CHAPTER IX.

LAKES AND SWAMPS.

LAKES.

116. Origin of Lake Basins. — A lake is a body of water occupying a basin or depression on the surface of the land. Lakes form parts of river systems, but their basins are not usually made by the rivers. In their work of valley cutting, rivers tend to establish regular slopes, and they are capable of making only small basins: for example, pot holes (p. 54) and ox-bow lakes (p. 63). Rivers could not make deep basins because water would gather in them and check the current, thus taking away its cutting power. The majority of lake basins are formed by dams across stream valleys.

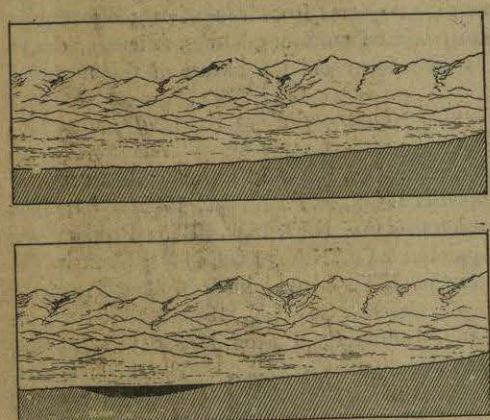

Fig. 296. — Two diagrams of the same valley. In the lower figure a lake has been formed by downfolding, or warping, of its bottom.

Most of the leading causes for lake basins have already been stated. (See pages 55, 60, 63, 67, 76, 78, 95, 97, 103, 121, 123, 130, 131, 142, 148, 149, 154, and 156.) Make a list of these causes. From it you will see that there are various reasons why

Fig. 297. — A view on Lake Como, occupying a mountain valley broadened and deepened by glacial erosion and dammed by deposit of moraine across the valley. A hanging valley (p. 142) is seen on the opposite side. The town in the foreground (Bellano) is on a stream delta, which has been built out into the lake.

FIG. 298.—Lake Cayuga, central New York, occupying a river valley broadened and deepened by glacial erosion and dammed at one end by drift deposits.

FIG. 299.—Lower Ausable lake in the Adirondacks, occupying a mountain valley dammed by drift.

dams may be made across stream valleys, changing them to lake basins. By far the most important of these causes are the glacial dams which have so recently interfered with the drainage of large areas of Europe and America. Many lakes, such as the Great Lakes (p. 156), are due to a combination of two or more causes.

There are still other causes than those already stated for lakes and ponds. For example, beavers build dams of wood and mud across streams to make swamps and ponds for their homes and feeding grounds. Man is now one of the most important agents in the making of lake basins. To supply water for power, for the use of cities, and for irrigation, men are making ponds and lakes in many parts of the earth.

Summary.—*Lake basins, though parts of river systems, are not generally formed by the rivers, but by some interference with drainage, usually by some kind of dam. Man is now making many lakes.*

117. Size and Form of Lakes.—There is every gradation from mere ponds to the largest of lakes. Some are very shallow; others have great depth; in many the bottom is below sea level; and even the surface of some, like Dead Sea, is below sea level. The following tables give some facts regarding the size and depth of certain large lakes.

THE GREAT LAKES.

	Length, miles.	Average width, miles.	Maximum width, miles.	Shore line, miles.	Water area (including is'ds.), square miles.	Average depth, feet.	Maximum depth sounded, feet.	Surface above tide water, feet.	Deepest point above tide water, feet.	Water volume, cubic miles.	Land area of water-shed, square miles.	Aggregate land and water area of water-shed, square miles.
Superior . . .	390	70	160	1,300	31,200	475	1,008	602	−406	2,800	51,600	82,800
Michigan . . .	335	58	85	875	20,200	335	870	581	−289	1,290	37,700	60,100
Huron	250	54	100	725	17,400	210	702	581	−121	650	31,700	55,700
Erie	25	40	58	590	10,000	70	204	573	369	130	22,700	32,700
Ontario	180	40	68	600	7,300	300	738	247	−491	410	21,600	28,900

SOME OF THE LARGEST LAKES IN THE WORLD.

NAME.	AREA (SQUARE MILES).	ELEVATION (FEET).	GREATEST DEPTH (FEET).
Caspian	169,000	−85	2,400
Superior	31,200	602	1,008
Victoria Nyanza	30,000	4,000	590
Aral	26,900	160	225
Huron	17,400	581	702
Michigan	20,200	581	870
Nyassa	14,000	1,500	600+
Tanganyika	12,650	2,800	2,100
Baikal	12,500	1,312	4,550
Great Bear	11,200	200	——
Great Slave	10,100	——	650+
Chad	10,000+ variable	8-900	12
Erie	10,000	573	204
Winnipeg	9,400	710	70
Balkash	7,800	780	135+
Ontario	7,300	247	738

The great majority of lakes are longer in one direction than in others. The explanation of this fact is that they occupy parts of river valleys, and, therefore, have a long axis in the direction of the valley. If the water rises into tributary valleys, the outline of the lake becomes irregular, as in the case of Lake Champlain. Because the basin which they occupy is round, some lakes are nearly circular. This is true, for instance, of crater lakes (Figs. 215, 216, 225), sink-hole lakes (p. 60), and kettle-hole ponds (Fig. 294).

Deltas built out into lakes help to make them irregular; and, on the projecting deltas, towns and villages are often placed (Figs. 107, 297). Deltas at the head of lakes, where the inlet streams enter, shorten the lake.

On the other hand, waves tend to straighten lake shores by cutting back headlands and building beaches, which often shut in small bays, transforming them to ponds (Fig. 370).

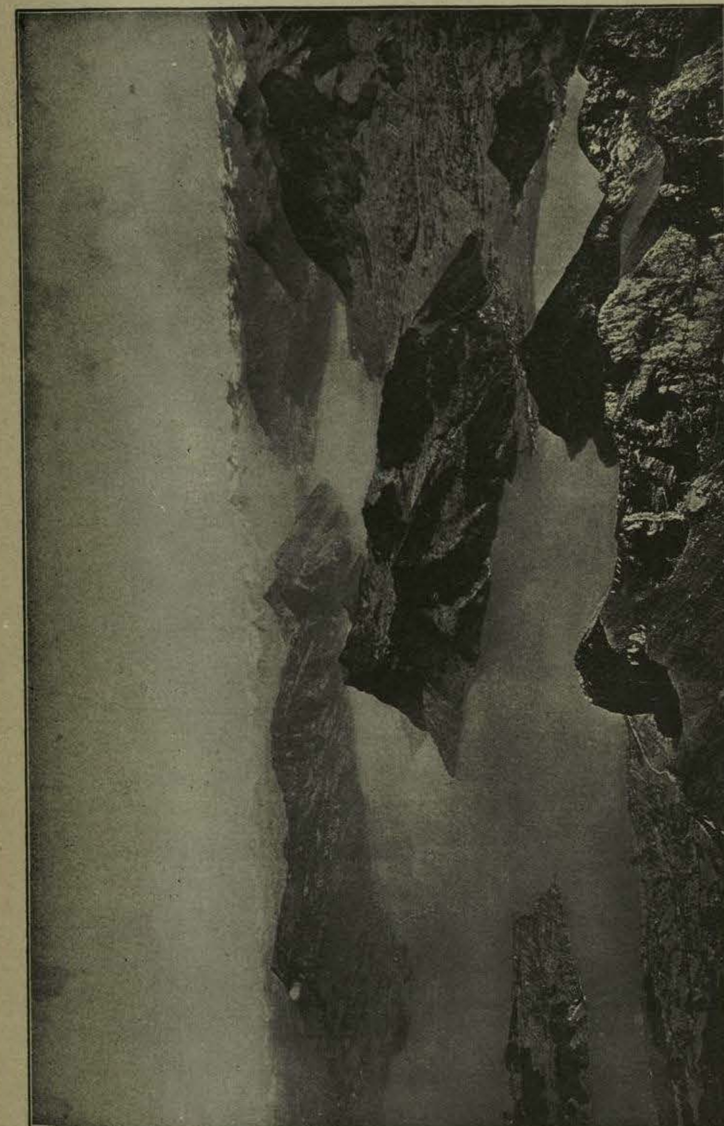

FIG. 300. — Lake Lucerne, a very irregular lake occupying some of the mountain valleys of the Alps.

FIG. 301. — A map showing the extent of ancient Lake Bonneville, as indicated by the beaches and other shore lines on the surrounding mountain slopes. The present Great Salt Lake is shown occupying a part of the desert plain on the site of this extinct lake.

Summary. — *Lakes vary greatly in size, depth, and form; but most lakes are long, because they occupy parts of river valleys. Deltas on the sides of lakes make them irregular; but waves tend to straighten the shores.*

118. Salt Lakes. — The largest lake in the world, the Caspian Sea, is salt. It receives an enormous inflow of fresh water from the Volga and other rivers; but in that dry climate, evaporation is so rapid that the water does not fill the basin and overflow. Its surface is about 85 feet below sea level.

Dead Sea, whose surface is 1300 feet below sea level, is one of the saltest lakes in the world, being nearly a quarter salt, although entered by the fresh-water Jordan.

Great Salt Lake is about one fifth salt; and this amount so increases the density of the water that a man cannot sink in it. Where the water has risen over the low plain surrounding the lake, and evaporated, the ground is incrusted with salt; and, by leading the water into shallow basins, and allowing it to evaporate, salt for use is obtained.

The explanation of salt lakes in dry climates is as follows: Streams carry salt, gypsum, carbonate of lime, and other mineral substances in solution (p. 51). Where lakes have outflows, these substances are in part borne away by the outlets; but in arid climates evaporation is so great that the lakes cannot rise and overflow the rims of their basins. Therefore, while the water is removed by evaporation, the mineral substances are left, and the water grows gradually salter. If evaporation continues long enough, there will be so much salt that some of it must be deposited on the bottom. Great Salt Lake is not yet salt enough for this; but carbonate of lime is being deposited.

In the Great Salt Lake basin there are wonderfully perfect deltas, beaches, and wave-cut cliffs on the mountain sides, hundreds of feet above the valley bottom. By tracing these shore lines it is found that a great fresh-water lake, now named Lake Bonneville (Fig. 301), formerly filled this basin, overflowing into the Columbia. Its area was as great as that of Lake Huron, and, on the site of Salt Lake City (Fig. 133), the water was over 1000 feet deep. Great Salt Lake is the shrunken descendant of Lake Bonneville, occupying a shallow depression on the lake-bottom plain. In other arid regions there is evidence of former periods of greater moisture.

Summary. — *Salt lakes, common in arid regions, are due to the fact that evaporation prevents the water from rising to a point of overflow, and, by removing the water, leaves behind salt and other dissolved mineral substances. Elevated shore lines around the basin of Great Salt Lake prove former periods of greater moisture.*

119. Life History of Lakes. — Some lakes disappear by the sudden removal of the dam, as in the case of glacial lakes (p. 149); others, like Lake Bonneville, disappear by evaporation. But most lakes have a different life history, being destroyed partly by filling, partly by cutting down at the outlet. Cutting at the outlet is usually slight, because the sediment has been filtered out in the quiet lake water, thus robbing the outlet stream of tools for erosion. This is illustrated by Niagara River, which, though emerging from Lake Erie with great volume, has been able to do little more than cut a shallow valley in the loose glacial drift (Fig. 483).

Every stream that enters a lake is bringing to it sediment which is helping to fill the basin; and the waves, winds, and rain wash add to this sediment supply. The finer rock fragments are carried out into the lake and strewn over its bottom, while the coarsest fragments are deposited near the shore, especially opposite the stream mouths, building deltas. (Figs. 107, 293, 297.)

As soon as part of a lake becomes shallow enough, vegetation commences to grow in the quiet water (Figs. 303, 306). The death of these plants — including lilies, reeds, cane, and sphagnum moss — supplies further material for lake filling. Gradually the lake is replaced by a swampy plain (Fig. 304), the upper layers of which are made of vegetable remains.

Over this swampy plain the streams meander, gradually building it higher by flood deposits until it becomes a dry-land plain. During its existence, a lake acts as a temporary base level, below which the incoming streams cannot cut. But when a lake is filled, the outlet stream, being no longer robbed of its sediment, is able to cut more rapidly; and, as the outlet stream deepens its valley, opportunity is given for the streams on the lake plain to cut valleys. Then the sediment with which the lake basin has been filled is slowly removed. In the glacial belt there are many illustrations of partly or completely filled lakes and ponds; and among mountains every gradation in lake destruction is found, even to the point where all lake sediment has been removed.

Summary. — *Lakes are normally removed by combined cutting at the outlet and filling with sediment; but down-cutting at the outlet is usually slight because the outflowing streams have little sediment. Plant growth, and the floods of streams that flow over the swampy plain, accomplish the final stage. When filling is complete, the streams are able to cut into these lake beds and remove them.*

120. Importance of Lakes. — Lakes are highly important as resorts for people in search of rest and recreation. The beautiful scenery, cool climate, boating, bathing, and fishing attract thousands of people each summer to the Great Lakes, Lake George, Lake Champlain, and the lakes of the Adirondacks, the Catskills, and New England.

Lakes have a decided influence on climate. In summer the water warms less rapidly than the land, and this cools the air over the lakes. In winter, on the other hand, when the land is frozen and snow covered, deep lakes are open and the temperature is, therefore, above freezing point. This open water acts like a great stove, raising the temperature of the air, which winds carry to the neighboring land.

The lake water warms so slowly in spring that its presence chills the land near by and retards the buds of plants. It also helps to prevent late spring frosts. This is very important to delicate plants, like some of the fruits which are greatly injured by frosts late in spring after the buds have appeared. The water, warmed in summer, also tends to prevent early autumn frosts, and thus the growing season for delicate plants is prolonged. For these reasons lake shores are often the seat of important fruit-raising industries. This is well illustrated on the shores of the Great Lakes. One of the best vineyard regions of the United States is along the south shore of Lake Erie; and the peninsula of Ontario, between Lakes Erie, Ontario, and Huron, has so moderate a climate that peaches and tobacco are grown. A similar influence is felt all along the Great Lakes.

Lakes are an important source of food fish. They are also a source of ice, which may be stored for use in summer. To freeze shallow lakes does not require great cold; but large, deep lakes rarely freeze. The reason for this fact is that, until a temperature of 39° is reached, fresh water becomes steadily heavier and sinks. It is, therefore, necessary to lower the temperature of the entire lake to 39° before the surface freezes. The settling of cold water in winter gives to the bottom of deep lakes a temperature of 39° throughout the year.

Lakes are also of great value in navigation. In early days the Great Lakes were of the highest service as pathways for the explorers of the wilderness; to-day they are thronged with ships going in all directions. By this lake navigation and commerce the location of several great cities has been determined — Duluth, Milwaukee, Chicago, Detroit, Toledo, Cleveland, Buffalo, Toronto, and others (p. 313).

The building of railways into the interior of Africa is now opening up the great African lakes to navigation. They have already been important factors in the development of tropical Africa, and were traversed by steamboats even at the time when it was necessary for all the machinery to be carried to them on the backs of men.

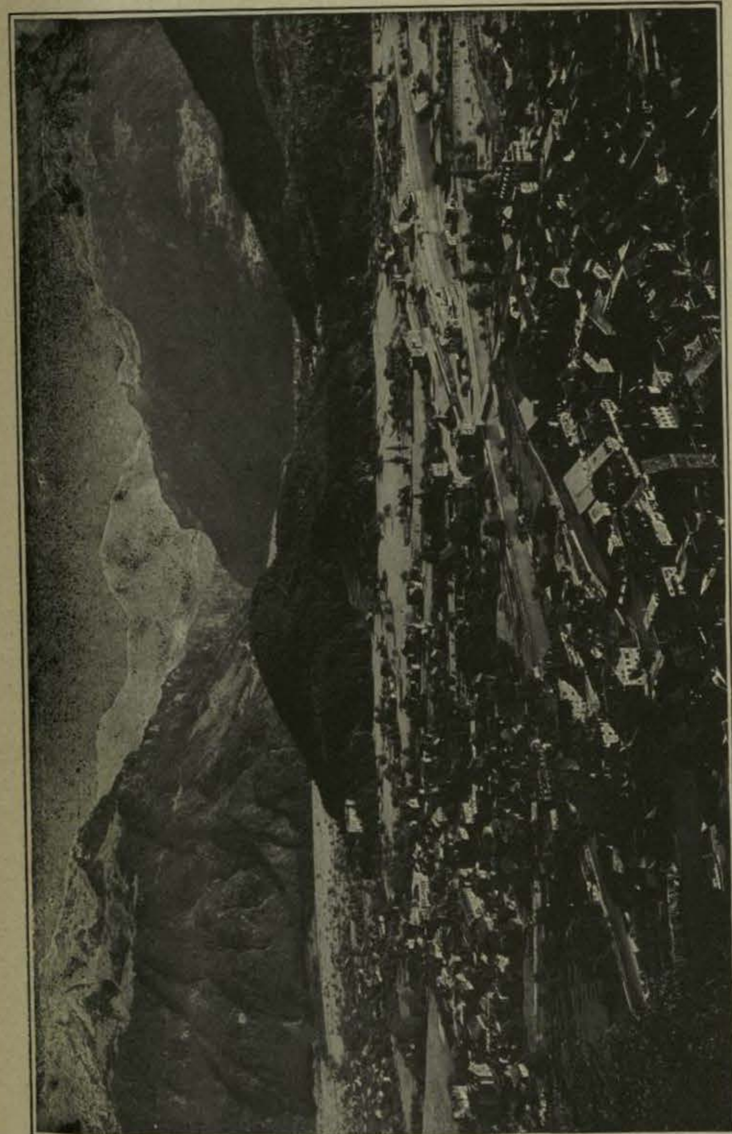

FIG. 302. — The town of Interlaken on the delta which has divided an Alpine lake into two lakes, Thun and Brienz. The stream connecting the two is seen in the picture.

FIG. 303. — A pond in which vegetation is aiding in filling. Lilies are the farthest out, then low shrubs, then low trees, and finally the forest.

FIG. 304. — A filled pond in the Adirondacks, showing the swamp plain and the stream crossing it. It is still too swampy for trees to grow. (Copyright, S. R. Stoddard, 1888.)

As storage basins and regulators of water supply, lakes serve still another important purpose. While the volume of such rivers as the Mississippi varies with the rainfall, the lake-fed Niagara and St. Lawrence maintain a very uniform flow. It is because they store large quantities of water for steady supply that lakes and ponds are so useful for city water supply, for factories, and for irrigation. The fact that sediment settles in lakes makes them of further value in supplying clear drinking water, even though entered by very muddy streams. Indeed, ponds are often made part of a city water supply for this very purpose of removing sediment.

The drying up of salt lakes leaves beds of salt, some of which are found on the surface of arid lands, as in western United States; others are buried deep in the earth. Dried-up salt lakes also supply other mineral substances, one of the most important being gypsum, which is used for plaster of paris, land fertilizer, and the "chalk" of crayons.

Summary. — *Lakes are important as resorts; they have decided influence on the climate of near-by land; they are a source of ice; they supply food fish; they are very useful for navigation; they act as storage reservoirs for a steady supply of water, and as settling basins for sediment; and dried-up salt lakes furnish beds of salt, gypsum, and other mineral substances.*

SWAMPS.

121. Causes of Swamps. — A swamp is a damp place on the land, not ordinarily covered by standing water. It is caused by some interference with the run-off of water, such as a gentle slope, or the growth of swamp-loving vegetation. One of the most common causes of swamps is the filling of lakes, forming surfaces so level that swamp plants grow there in abundance. During the stages of lake filling, swamps are formed on deltas, in bays, and, if the lake is small, even along the shores (Figs. 303, 306); and, when completely filled, the lake is replaced by a swamp (Fig. 304).

In cool, damp, temperate climates, the most important swamp-producing plant is the sphagnum moss, which forms *peat bogs*. Sphagnum often grows out from the shores of small, shallow ponds, floating on the surface (Fig. 305), and, by the decay of its lower parts, causing a deposit of vegetable muck on the bottom. Eventually the sphagnum may reach entirely across a pond, with growing plants above and a thick, liquid mass of decaying vegetation below. It is then called a *quaking bog* (Fig. 305), because it trembles, or quakes, under the foot. If one sinks into the muck below, escape is impossible. Very perfect remains of extinct animals, and even of men, have been found in the peat bogs of Ireland, the decaying vegetation forming preserving acids which interfere with decay.

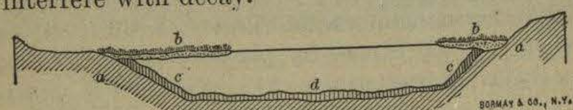

FIG. 305. — To show the growth of sphagnum moss out from the shore, forming a quaking bog. In time the moss from the sides will meet, completely inclosing the pond, and, by its decay, covering the entire bottom with muck.

Swampy or boggy places are common on hillsides where springs appear, encouraging the growth of sphagnum and other swamp plants. Sphagnum holds water like a sponge, and is thus able to grow some distance from the spring; in fact, it may even climb the hillside, making a *climbing bog*. In the damp climate of Ireland, climbing bogs sometimes become so heavy with water that they slide down the hillside, becoming "bursting bogs," by which both life and property have been destroyed.

The Arctic tundra, in winter a frozen, snow-covered desert, in summer becomes a vast swamp, wherever there is soil. The reason for this is that the melting frost makes the ground wet, as it does in all cold climates in spring. Every rain makes the tundra more swampy, partly because the frost prevents the water from soaking into the ground, and partly because it helps the frost to melt. In this swampy land mosquitoes develop in such numbers as to become a great pest.

The overflow of rivers causes swamps in low places on floodplains, especially on the low ground just behind the natural levees. These swamps are unfit for cultivation and are occupied by dense forests of cypress, black gum, and other swamp-loving trees (Fig. 308). Swamps are also found along the lower courses of rivers, where the river water is backed up by the tide and caused to overflow low land (Fig. 121).

Level coastal plains (p. 72) often have so gentle a slope that the water cannot run off; and the drainage is further interfered with by the rank growth of vegetation which the water encourages. Such swamps are found on the coastal plain of Texas and in Florida (Figs. 78, 79), especially in the Everglades region. The famous Dismal Swamp on the coastal plain of Virginia and North Carolina is another illustration (Fig. 307). By clearing off the vegetation, and cutting ditches for the water to run through, parts of Dismal Swamp have been drained.

Naturally there are few swamps in arid lands; but some are found near springs and on the river floodplains. There are also marshy places — *alkali flats* and *salines* (p. 87) — in which only a few species of plants can grow. At times of flood they may become shallow, muddy lakes, called *playas*; but, at other seasons, evaporation changes them to hardened mud, crusted over with alkali and salt. When wet, the deep, sticky mud often makes them quite impassable.

Swamps, or marshes, are also found on the seacoast (pp. 216, 217).

Summary. — *Swamps are caused during the filling of lakes, one form of such swamps being the peat bog, formed by the growth of sphagnum moss. Sphagnum also makes swampy places around springs, and climbing bogs on hillsides. The melting of frost in summer causes the Arctic tundra to be swampy wherever there is soil. Swamps also occur along rivers and on level coastal plains. In arid lands, where evaporation causes a deposit of salt or alkali, there are swampy tracts, called alkali flats and salines.*

122. Effects of Swamps. — The dampness of swamps makes them unhealthful; and malaria, transmitted by mosquitoes which breed in the water, prevails in many swamp regions. In tropical regions, as along the narrow coastal plain of the central African coast, and in Central America, fever is so common that white men suffer even in crossing the level, damp lowland. Because of malaria, parts of Italy have become quite deserted; and some of the river bottoms and rice swamps of the South have been left to the negroes, who suffer little from the unhealthful climate.

Swampy conditions unfit land for most purposes except rice production; but, when drained, the rich, black soil is very productive. For this reason, as well as for the sake of health, swamp lands are being drained, where possible. This has been done much more extensively in Europe than in America, where land is less valuable. The most extensive drainage has been carried on in the Netherlands, where the low, swampy delta of the Rhine, and even part of the shallow sea bottom, have been protected by dikes, and drained by pumping. About one half of the Netherlands is reclaimed land, a large part of it being below sea level.

The salines of arid lands have valuable stores of salt; and the peat bogs of cool temperate climates are important sources of fuel. Coal and wood are so abundant in America that this source of fuel is scarcely touched; but in northern Europe it is a very important fuel, being cut out with spades (Fig. 309) and dried and stored for winter. Coal beds are similar swamp deposits, made ages ago, and covered and preserved beneath thick beds of sediment. The swamp deposits of Florida would, if covered with layers of sediment, slowly change to coal.

Summary. — *Swamps are unhealthful, being a source of malaria; they are of little value unless drained; but the salines supply salt, and the peat bogs fuel. Coal is made of swamp deposits, slowly changed to mineral and preserved beneath beds of sediment.*

Fig. 306. — A lake in the Adirondacks (Fifth Lake, Fulton Chain) in which vegetation is aiding in filling. By this the lake shores have been changed to swamps.

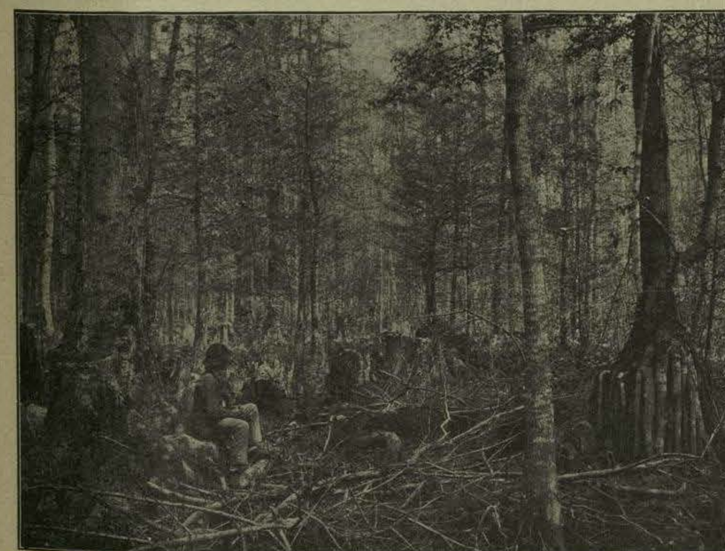

Fig. 307. — A view in the Dismal Swamp. The cypress knees and roots are seen rising to a level above the reach of high water.

FIG. 308. — A river swamp in Mississippi.

FIG. 309. — Digging peat in a bog in Ireland.

TOPICAL OUTLINE, QUESTIONS, AND SUGGESTIONS.

TOPICAL OUTLINE. — 116. **Origin of Lake Basins.** — Definition; impossibility of formation of large basins by rivers; causes for lakes; most important cause; combination of causes; effect of beavers; of man.

117. **Size and Form of Lakes.** — Variation in size; in depth; long lakes; irregular lakes; circular lakes; effect of deltas; effect of waves.

118. **Salt Lakes.** — (*a*) Instances: Caspian Sea; Dead Sea; Great Salt Lake. (*b*) Cause: source of salt; failure to overflow; increasing saltness. (*c*) Former moist periods: shore lines; Lake Bonneville.

119. **Life History of Lakes.** — Exceptional causes for removal; cutting at outlet; slight importance; sources of sediment; places of deposit; effect of vegetation; change to dry land; removal of lake beds.

120. **Importance of Lakes.** — (*a*) Summer resorts: reason; instances. (*b*) Climate: summer influence; winter; spring; autumn; effect on vegetation; illustrations. (*c*) Food fish. (*d*) Freezing: ice; reason why deep lakes do not freeze. (*e*) Navigation: Great Lakes; cities; African lakes. (*f*) Water supply: effect on floods; storage of water; settling of sediment. (*g*) Dried-up salt lakes: salt; gypsum.

121. **Causes of Swamps.** — (*a*) Definition. (*b*) Lake swamps; filled lakes; lake shore swamps. (*c*) Peat bogs: sphagnum; quaking bogs; animal remains. (*d*) Hillside swamps: springs; climbing bogs; bursting bogs. (*e*) Tundra swamps: in winter; in summer. (*f*) River swamps: floodplains; in lower course. (*g*) Coastal plain swamps: cause; illustrations; drainage. (*h*) Arid land swamps: scarcity; alkali flats; salines; playa lakes. (*i*) Seashore swamps.

122. **Effects of Swamps.** — Effect on health; effect on cultivation; drained swamps; Netherlands; supply of salt; of peat; origin of coal.

QUESTIONS. — 116. Why is it not possible for rivers to excavate large basins? State the causes for lake basins.

117. How do lakes vary in size and depth? In form? Why? What effects have deltas? Waves?

118. What is the condition of Caspian Sea? Dead Sea? Great Salt Lake? What causes salt lakes? Describe Lake Bonneville.

119. What happens at the outlet of most lakes? With what materials are lakes filled? What is the last stage in the life history of lakes?

120. Why are lakes favorite summer resorts? How does the lake water influence climate? What effect has this on vegetation? Why do not deep lakes freeze? Give illustrations of the value of lakes in navigation. What effect have lakes on water supply? What important mineral substances are supplied from dried-up salt lakes?

121. What is a swamp? In what ways are swamps associated with lakes? What are peat bogs? Quaking bogs? Climbing bogs? Why are tundras swampy in summer? Where near rivers do swamps occur? Why are swamps common on coastal plains? Give illustrations. What are alkali flats and salines? Playas?

122. What effect have swamps on health? What effect have swamps on agriculture? How may they be made valuable? What fuel is supplied from swamps? What is the origin of coal?

SUGGESTIONS. — (1) Make a valley in clay and pour water into it. It is a stream valley. Place a dam across it and make a miniature lake. What is its shape? Make one or two tributary valleys into which the water rises. What is the shape then? Wash sediment into the lake by sprinkling the sides with a watering pot. Notice the growth of deltas. The lake may even be filled. (2) In a deep jar of water, take the temperature at the top and bottom. Pound up ice and put it into the jar, and when it has all melted, again take the temperature at the top and the bottom. Why has the bottom water this temperature? Continue putting in ice until the temperature at the surface is 36°. What is the temperature at the bottom then? (3) Place a large dish of warm water in a cold room. Does the temperature of the air change as a thermometer is brought near the water? Try the same experiment with a large dish of ice-cold water in a warm room. (4) If your home is near a lake, study it. Can you find out what caused it? Does the outlet stream flow in a deep or shallow valley? Are there any deltas? Where? Any signs of filling by wave action? Are there any swamps? What kinds of plants grow on the shallow lake bottom and shore? (5) Are there any swamps near your home? What is their cause? Is it believed that they are unhealthful? Are any of them partly or wholly drained? How was it done? What effect has the draining had? (6) Make three surfaces of clay: (1) a steep slope, (2) a plain, (3) a plain with vegetation (made by putting pieces of grass in it). Sprinkle with water. Which remains wet longest? Why? Which dries first?

Reference Books. — RUSSELL, *Lakes of North America*, Ginn & Co., Boston, 1895, $1.50; TARR, *Physical Geography of New York State*, Chapter VI, Macmillan Co., N.Y., 1902, $3.50; GILBERT, *Lake Bonneville*, Monograph I, U. S. Geological Survey; *Lake Bonneville*, 2d Annual, U. S. Geological Survey, p. 169; RUSSELL, *Present and Extinct Lakes of Nevada, National Geographical Monographs*, American Book Co., New York, 1895, $2.50; *Lake Lahonton*, 3d Annual, U. S. Geological Survey, p. 195; *Lake Lahonton*, Monograph XI, U. S. Geological Survey; *Mono Lake Region*, 8th Annual, U. S. Geological Survey, p. 267.

CHAPTER X.

THE OCEAN.

123. Importance of the Ocean. — We have already learned (p. 15) that the ocean is in many ways of importance to man. It supplies vapor for rain, and moderates the climate of the lands, it is a source of food and other products that man needs; and it is an important highway of communication between all quarters of the globe.

THE OCEAN BOTTOM.

124. Oceanography.—Oceanography is the study of the ocean, both the surface and the bottom. For carrying on this study there have been numerous exploring expeditions, the most important being that of the British ship *Challenger*, which spent four years in studying the Atlantic, Pacific, Indian, and Southern oceans. Other governments have also sent out ships for this purpose, among them the U. S. Coast Survey steamer *Blake* and the U. S. Fish Commission steamer *Albatross*. One reason for a special study of

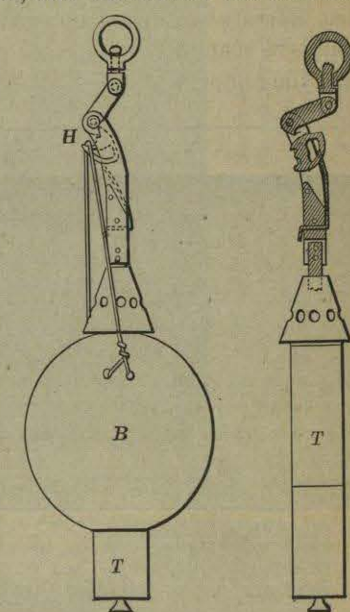

FIG. 310. — Deep-sea sounding apparatus. *B*, cannon ball suspended from hook *H*, which drops when the apparatus strikes the bottom, releasing the ball, as shown in the right-hand figure.