

Lake Biwa Museum



Geological History

The rocks that lie beneath Shiga Prefecture have a very long history, stretching back 250 million years. These rocks and the fossils preserved in them can tell us a great deal about the history of the area.



Where Did Those Rocks in the Riverbed Come From?

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Two million years ago the area was dominated by forests of *Metasequoia*, the dawn redwood. The fossil stump of a large *Metasequoia* tree displayed in the museum died approximately two million years ago after reaching an age of 400 years. It was only recently exposed by erosive floodwater of the Echi River, east of Lake Biwa. With the fossilized stump, researchers also found elephant footprints and fossil insects and plants. This information has helped to build up an idea of life in the area two million years ago.

Fossilized Metasequoia tree stump

Rocks that Form Mountains

The rocks that underlie the lowlands and form the mountains of Shiga Prefecture consist of igneous, metamorphic and sedimentary types. Igneous rocks, such as granite, formed by the slow solidification of molten rock deep in the crust. Later, these igneous rocks were uplifted and now form many of the mountains in the area. Basalts are solidified volcanic lava, and welded tuffs consist of volcanic material that was sufficiently hot at time of eruption to weld together. Sedimentary rocks, such as mudstones, limestones and sandstones, were formed by the compaction of sediments.



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Crumpled rocks



Formation of the Sea of Japan

Twenty-five million years ago, the Sea of Japan did not yet exist, and the land destined to become Japan was still part of the eastern margin of continental Asia. Through the process of tectonic rifting, the eastern margin of the continent developed a large rift valley that contained one or more freshwater lakes. As the rifting continued, about 22 million years ago, saltwater began to flood the rift valley, and by 19 million years ago the rift had become a continuous saltwater strait, the beginning of the Sea of Japan.

Seventeen million years ago, the southeastern corner of Shiga Prefecture was covered by the sea. Fossil dolphins, whales, sharks, seals, fish, marine clams, oysters and snails have been found from this time and are on display.

Replica of a whale fossil found in Shiga Prefecture

Origin of Freshwater Fishes in East Asia

East Asia is home to a huge number of freshwater fish of the Cyprinidae family (the carp family). Some of these fish evolved in the freshwater lakes that formed in the rift valley that was the beginning of the Sea of Japan. This long, narrow lake lasted several million years and was home to many of the ancestors of Lake Biwa's fish, including cyprinids.

The fossil teeth of these fish are very useful for studying their evolution.



Fossil fish through time

History of Lake Biwa: a Much-traveled Ancient Lake Lake Biwa is a member of a very special group of lakes called ancient lakes. These lakes have an uninterrupted history of Lake Biwa longer than 100,000 years, and there are fewer than 30 such (Recent) lakes in the world. The Lake Biwa region has a lake history Lake Katata stretching back four million years, when Lake Oyamada (1~0.4 million Gamo Lakelands years ago) (2.5~1.8 million formed to the southeast of the location of the present-day years ago) lake. Lake Koka (2.7~2.5 million years ago) Lake Ayama (3~2.7 million years ago) Lake Oyamada (4~3.2 million years ago)

History of lakes in the area

Life Under a Subtropical Climate

Such ancient lakes are biologically very interesting as they often contain endemic species (species that are found nowhere else) that have evolved in the lakes. The secret to lake longevity is subsidence; if subsidence rates of the bedrock are faster than sediment can fill up the lake, they continue to survive and can get deeper over time. The land below Lake Biwa has subsided 720 m over the last 800.000

years and the lake will continue to get deeper.

Between 3.5 and 4 million years ago the climate of this region was subtropical. During that time, a small, shallow lake, Lake Oyamada, existed to the southeast of the present Lake Biwa. Large mud snails, two-meter long carps and now-extinct fish lived in the lake together with very large soft-shelled turtles and crocodiles. The shores of the lake were inhabited by the Mie elephant, which could reach a height of four meters at the shoulder.

> Replica of a Stegodon elephant skeleton, similar to the Mie elephant





The Akebono elephant in the swamp

The Age when Elephants Roamed

Two million years ago this area was dominated by the Gamo Lakelands, surrounded by a forest of 20- to 30meter-high Metasequoia. Reduced mostly to swamp lands, the Gamo Lakelands were still not at the present location of Lake Biwa. The climate had cooled slightly from two million years earlier, but was still warm. The Mie elephant had already disappeared and a smaller species, the Akebono elephant, now lived here.

Later, about one million years ago, when the climate became even colder, the Akebono elephant also disappeared from Japan.



Exploration Beneath the Museum

To find out what happened to the lake during the last million years, a 900-meter core was drilled below the present site of the aquarium in 1992.

Analysis of the core revealed that during the past 1.8 million years the site was located either near to the lake shore, or near a river which flowed into the lake. Among the sedimentary strata present in the core were deposits of volcanic ash that had settled out in the lake basin after volcanic eruptions elsewhere. These ash layers can be dated precisely, making it possible to trace the succession of events revealed by the different kinds of sediment in the core and their relation to the dated ash layers. The surface of the core corresponds to the present time, and the bottom to 1.8 million years ago.

Sections of the borehole

The Process of Evolution in Lake Biwa

Lake Biwa is home to many endemic species, i.e. species that live only in Lake Biwa and its connected rivers, and nowhere else in the world. About 54 fish species are native to this lake basin, and 16 (20%) of them are endemic at the species or subspecies level. Endemism reaches 49% for snails (Gastropoda) and 39% for mussels and clams (Bivalvia).

Well known examples of endemic fish are the Lake Biwa catfish, the Lake Biwa salmon and two kinds of crucian carps. Other species, like the lakeweed chub and some shellfish, are known as relict endemics. This means that in ancient times they were widely distributed, but now are found only in Lake Biwa.



Above the grey line are endemic species, below are widely distributed species



Natural History Laboratory

The techniques used by researchers to reconstruct the history of Lake Biwa are very varied. Palaeontological sites, often in river beds, have been carefully examined and information on fossils, sediment type and age of the strata have been carefully collected.

Back in the laboratory, researchers first clean the fossils using drills, brushes and hammers and then identify them. For very small fossils, such as fossil fish teeth, a scanning electron microscope may be used. Some of these techniques and tools are displayed in the Natural History Laboratory.



Sediments

By the exit of the Natural History Laboratory is a model of a sediment profile from the future. Sedimentation is a continuous process: it happened in the past, it is occurring now, and it will continue in the future.



Human History

Lake Biwa has played an important role in shaping the local culture of the surrounding area and this exhibition room explores this relationship. The earliest evidence of human activity around Lake Biwa dates back more than 20,000 years and can be seen at various archaeological sites, some of which are now

flooded by the lake. The lake acted as a major transport route for goods for hundreds of years and the main land route from east Japan to Kyoto and the west passed nearby.

Underwater Archaeology

Traces of ancient people's activities are frequently discovered around Lake Biwa. However, due to ongoing, slow changes in the outline of the lake, parts of the former shore have become submerged, taking with them the remnants of old lakeshore societies. Over 100 well preserved sites of ancient human settlements have been found underwater in Lake Biwa.



Model of a coffer dam



Two main methods are used to study underwater archaeological sites. One method is for SCUBA divers to use pumps to suck substrate from the bottom to a boat. The sediment is then examined to collect any artifacts it may contain. The other method is to construct a coffer dam so that archaeologists can study the site under dry conditions. First a water-tight barrier is constructed around the site and then the water is pumped out.

SCUBA



Life in the Jomon Period: Hunting and Gathering

From 1989 to 1991 a coffer dam was used to study the Awazu shell mound in the southern basin of Lake Biwa. The shell mound is one of the largest freshwater shell mounds in the world and was a garbage tip for the ancient Jomon people more than 5,000 years ago.

After they had eaten shellfish (mostly freshwater clams), people disposed of the empty shells in the same place nearby, forming a

large and permanent refuse dump. In addition to shells, archaeologists found many other items in the mound, such as fish bones, plant remains, pottery, earrings, knives, net sinkers and preserved animal dung. The site provided an extraordinary insight into the life of some of the first people to live in this area.



Bone and stone tools

Wooden agricultural tools

Life in the Yayoi Period: Beginning of Cultivation Agriculture-based civilization appeared rather recently in Japan. During the Yayoi Period, from about 900 B.C. until 250 A.D., agricultural techniques imported from China and the Korean Peninsula initiated paddy-field rice cultivation around the lake. It was as a result of the need to control rice production and regulate land-use that society became socially stratified and the lake and river areas began to be governed by local lords.



Wood used to make fire

Many of the agricultural tools used during this period were made from wood. Such tools are often found very well preserved in the peaty mud or in attached lakes in the Lake Biwa area.





7th century foundations of the Seta Bridge

Lake Biwa and Ancient Transport Routes In ancient times Lake Biwa was an important crossroads connecting many points of the country, from east to west and from north to south. One of the places that used to be a major junction for ground transport is the Seta Bridge. It was first built during the 7th century using Korean techniques and spans the Seta River at the southern end of Lake Biwa. Warriors aspiring to be rulers of Japan fought on the bridge and in the sediments around the bridge various artifacts have been recovered, such as swords, arrowheads and coins.

Ship-borne Transportation

From ancient times until the late 19th century Lake Biwa was the most important route for transportation of goods and materials coming from the northern and eastern parts of Japan to the capital, Kyoto, and to Osaka. During the 18th Century, typical goods included dried seafood (cod, sardines, herrings, herring roe, squid, abalone, sea slugs, and seaweed), rapeseed, rice, red rice cakes, rain hats, ramie (a plant used for fibers), paper, deer skins, cotton, white silk, and copper.



Products transported from northern areas of Japan to Otsu in the five years from 1778

The 'Maruko-bune'

The 'maruko-bune' is a type of traditional wooden boat unique to Lake Biwa, which formerly played a major role in transportation in the region. Maruko means 'round', referring to the rounded hull in cross-section, and which gave the boats high stability in the often choppy waters of the lake. They were used extensively during the Edo Period (1603-1868), and even though much reduced in numbers, were still in use before World War II.

The Museum has the last 'maruko-bune' ever built, commissioned from the last surviving 'maruko-bune' builder.



A fisherman's house

Fishing in Lake Biwa

Fishing has played a central role in the culture of the area, and many different techniques have been employed.

One ancient technique that is still used today is the 'eri' fish trap. These are permanent, anchor-shaped fish traps built near the shore, that concentrate fish into two traps.

The fishermen scoop the fish from the trap using long-handled nets. The placement of these traps requires detailed knowledge of fish behaviour and water currents, and their use was strictly controlled. A village that could obtain permission to build an 'eri' usually became very prosperous and powerful.



Model of an 'eri' fish trap

Mastering Water: Modern Period

Rice farming requires a very careful control of the water system for irrigation purposes. As a result, the natural streams and rivers in Japan have been extensively modified.

> Several devices, such as humanpowered irrigation wheels and versions of Archimedes' screw, were developed for drawing water from a river or the lake and directing it to the fields.

> > Orange areas were

flooded in 1896



Archimedes' screw

Regulating Water Levels Although they have long enjoyed the benefits of Lake Biwa's water supply. the lakeside residents until recently also had to endure its floods. With 120 inflowing rivers, but only one outflowing river, the Seta River, coupled with deforestation of the areas around the lake. flooding has been a major problem in the area. In 1896 a devastating flood occurred, with water levels rising 3.7 m above normal, and some areas remained under water for over eight months.

Today, floodgates on the outflowing Seta River allow careful control of the water levels in Lake Biwa so that lake flooding is no longer a problem for the residents in the region.



The Age of Steamships

From the end of the 19th century to the early 20th century Nagahama, located on the east side of the lake's north basin, was a very important



connection point for trains and ships. In those days there was no railroad connecting Nagahama to Otsu, and people travelling by rail had to tranverse the lake between these two points by ship.



Replica of a waiting room

Nature Connecting with Our Lifestyles

This exhibition room explores the relationship between the nature of the Lake Biwa watershed and people.

Starting with the lake and moving outwards through the reed beds to the rice paddies, rivers and forests, the environment, wildlife and the relationship between people and nature are examined.

Around the walls are exhibits displaying different themes about Lake Biwa, including its topography, differences in water temperatures with depth, changes in the shape of the lake over time, and water use of Lake Biwa. Now about 14 million people rely on Lake Biwa and its out flowing river system for tap water, including most of the cities of Kyoto and



Osaka.

Let's Go to Lake Biwa

On the floor at the center of the circular room you can see a six meter diameter aerial photo image of Lake Biwa and its surroundings, at a scale of 1:10,000.

Into the Reed Marshes

Reed beds are one of the typical landscapes of Lake Biwa. This section shows how reed beds change with the seasons, the kinds of creatures that can be observed in each season, and how the reed beds are used by people. Fish, birds and other wildlife reproduce in the reed beds during the summer, while people cut the reeds in winter to make roofs, screens and festival torches.



Reed beds change their appearance with the seasons. In this section, dioramas reproduce reed beds in spring to summer, summer to fall, and in winter, and display the species that populate each season.



To the Rice Paddies

In addition to cultivating rice, rice paddies also provide a home for over 5,000 species of plants and animals. Some of these are only found around Lake Biwa, such as endemic species of fish that spawn in the

surrounding rice paddies.

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Changes in farming practices from 1960 to 1980 have reduced access to the rice paddies for these fish, but the local project 'Fish Cradle Rice Paddies' is helping to alleviate these problems.





Gazing into a rice paddy

In this diorama tiny creatures that inhabit rice paddies are shown 20 times their actual size. At certain times an enormous number of water fleas can be found in rice paddies. As soon as the paddies are flooded, very small phytoplankton and protists appear in large numbers. Water fleas eat them and proliferate, while young crucian carp in turn eat the water fleas. As the carp grow, they eat more water fleas. Finally, all water fleas are consumed and the phytoplankton and protists start to proliferate again.

Migratory animals between rice paddies and other environments

Many species found in rice paddies do not spend their whole lives there. This section introduces animals, such as turtles, that travel between rice paddies and other areas including the rivers and forests. Herons and egrets builds nests among

trees along the riverside and fly to rice paddies to catch and eat crayfish, fish and frogs. Many frogs that grow up in rice paddies also inhabit the forests and meadows after they move to land. For these species, the paddies and such as important.



From Rivers to Forests

The "From Rivers to Forests" zone explains how the environments of rivers and forests are essential to Lake Biwa, and the relationship between the species living there and people.



Rivers and Lake Biwa

This is a diorama of a typical river. You can see fish and birds in the river. Due to river modifications and dam constructions, problems such as flooding and water shortages have been greatly reduced. However, these works decrease water levels of the rivers, so fish cannot escape from fish-eating birds, and plovers cannot breed because vegetation covers the gravel banks.

Some sandy beaches along the lakeshore have contracted because the amount of sand delivered from the forests to the lake by rivers has been reduced. It is important to maintain the connections between the lake and the rivers that deliver water and sand.

Animals linking forests, rivers, and lakes/seas

Great cormorants are native to Japan, but because they damage valuable forests and eat sweetfish, an important resource for the local fishery, countermeasures to reduce the impact of the birds have been recently taken. Because some creatures such as great cormorants and deer have become too numerous in forests, the relationships among people, forest plants and wildlife have become unbalanced.

Please pick up the model of a great cormorant from the display table to get a sense of their size and weight, and discover how much fish they eat every day.

Forest plantations

In forest plantations that are not well-maintained, trees are spindly and the forests are dark because not much sunlight can enter. Approximately 40% of the forests around Lake Biwa are planted forests, and they need regular maintenance, such as pruning and thinning, to keep them healthy. It is important to cultivate forest plantations so that they produce good quality wood and protect the Lake Biwa environment. Changing lifestyles This exhibit displays many home appliances and other popular products that appeared between the 1960s and the present. TVs, washing machines, rice cookers... these new products have entered our lives and dramatically changed lifestyles. Since the 1990s, the development of communication technologies, such as PCs, mobile phones and smartphones, has further altered our lifestyles.

Our Lifestyles

The "Our Lifestyles" zone examines the connection between our lifestyles and the environment of Lake Biwa.



Daily life of a rural family in 1964

This exhibit captures one moment at 10:00 am on May 10th, 1964, of the Tomie family who lived in Honjo-cho, Hikone City, Shiga Prefecture. Five people were living in the house - a recently married young couple, their new born baby and the baby's grandparents. No water service was available at that time. Drinking water from a flowing well was filtered for use. There was a 'kawaya', a preparation area built over a stream, where dishes were washed and vegetables prepared. Rice straw was used as fuel to heat bath water and to cook food. Human waste from the toilet was a precious fertilizer to be spread on fields.

Lake Biwa Regional Plant and Wildlife Collection

This section showcases the diversity and uniqueness of the species that inhabit Shiga Prefecture, including many of the endemic species found locally.

The Future of Lake Biwa

In the Research Stadium five of the Museum's scientists explain their research using videos, quizzes and specimens. Local community groups also showcase their studies on the local area.

Have an opinion about Lake Biwa and our environment? Here you can leave a message on the board.





Aquarium

The Lake Biwa Museum's aquarium is one of the largest freshwater aquarium facilities in Japan, and features fishes and other aquatic organisms from Lake Biwa, its watershed and several other lakes of the world.



Let's Go into Lake Biwa

Things that Live in Satellite Lakes and Marshes Vast reed beds can be found along the shores of Lake Biwa and in the satellite lakes. In spring, crucian carp gather in the reed beds to spawn. These fish are used to prepare 'funazushi', a specialty sushi dish of Shiga Prefecture. Numerous other fish and birds also come to the reed beds to reproduce.





Things that Live Offshore

In the tunnel tank you can see fish, such as Biwa salmon and Japanese crucian carp, which can be found swimming in the waters offshore. The depth of the lake offshore is nearly 100 m. In the summer the surface waters are warm, but below 20 m depth the water is 18°C (64°F) or lower throughout the year. Species that like cold water inhabit this area.

The King of Lake Biwa: the Lake Biwa Catfish

The giant Lake Biwa catfish is the symbol of the Lake Biwa Museum. They can grow to over 1 m in length and weigh over 30 kg, and are the largest native species in Lake Biwa.

This species is a nocturnal predator, spending the day at over 20 m depth and coming up into shallower water at night to prey on smaller fish.

'Koayu' sweetfish in Lake Biwa

Sweetfish that live offshore are called koayu (small ayu) because they only grow up to 10 cm in length. Usually, sweet-



fish make their way down to the sea soon after they hatch, and from spring to early summer they mature while swimming upriver. However, koayu are different. They stay offshore in Lake Biwa until fall, when they head upriver to spawn. Koayu comprises the highest value fishery in Lake Biwa.

Fish Related to Our Lifestyles

Species Endemic to Lake Biwa

Lake Biwa has a history of four million years, and because of this, many endemic species have evolved in the lake, including the Biwa oily gudgeon, the Seta shijimi clam, and the rocky catfish. Some of these endemic species are important to the local fisheries.

Fishing techniques and recipes to utilize these species were developed long ago and continue to be used.





Artificially Introduced Aquatic Wildlife The lakeshore and waterways between Kusatsu City and Moriyama City are full of species that originated from outside Japan, such as red swamp crayfish, red-eared sliders, largemouth bass and bluegills. These species were artificially introduced to the lake for sport fishing and as unwanted pets. To native species such imported species are the same as invading aliens.

'Kawazakanaya' Freshwater Fish Stores

The number of 'kawazakanaya', freshwater fish stores, has decreased recently. The opportunities to eat Lake Biwa fish have unfortunately diminished because of decreasing catches, and increasing availability of marine fish at markets. However, there are many tasty fish and shellfish in Lake Biwa, such as Biwa salmon, sweetfish and Seta freshwater clams, and fishermen catch them each season. 'Kawazakanaya' also sell prepared dishes, such as 'tsukudani' (simmered dishes with a soy sauce based soup), 'shioyaki' (salt-grilled fish) and 'sashimi' (raw slices of fresh fish).





In rivers flowing into Lake Biwa a variety of fish go upstream depending on the season. From spring to summer, weirs called 'yana' are installed to catch fish such as sweetfish, Japanese dace and three-lips going upstream. In the middle reaches of rivers sweetfish are common during spring and summer. Giant Japanese salamanders also live in the middle reaches of rivers.

Further upstream, char and 'amago' salmon live in the cold, nutrient-poor waters.



Many waterfowl overwinter on Lake Biwa. The little grebe, Shiga's prefectural bird, is the best-known bird in Lake Biwa. This small bird is about 25 cm long and inhabits the lake throughout the year.

Fish Conservation & Breeding

About 40 kinds of endangered fish from all over Japan are bred in the Museum's Conservation and Breeding Center.



World of the Ancient Lake

The World's Oldest Lake, Baikal More than 1000 endemic species inhabit Lake Baikal, which is approximately 30 million years old.



Baikal seals are the only exclusively freshwater seal species, and they are endemic to Lake Baikal. They are able to dive to depths of 400 m, and they eat Baikal oilfish, one of the sculpin family. Baikal seals are distinguished by their large eyes, which help them see in the lake's deep waters.

The temperature at Lake Baikal drops below minus 20°C (minus 4°F) in winter and the lake surface is covered by more than 1 m of ice. This is why Baikal seals have a thick layer of blubber under their fur and skin.

In addition to Lake Baikal, fish from other ancient lakes, Lakes Tanganyika, Malawi and Victoria, are on display.

Touching Corner

In this section you can touch fish and crayfish. Let's get a sense of some creatures that you usually don't see up close. A staff member will assist you.

Sturgeons and gars are representatives of ancient fish, groups that have shown very little evolution over millions of years.

83% of species living in Lake Biwa are tiny, and usually go unnoticed by most people. The Micro Aquarium attempts to showcase the amazing variety of some of these creatures living in Lake Biwa and other aquatic habitats in Shiga Prefecture.



Now let's go and experience Lake Biwa for real!



Forests of Ancient Times When elephants roamed the area two million years ago typical trees included *Metasequoia* and other deciduous conifers. Later, during the Jomon and Yayoi periods (5,500 ~ 1,800 years ago), evergreen and broadleaf trees were common.

Life and Culture Laboratory Modelled on a traditional Japanese farmhouse, this building is used for various Museum activities throughout the year.

Treetop Walk Get high up into the tree tops for a close -up look at the types of trees in the museum's grounds and the wildlife living in their branches.

Lake Biwa's Birdlife

Approximately 100,000 birds representing about 140 species overwinter on the lake

every year.

Rice field Every year the Museum plants small fields of rice and vegetable. During the growing season the rice fields teem with acuatic life.

Little grebe

Museum Activities

The Lake Biwa Museum runs many activities for the local community and visitors. These include hands-on courses for school children, such as studying plankton and making plankton models, making fossil replicas and using reeds as musical instruments.

Other activities include Field Reporters and Hashikake Groups for people of all ages who wish to use the Museum as a center to pursue research and other activities associated with the Museum.

For further details please contact a staff member or email query@biwahaku.jp



One of the Museum's teaching labs, fully equipped with microscopes

- Size: 674 km²
- Volume: Total 27.5 km³
 - North Basin 27.3 km³
 - South Basin 0.2 cubic km³
- Max depth:
 - North Basin 104 m
 - South Basin 8 m
- Mean depth:
 - North Basin 44 m
 - South Basin 3.5 m
- Length of shoreline: 235 km
- Catchment area: 3,174 km²
- No. of inflowing rivers: 120
- No. of outflowing rivers: 1 (the Seta River)
- Trophic status:
 - North basin mesotrophic
 - South basin eutrophic
- Conservation Status:
 - Designated a quasi-national park in 1950.
 - Entire Lake Biwa region designated as a wildlife sanctuary in 1971
 - Registered with the Ramsar Convention on Wetlands in 1993 as a wetland of international importance



- No. of endemic species/subspecies: 62, including:
 - 16 species/subspecies of fish (20% of total)
 - 9 species of bivalves (39% of total)
 - 21 species of gastropods (49% of total)

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Please note: Because the contents of the galleries are regularly updated, some of the exhibits on display during your visit might differ from the description in this guide.