayor. Port. 8vo. Neuchâtel, 1887.

Agassiz as a Lecturer. (*Scientific American*, n. s., v. vi., Mar. 1, 1862, p. 137.)

Agassiz Museum at Cambridge. Illus. (*Science*, v. vi., Nov. 13, 1885, pp. 421-424.)

Agassiz at San Francisco. (*Nature*, v. vi., Oct. 24, 1872, pp. 509, 510.)

Agassiz in the United States. (*Mining and Scientific Press*, S. Fr., v. xxv., Sept. 7, 1872, p. 145.)

Agassiz Memorial, The. (*Scientific American*, v. xxx., Apr. 18, 1874, p. 240.)

Agassiz Memorial Meeting. Proceedings and Addresses. San Francisco, Dec. 22, 1873. (California Academy of Sciences, *Proceedings*, v. v., 1873–74, pp. 220–243.)

5.—Articles on Agassiz; Biographical Sketches; Criticisms and Accounts of his Researches and Theories.

*—— (Amer. Acad. of Arts and Sci. *Proceedings*, v. ix., 1874, pp. 310–320.)

—— (*American Annual Cyclopædia*, 1873, pp. 8–10.)

—— With Port. (*Appleton's Cyclopædia of American Biography*, v. i., pp. 34–36.)

—— With Port. (*Appleton's Journal*, v. iii., Apr., 1870, pp. 492–494.)

—— (*Athenæum*, Dec. 20, 1873, pp. 818, 819.)

—— (*Eclectic Magazine*, v. xxiii., May, 1851, pp. 13–16.)

—— With Port. (*Eclectic Mag.*, v. xli., Aug., 1857, pp. 569–571.)

—— With Port. (*Eclectic Mag.*, v. lxi., Jan., 1864, pp. 125, 126.)

—— Port and Illus. (*Frank Leslie's Illus. Newspaper*, v. xxxvii., Jan. 3, 1874, pp. 277, 278.)

—— (*Harper's Magazine*, v. xxv., 1862, pp. 194–201.)

—— (*Harper's Weekly*, v. xviii., Jan. 24, 1874, p. 82.) With Port. of Agassiz in his studio, (p. 80.)

—— With Port. (*Littell's Living Age*, v. lxii., 3d. ser., v. vi., July 9, 1859, pp. 67–69.)

*—— (*London Quarterly Rev.*, v. lxvi., July, 1886, pp. 205– .)

—— *Same.* (*Littell's Living Age*, v. clxx., 5th ser., v. lv., Aug. 14, 1886, pp. 387–395.)

—— With Port. (*Practical Mag.*, v. ii., 1873, pp. 321–323.)

—— With Port. (*Mining and Scientific Press*, S. Fr., v. xxv., Aug. 31, 1872, p. 129.)

—— With Port. *Phrenological Journal*, v. lviii., Feb., 1874, pp. 102–104.

—— (*Popular Science Monthly*, v. iv., Feb., 1874, pp. 495–499.)

—— (*Popular Science News*, v. xviii., Dec., 1884, p. 169.)

—— With Port. (p. 7). (*Scientific American*, v. xxx., Jan. 3, 1874, p. 2.)

*—— (Société de Physique et d'Histoire Naturelle, Genève. *Mémoires*, v. xxiii., 1874, pp. 471–478.)

Bliss, Richard, *Jr.* [Sketch of] Professor Louis Agassiz. With Port. (p. 513). (*Popular Science Monthly*, v. iv., Mar., 1874, pp. 608–618.)

Blanchard, Emile. Un Naturaliste du xixe Siècle—Louis Agassiz. (*Revue des Deux Mondes*, 3e sér., T. x. 1er Jul., 1874, pp. 5–34; 1er Août, pp. 539–569.)

***Bronn, H. G.** La Théorie des Glaces et ses Progrès les plus Récénts. (*Bibliothèque Universelle de Genève*, T. xli., 1842, pp. 118–139.)

*—— *Same.* In German. (*Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde*, 1842, pp. 56–88.)

*—— *Same.* In English. (*Edinburgh New Phil. Jl.*, v. xxxiii., 1842, pp. 217–283; v. xxxiv., pp. 364–383.)

Couthino, *Dr.* J. M. Professor Agassiz's Labors on the Amazon. [Two letters.] (*In* Fletcher, J. C., *and* Kidder, D. P. "Brazil and the Brazilians." Appendix J., pp. 627–633.) Bost., 1868.

Desor, Edouard. L'Ascension de la Jangfrau Effectuée le 28 Août, 1841, par MM. Agassiz [and others]. 8vo. Geneva, 1841.

—— Compte Rendu des Recherches de M. Agassiz pendant ses Deux Derniers Séjours à l'Hôtel des Neuchatelois, sur le Glacier Inférieur de l'Aar. 8vo. Geneva, 1843.

—— Excursions et Séjour de M. Agassiz sur la Mer de Glace de Lauteraar et du Finsteraar. 8vo. Geneva, 1841.

—— Excursions et Séjours dans les Glaciers et les Hautes Régions des Alpes, de M. Agassiz. 12mo. Neuchâtel, 1844.

—— Nouvelles Excursions et Séjours dans les Glaciers et les Hautes Régions des Alpes, de M. Agassiz et de ses Compagnons de Voyage. 8vo. Neuchatel et Paris, 1846.

Emerson, George B. What we Owe to Louis Agassiz as a Teacher. An address [delivered] before the Boston Society of Natural History, Jan. 7, 1874. 17 pp. 8vo. Bost., 1874.

—— *Same.* (Bost. Soc. of Nat. Hist. *Proceedings*, v. xvi., pt. 3, 1874, pp. 211–225.)

*—— *Same.* (*Amer. Jl. of Education*, v. xxviii., p. 881.)

Farve, Ernest. Louis Agassiz: a biographical notice. Tr. by M. A. Henry. (Smithsonian Institution. *Annual Report*, 1878, pp. 236–261.)

—— *Same.* (U. S. Pub. Docs., 45th Cong., 3d Sess., 1878–79. *Senate Misc. Docs.*, v. iii., No. 59, pp. 236–261.)

Note :—From the "Archives des Sciences de la Bibliothèque Universelle," Genève, T., lxix., Mai, 1877.

Fiske, John. Agassiz and Darwinism. (*Popular Science Monthly*, v. iii., Oct. 1873, pp. 692–705.)

Funeral of Agassiz. (*New York Times*, Dec. 18, 1873.)

Garfield, J. A. Biogr. Notice of . . . Louis Agassiz. (Smithsonian Institution. *Annual Report*, 1873, pp. 149–151.)

—— *Same.* (U. S. Pub. Docs., 43d Cong., 1st. Sess., 1873–74. *Senate Misc. Docs.*, v. ii., No. 130, pp. 149–151.)

Gray, A. [Sketch of] Agassiz. (*Nation*, v. xvii., Dec. 18, 1873, pp. 404, 405.)

***Guyot, A.** [Memoir of] Agassiz. (National Acad. of Sci. *Biogr. Memoirs*, v. ii.)

***Haworth, H. H.** Agassiz not the Author of the Glacial Theory. (Manchester Literary and Phil. Soc. *Memoirs*, 4th ser., v. iii., p. 144.)

Holmes, O. W. Farewell to Agassiz. [Poem.] (*Atlantic Monthly*, v. xvi., Nov., 1865, pp. 584, 585.)

In the Laboratory with Agassiz. By a former pupil. [*Every Saturday*, v. xvi. (n. s., v. i.), Apr. 4, 1874, pp. 369, 370.]

—— *Same.* (*Scientific American*, v. xxx., Apr. 18, 1874, pp. 244, 245.)

***Kirk, John.** The Doctrine of Creation according to Darwin, Agassiz, and Moses. 8vo. Lond., 1869.

Laugel, Auguste. Un Naturaliste Philosophie—M. Agassiz et ses Travaux. Ses Théories sur la Pluralité des Créations et la Classification des Êtres. (*Revue des Deux Mondes*, 2e sér., T. xi., 1er Sept., 1857, pp. 77–108.)

Le Conte, Joseph. Relation of Louis Agassiz to the Theory of Evolution. (*In his* "Evolution and its Relation to Religious Thought," pp. 32–49, N. Y., 1888.)

—— *Same.* (*Popular Science Monthly*, v. xxxii., Nov., 1887, pp. 17–26.)

***Life and Writings of Agassiz.** (*Edinburgh New Philosophical Journal*, v. xlvi., pp. 1– .)

Life and Writings of Agassiz. (*Massachusetts Quarterly*, v. i., Dec., 1847, pp. 96–119.)

***Life-Work of Agassiz.** (*American*, Phila., v. xi., pp. 71– .)

Longfellow, H. W. The Fiftieth Birthday of Agassiz. [Poem.] (*In his* Works.)

Lowell, J. R. Agassiz. [Poem.] (*Atlantic Monthly*, v. xxxiii., May, 1874, pp. 586–596.)

***Lyman, Theodore.** Commemorative Notice of Louis Agassiz. (American Academy of Arts and Sciences, Annual Report of Council, 13 pp. 8vo. [Cambridge, 1873.]

Lyman Theodore. Recollections of Louis Agassiz. (*Atlantic Monthly*, v. xxxiii., Feb., 1874, pp. 221–229.)

Marcou, Jules. Louis Agassiz at Neuchâtel. (*Nation*, v. xxxvi., Jan. 11, 1883, p. 36.)

Monument to Agassiz. Illus. (*Harper's Weekly*, v. xx., Jan. 29, 1876, p. 85.)

Mill (John Stuart) and Agassiz. (*National Quarterly Rev.*, v. xxviii., Mar., 1874, pp. 235–252.)

Parker, *Dr.* Peter. Biogr. Notice of L. Agassiz. (Smithsonian Institution. *Annual Report*, 1873, pp. 153, 154.)

—— *Same.* (U. S. Pub. Docs., 43d Cong., 1st Sess., 1873–74. *Senate Miscel. Docs.*, v. ii., No. 130, pp. 153, 154.)

Penikese Island, School at :

—— Jordan, *Prof.* David Starr. Agassiz at Penikese. (*Popular Science Monthly*, v. xl., Apr., 1892, pp. 721–729.)

—— Anderson School of Natural History. (*Nation*, v. xvii., Sept. 11, 1873, pp. 174, 175.)

—— (*Harper's Weekly*, v. xvii., Aug. 9, 1873, pp. 701, 702.) With Port. of A. and of John Anderson. Illus.

—— [Programme of] Prof. Agassiz's School of Natural History. (*Popular Science Monthly*, v. iii., May, 1873, pp. 123, 124.)

—— Agassiz at Penikese. With Port. (*In* "Tribune Popular Science," pp. 47–64. Bost., 1874.)

***Phœbus, *Mrs.* V. C.** Agassiz and his Work. (*Methodist Review*, v. xlvi., p. 405.)

Pourtalès, L. F. de. Sketch of Agassiz. 3 pp. (*In* Vaille, F. O., *and* Clark, H. A. Harvard book, v. i.)

Putnam, A. Agassiz and Spiritualism. 16mo. Bost., 1874.

Putnam, F. W. The Anderson School of Natural History at Penikese. (Amer. Assoc. for the Advance. of Sci. *Proceedings*, v. xxiii., 1874, pp. 144–146.)

Richardson, Ralph. Agassiz and Glacial Geology. [Address.] (Edinburgh Geol. Soc. *Transactions*, v. iv., part iii., 1883, pp. 245–262.)

—— [Sketch of] Agassiz. (Edinburgh Geol. Soc. *Transactions*, v. ii., 1874, pp. 285–287.

Scientific Worthies. Agassiz. (*Nature*, v. xix., April 17, 1879, pp. 573–576.)

Smyth, T. Unity of the Human Races, with a Review of the Theory of Agassiz. 8vo. Edinburgh, 1851.

Stebbins, R. P. Discourse on Louis Agassiz. (Smithsonian Institution. *Annual Report*, 1873, pp. 198–210.)

—— *Same.* (U. S. Pub. Docs., 43d Cong., 1st Sess., 1873–74. *Senate Misc. Docs.*, v. ii., No. 130, pp. 198–210.)

Treudley, F. Student Life of Agassiz. (*Education*, Bost., v. ix., May, 1889, pp. 595–600.)

Visit of Prof. Agassiz to Brazil. (U. S. Pub. Docs., 39th Cong., 2d Sess., 1866–67. *House Ex. Docs.*, v. xi., No. 86.)

Vogt, C. Agassiz und seiner Freunde Geologische Alpenreisen.

Waterston, *Rev.* **R. C.** Connection of Prof. Agassiz with the Centennial Anniversary of the Birth of Humboldt. (Bost. Soc. of Nat. Hist. *Proceedings*, v. xvi., pt. 3, 1874, pp. 225-237.)

Whipple, E. P. Agassiz. (*In his* "Character and Characteristic Men," pp. 266–292, Bost., 1879.)

Whittier, J. G. Prayer of Agassiz. [Poem.] (*In* "Tribune Popular Science," p. 46, Bost., 1874.)

Wortley, *Lady* **E. S.** American Notabilities: Prof. Agassiz. (*In her* "Travels in the United States," N. Y., 1851.)

—— *Same.* (*Harper's Mag.*, v. iii., Aug., 1851, p. 384.)

6.—Principal Reviews of Agassiz's Works.

Contributions to the Natural History of the United States of America.

—— (*Amer Jl. of Sci. and Arts*, 2d ser., v. xxv., 1858, pp. 126–128, 202–216, 321–341.)

—— Architecture of the Animal Kingdom. (*Southern Review*, N. S., v. iii., Jan., 1868, pp. 46–75.)

—— Classification. (*Harper's Mag.*, v. xvi., Jan. 1858, pp. 262–266.)

—— Classification in Natural History. (*Southern Review*, N. S., vol. iv., Oct., 1868, pp. 465–476.)

—— Hill, T. Natural History of the U. S. (*Christian Examiner*, v. lxiv., Jan., 1858, pp. 56–74.)

—— Holmes, O. W. Agassiz's Natural History. (*Atlantic Monthly*, v. i., Jan., 1858, pp. 320–333.)

—— Professor Agassiz on the Origin of Species. (*Amer. Jl. of Sci. and Arts*, 2d ser., v. xxx., 1860, pp. 142–155.)

Geological Sketches. First Series:

—— [*Littell's Living Age*, v. xci. (4th ser., v. iii.), Dec. 29, 1866, pp. 805–809.]

Journey in Brazil:

—— (*Nation*, v. vi., Feb. 20, 1868, pp. 153, 154.)

Lake Superior: Its Physical Character [etc.]:

—— Emerson, G. B. Agassiz's Tour to Lake Superior. (*Christian Examiner*, v. xlix., July, 1850, pp. 9–37.)

Methods of Study in Natural History:

—— Architecture of the Animal Kingdom. (*Southern Review*, N. S., v. iii., Jan., 1868, pp. 46–75.)

—— (*Atlantic Monthly*, v. xiii., Jan., 1864, pp. 131, 132.)

Monographies d'Echinodermes Vivants et Fossiles:

—— (*Amer. Jl. of Sci. and Arts*, v. xxxvii., 1839. pp. 369–371; v. xlii., 1842, pp. 378, 379; v. xlv., 1843, pp. 399, 400.)

Nomenclatur Zoölogicus:

—— (*Amer. Jl. of Sci. and Arts*, 2d ser., v. iii., Mar., 1847, pp. 302–309.)

Recherches sur les Poissons Fossiles:

—— Agassiz on Fossil Fish. (*Quarterly Review*, v. lv., Feb., 1836, pp. 433–445.)

—— (*Calcutta Jl. of Nat. Hist.*, v. iii., 1843, pp. 313, 314.)

Louis Agassiz: His Life and Correspondence.

—— (*Athenæum*, Jan. 2, 1886, pp. 36, 37.)

—— (*Literary World*, v. xvi., Oct. 17, 1885, pp. 368, 369.)

—— (*Saturday Review*, v. lxi., Mar. 6, 1886, pp. 344, 345.)

—— (*Spectator*, v. lviii., Dec. 19, 1885, pp. 1703, 1704.)

—— Allen, Grant. (*Academy*, v. xxviii., Nov. 7, 1885, pp. 309, 310.)

—— Gray, Asa. (*Andover Review*, v. v., Jan., 1886, pp. 38–44.

*—— —— *Same.* (*British and Foreign Evangelical Review*, v. xxxv., 1886, p. 386.)

—— Life of Agassiz, The. (*Science*, v. vi., Oct. 16, 1885, pp. 330–332.)

—— Scudder, H. E. (*Atlantic Monthly*, v. lvi., Dec., 1885, pp. 848–850.)

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