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## Summary

Bilal Haq, a scientist from the National Science Foundation Arlington, Virginia encountered foraminifera on his trip to Qingdao in China.

Foraminifera are small creatures that grow shells on their bodies. Their shells are varied and very diverse, as if they are created by visionary artists. Haq thought the foraminifera would make beautiful pieces of art and should be put on display. Haq's fellow colleague from China, Zheng, agreed and put things into action by involving local craft workers. It resulted in a park for foraminifera since the end of 2009 and already a million people have visited (Larkins, 2012).

It is interesting to see the foraminifera because there are many different living and fossilized varieties. They have their homes in every sea of the earth. Their shells are examples for great research of evolution because one can study how the climate of the earth has evolved in time. Also, they can be used for studying the link Darwin missed in evolution, especially when it comes to fossils. More specifically, they can be used for the outline of evolution. The park is definitely a must see because there are not only living foraminifera to see but also the different stages of fossils of the foraminifera are shown. This way one can see for oneself how the evolution gradually took place in these creatures (Larkins).

An interesting fact that did not appear in the Smithsonian article is that the change in the rotation of the world can be studied from the foraminifera as well. We know that foraminifera can give us an overview of the evolution when it comes to fossils but that it can provide us with the evolution of the

earth is an interesting addition to what foraminifera can teach us.

Furthermore, foraminifera are used as art forms by artists, such as by the artist Earnst Haeckel (Baucon, 2010).

In the exhausting warmth of the Western Desert in Egypt there is a place called Wadi Hitan (The Valley of the Whales). It is called like this because interestingly, the remains of bone whales have been found there. That is striking since in this place you are not likely to find whales since they live in water nowadays. However, these whale bones show that the whales had legs on them. This confirms the belief of researchers that whales used to be creatures that were earth bound creatures before they were creatures of the sea and the bones are an interesting station in between of their development. The crucial question remains how these creatures lost their feet and how they developed to being a sea creature (Tucker, 2012).

The findings in Wadi Hitan show what the limbs of the whales must have looked like and on the basis of that conclusions can be drawn on how their development must have taken place. First their legs were longer because of walking the earth and later when they came closer to the sea and dipped into it, gradually their limbs became obsolete and their bodies adjusted to it and after that the legs were gone completely. This site is a must see because it is fascinating to see one of the stages of evolution of the whale and to see the bones the way the scientists found them on the site with your very own eyes (Tucker, 2012).

In an additional article on Wadi Hitan from the UNESCO World Heritage site it is informed the amount of the whale bones found is exceptional, just as well

as the fact that the place is easy to access. Wadi Hitan is the most important place in the world when it comes to how whales have transformed themselves and there is no comparison to any other site (Unesco World Heritage).

Spilberk Castle in Brno was an infamous incarceration place during the reign of the Habsburgs but it was also the place where Gregor Mendel spent around eight years researching his theories and cultivating his ideas. His findings eventually led to the study of contemporary genetics which for a large part are based on the studies of Mendel. Mendel studied the breeding of plants, more specifically that of peas and how they inherit certain traits. He was a meticulous scientist and used different disciplines (Py-Lieberman 2012).

The findings of his studies had large implications, although they were not understood at the time. The results and the ideas regarding inheritance can be applied to other creatures as well. This is interesting in the field of evolution because it provides ideas on how we inherit certain characteristics and how certain traits can happen independently. This is a must see on the evolution world tour because it is the place where the breakthrough that laid modern genetics happened and one can see the place where Mendel had his pea garden, the plant that he studied and from which he drew all the conclusions (Py-Lieberman, 2012).

An additional interesting fact about the Spilberk Castle in Brno is that it is the home of the Brno City Museum and one of the most important centres of culture in the city. It became officially a Czech heritage monument in the

year of 1962. Such an old building breathes life into the city with all kinds of contemporary events from different disciplines (Brno City Museum).

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## Reference

Mendel was born into an ethnic German family in Heinzendorf bei Odrau, Austrian Silesia, Austrian Empire (now Hynčice, Czech Republic), and was baptized two days later as Johann. He was the son of Anton and Rosine (Schwirtlich) Mendel, and had one older sister (Veronica) and one younger (Theresia). They lived and worked on a farm which had been owned by the

Mendel family for at least 130 years.[4] During his childhood, Mendel worked as a gardener, studied beekeeping, and as a young man attended Gymnasium (school) in Opava. From 1840 to 1843, he studied practical and theoretical philosophy as well as physics at the University of Olomouc Faculty of Philosophy, taking a year off through illness.

When Mendel entered the Faculty of Philosophy, the Department of Natural History and Agriculture was headed by Johann Karl Nestler, who conducted extensive research of hereditary traits of plants and animals, especially sheep. In 1843 Mendel began his training as a priest. Upon recommendation of his physics teacher Friedrich Franz,[citation needed] he entered the Augustinian Abbey of St Thomas in Brno in 1843. Born Johann Mendel, he took the name Gregor upon entering religious life. In 1851 he was sent to the University of Vienna to study under the sponsorship of Abbot C. F. Napp. At Vienna, his professor of physics was Christian Doppler.[5] Mendel returned to his abbey in 1853 as a teacher, principally of physics, and by 1867, he had replaced Napp as abbot of the monastery.[6]

Besides his work on plant breeding while at St Thomas's Abbey, Mendel also bred bees in a bee house that was built for him, using bee hives that he designed.[7] He also studied astronomy and meteorology,[6] founding the 'Austrian Meteorological

The religious order of Augustinians-Eremites founded in 1256, has long upheld a tradition in teaching and learning in the fields of art and science. The community in Moravia was established in 1346 and granted a charter by the Moravian Margrave John Henry of Luxembourg that was endorsed by the Pope in 1356 with the approval of the Bishop of Olomouc. Before long, the

monastery earned its reputation as a vital centre of creative interest in theology and culture, attracting various well-known philosophers, musicologists, mathematicians, mineralogists, botanists and such like throughout its history.

The original complex, founded by the Augustinians in 1347 on the outskirts of the city beyond the Rhine Gate (Moravian Square in what is now known as the Governor's Palace), had to be rebuilt in the 15C after being destroyed by fire during the Hussite raids. What remains there is the Augustinian Thurn, founded in 1653 as a result of a substantial endowment from Sibylla Polyxena Francesca von Montani (Countess von Thurn und Walsassina) for the encouragement of music. It was largely as a result of the sponsorship of this institution that Leos Janacek (1854-1928) was able to remain in Brno as director of the Old Brno Choir.

In 1752, the augustinian convent was promoted to abbey by Pope Benedict XIV. Then, in 1783 during the reign of the Hapsburg Emperor Joseph II, the friars were forced to leave and take up residence in a former Cistercian monastery in Old Brno, where the community has resided ever since. Its sixth abbot was Gregor Mendel; the present abbot Lukas Evzen Martinec - the eleventh to succeed to the post - is responsible for the gradual restoration of the abbey since 1996.

For seven centuries, the skyline of Brno—the second-largest city in the Czech Republic—has been dominated by Spilberk Castle. Built on the summit of the highest hill in the city, it was one of Europe's most notorious prisons, and a conspicuous warning to those who would oppose the rule of the Hapsburg dynasty.

Yet, for many, the most impressive site in Brno is a four- acre patch of land near the base of the hill. This is where Gregor Mendel, a friar at the Augustinian Abbey of St. Thomas, spent eight growing seasons (1856-63) cultivating and breeding as many as 10, 000 pea plants (*Pisum sativum*), and meticulously counting some 40, 000 blossoms and 300, 000 peas. His experiments laid the foundations for modern genetics. And unbeknown to Mendel at the time, his discovery of how physical traits are passed down from one generation to the next revealed a crucial biological mechanism underlying Darwin's theory of evolution through natural selection.

" Mendel is a giant in the history of genetics," says David Fankhauser, a professor of biology and chemistry at the University of Cincinnati Clermont College, who made a " pilgrimage" to the abbey in 2006. " I wanted to feel what it was like to be him in his garden and look at his digs, as it were."

Mendel never explicitly described his motivation for his breeding experiments. Some biographers speculate that he was investigating a popular theory that hybridization created new species. Even before Darwin published *On the Origin of Species*, naturalists were increasingly skeptical about the prevailing idea that every form of life remained unchanged. The naturalists' own observations suggested otherwise, and many postulated that new species emerged when inherited characteristics rearranged themselves into different combinations.

Other scientists prior to Mendel had conducted plant-breeding experiments, but the results were largely inconclusive. Mendel succeeded, in part, because he was the right man in the right place. The Abbey of St. Thomas adhered to the Augustinian dictum *per scientiam ad sapientiam* (from



knowledge to wisdom). The abbot, Cyrill Napp, sought to establish his monastery as a leading center for scientific research and was so supportive of Mendel's work that he had a greenhouse built to expand the monk's outdoor laboratory.

For his part, Mendel had practical experience as a gardener. Growing up on his family's modest farmstead, in what is today the Czech Republic, he had tended fruit trees. Years later, his university studies included physics and mathematics—disciplines that imparted proper scientific rigor. “ No one has concentrated on the number of different forms that appear among the offspring of hybrids,” Mendel later commented on his predecessors' research. “ No one has arranged these forms into their separate generations. No one has counted them.”

“ I especially admire that he used very simple research techniques that anybody could have duplicated,” says Fankhauser. “ His obsessive recording of biological data and then his application of simple mathematical analysis—nothing more complex than algebra—were the keys to his success.”

Part of Mendel's genius also lay in his decision to study the inheritance patterns of specific plant traits (such as round or wrinkled seeds) separately from one another, whereas others had tended to look at such traits collectively. His research yielded two significant principles. The first law of inheritance (the law of segregation) states that traits are determined by a pair of “ factors” (known today as alleles, or paired genes)—one of which is dominant, the other recessive—and that each offspring receives a random allele from each parent. The second law (the law of independent assortment) states that allele pairs for each trait occur independently of one another.

Mendel published two papers describing his research; however the importance of his findings was not recognized in his lifetime. While some of his contemporaries saw his work as an interesting investigation into plant hybridization, they failed to appreciate the larger implication—in effect, they missed the forest for the peas. Also, efforts by naturalists to duplicate Mendel's findings using other species often failed. Today we know the reason: Most traits are determined by several gene pairs acting in tandem. Relatively few traits, such as the shape of a pea seed, are determined by just one pair of alleles. And we know that some genes are passed down in groups.

Mendel died at the abbey on January 6, 1884, at the age of 61. It wasn't until the early 20th century that scientists rediscovered Mendel's work and recognized its significance, including the implications for evolutionary biology. In the 19th century, skeptics of Darwin had argued that physical characteristics do not remain constant from one generation to the next. But Mendel's laws of inheritance demonstrated that a trait could breed true for multiple generations, eventually becoming common in a population if it enabled survival.

While Mendel posthumously garnered acclaim, his garden did not fare as well. Under communist rule in the 1950s—when classic genetics was deemed *scientia non grata*—officials shuttered the Abbey of St. Thomas and dismantled the remains of Mendel's greenhouse. The precise location of his pea beds was lost. But, by 1965, the political climate had changed to the point that Mendel was honored with a symposium celebrating the 100-year anniversary of the friar's initial lectures on his research. The greenhouse

foundations were excavated and scholars pinpointed the likely site of the garden, which is just through a gate in the convent walls.

For visitors who wish to see the garden for themselves, Brno is only a two-hour drive from Vienna or Prague, and trains from Budapest to Berlin regularly stop there. Cobbled streets in the town center lead up a hill to the abbey.

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A small museum adjacent to the garden houses a set of 19th-century grafting and pruning tools, Mendel’s brass microscope and some notes that he kept, just like any gardener, on weather patterns and conditions.

At the far end of the garden, a statue of Mendel is almost hidden by overgrown trees. One hand rests on a pedestal laden with pea vines; the other is open as if gesturing to say he understood that recognition would eventually come his way. “ I knew,” he wrote to a colleague in 1867, “ that the results I obtained were not easily compatible with our contemporary scientific knowledge.”

Read more: <http://www.smithsonianmag.com/travel/evotourism/Evotourism-World-Tour-Mendels-Garden-Czech-Republic.html#ixzz1mYDSYski>

In 1902, a team of geologists guided their camels into a valley in Egypt’s Western Desert—a desolate, dream-like place. Centuries of strong wind had

sculpted sandstone rocks into alien shapes, and at night the moonlight was so bright that the sand glowed like gold. There was no water for miles. A nearby hill was known as “ Mountain of Hell” because of the infernal summer heat.

Yet in this parched valley lay the bones of whales.

Some of the skeletons were 50 feet long, with vertebrae as thick as campfire logs. They dated back 37 million years, to an era when a shallow, tropical sea covered this area and all of northern Egypt.

And although the geologists didn’t realize it at the time, the prehistoric specimens in the sand would offer clues to one of evolution’s most nagging questions: how whales became whales in the first place. For these long-dead whales had feet.

“ We had sometimes joked about walking whales,” says Philip Gingerich, a University of Michigan paleontologist who discovered the dainty little appendages, complete with tiny toes, when working in Wadi Hitan (“ The Valley of the Whales”) in 1989. “ When we found what we did in Egypt, we thought, ‘ That’s not a joke anymore.’”

Scientists had long suspected that whales were terrestrial mammals that had eased into the ocean over millions of years, gradually losing their four legs. Modern whales, after all, have vestigial hind leg bones. But little in the fossil record illustrated the transition—until Gingerich began excavating Wadi Hitan’s hundreds of whale fossils, finding legs and knees.

Those skeletons “ are the Rosetta stones,” says Nick Pyenson, a curator of fossil marine mammals at the National Museum of Natural History. “ It’s the first time we could say we know what the hind limbs of these animals look

like. And they're bizarre." Older specimens of footed whales have since been identified, but Wadi Hitan's are unmatched in their numbers and state of preservation. The valley—about a three-hour drive from Cairo—is now a Unesco World Heritage site visited by some 14, 000 people each year.

Gingerich speculates that whales' landlubber ancestors were deer- or pig-like scavengers living near the sea. About 55 million years ago, they started spending more time in the water, first eating dead fish along the shore, and then chasing prey in the shallows, and then wading deeper. As they did, some evolved traits that facilitated hunting in water. Over time—since they no longer had to bear their full body weight at sea—they got bigger, their backbones elongating and their rib cages broadening.

Fossils from India, even older than the ones studied in Egypt, reveal that the whale's earliest ocean-dwelling ancestors kept their footing, using their legs to climb in and out of the water—most likely for breeding and giving birth on shore. But the more they relied on tails for locomotion, the more their legs shrank. " If you're going to be using your tail, legs get in the way," Pyenson says. " Smaller legs reduce drag. You want to become streamlined." The whales of Wadi Hitan had evolved to the point where they could not return to land. They were school bus-size creatures with feet only a few inches long, useless for walking. Eventually, the whales' legs would disappear altogether. Most of the fossils in the valley belong to two types: Basilosaurus was the giant, with an almost eel-like body. The more petite but heavily muscled Dorudon looked more like a modern whale, at least until its mouth opened to reveal a jaw lined with serrated daggers instead of peg-like teeth.

Far from a playground for gentle giants, prehistoric Wadi Hitan was a whale-

eat-whale world. That part of Egypt was likely a warm, nutrient-rich elongated gulf not unlike modern Baja California, where gray whales today come to bear young. Gingerich thinks that Dorudon likewise calved in the shallows, because there are unusual numbers of juvenile skeletons at the site. Some of the baby Dorudon have bite marks on their heads, likely inflicted by hungry Basilosauruses. Both whale ancestors would have feasted on other creatures in the area, which was home to sea cows, giant crocodiles, sharks and myriad other fish. Dorudon skeletons are sometimes found with jumbles of fish bones where their stomachs would have been. The Basilosaurus' teeth are typically broken from extensive use.

Once quite difficult to reach, Wadi Hitan has recently become an ecotourism destination. It is part of Wadi El-Rayan, a larger protected area that also includes a Saharan oasis inhabited by Dorcas gazelles and Fennec foxes. Visitors can hire a driver (preferably with a four-wheel-drive vehicle) in Cairo and travel over recently improved roads to the valley. The site includes an open-air museum with footpaths alongside some of the fossils, which are fully or partially exposed and easy to see. And, provided they remember to bring wood for the fire pit, the most intrepid guests can camp overnight on the ancient seafloor and sleep with the whales.

The skeletons are much as they were when the first geologists found them. In death, Dorudon almost always assumed a circular posture. Basilosaurus tended to come to rest in a more or less straight line. The ocean current perhaps pushed the bodies parallel to the coast. Using the whales' positions, scientists may one day be able to discern the shape of long-lost shores.

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Bilal Haq, a marine geologist at the National Science Foundation in Arlington, Virginia, was visiting a lab in Qingdao, China, where fellow scientist Zheng Shouyi had completed a set of detailed, palm-size models of foraminifera—microscopic marine organisms with ornate shells. “When I saw those,” says Haq, “I said, ‘My God, those would make excellent sculptures.’”

Being a “woman of action,” as Haq describes her, Zheng persuaded the Institute of Oceanology, the Chinese Academy of Sciences and the city government of Zhongshan (Zheng’s ancestral home) to establish a sculpture park devoted to foraminifera, or forams. Local artisans and stoneworkers created the sculptures under Zheng’s supervision. The 2.5-acre park, featuring 114 granite, marble and sandstone sculptures of foraminifera, opened to the public in December 2009. Since then, nearly a million visitors have strolled the hillside grounds, across the bay from Hong Kong.

A tribute to foraminifera was long overdue. The tiny organisms have lived on the planet for 330 million years. Plus, they’re the artisans of the single-celled community—creating their own custom-made skeletons by extracting calcium carbonate from seawater and cementing the particles together with glue secreted by their bodies. Their shells vary from simple tubes and spheres to elaborate, multi-chambered spirals and long, striated pods.

Forams “grow based on the same mathematics that the Greeks used in their

sculpture and their vases and their architecture,” says Tony Arnold, a paleontologist at Florida State University, “ and therefore are pleasing to the eye.”

Numbering more than 4, 000 species (and over 40, 000 in the fossil record), forams inhabit every ocean, subsisting on microscopic algae, bacteria and detritus, and providing food for snails, crustaceans and small fish. When they die, their shells form layers on the seafloor. Geologists use the deposits to measure the age of surrounding rock and sediment. Other scientists gather the tiny skeletons to study the history of earth’s climate. “ They preserve the original carbon and oxygen isotopes of that time, which are a proxy for past temperature,” says Haq.

Moreover, paleontologists recognized these tiny skeletons could provide crucial evidence that had eluded Charles Darwin, who argued that organisms go through intermediate stages on their way to becoming a new species. But Darwin was frustrated that he couldn’t find any examples of these stages in the fossil record; he concluded that nature and time had obliterated them. But in the 1990s, says Arnold, “ several people at once, myself being one of them, realized that the foraminifera, because they live in the deep sea, did have a continuous fossil record, and we could sample layers of them every few centimeters if we wanted to measure the change from one species to another.” In 1997, Arnold and paleontologist Bill Parker, also at Florida State, produced one of the most complete fossil records ever assembled, illustrating the evolution of forams over the past 66 million years. For display at the sculpture park, Zheng chose both living specimens and those that represent various eras in earth’s history, as far back as the

Carboniferous period (about 330 million years ago) and the Jurassic period (beginning 200 million years ago). Her favorite sculptures are based on six specimens from the Holocene epoch (beginning 10, 000 years ago) that she herself found in core samples around Zhongshan. They stand near the entrance to the park and remind visitors that, ten millennia earlier, this area was a shallow sea.

Read more: <http://www.smithsonianmag.com/travel/evotourism/Evotourism-World-Tour-Foraminifera-Sculpture-Park-China.html#ixzz1mTXh7CpR>