CLIMATE OF BERMUDA—LATITUDE, 32° 17′ N.; LONGITUDE, 64° 47′ W. PERIOD OF OBSERVATION, JANUARY 1, 1893, TO DECEMBER 31, 1896. ELEVATION OF PLACE OF OBSERVATION, 150 FEET. (*Fahrenheit Scale.*)

	Average mean temperature deduced from three daily observations.	Average maximum temperature per period.	Average minimum temperature per period.	Mean monthly range of temperature per period.	Mean relative humidity. Per cent.	Average number of fair days.	Average number of clear days.	Average number of fair and clear days.	Average rainfall. Inches.	Prevailing direction of the wind.	Average velocity of wind in miles per hour.
January	62.5°	67.0°	57.5°	9.5°	76	18	2	20	6.25	N.W.	10.8
February	62.2	66.4	56.9	9.5	78	19	3	22	3.98	N.W.	1.8
March	63.9	67.8	56.8	10.0	80	21	3	24	6.53	N.W.	10.2
April	66.1	69.4	59.2	10.2	79	24	2	26	3.08	S.W.	7.9
May	71.4	76.0	64.0	12.0	83	21	2	23	4.86	S.W.	7.2
June	77.7	80.9	70.0	10.9	82	22	3	25	5.59	S.	6.9
July	79.8	84.5	73.1	10.4	83	25	2	27	5.10	S. and S.W.	6.8
August	81.0	85.6	74.0	11.6	81	32	3	35	4.23	S. and S.W.	5.0
September	78.0	83.2	72.3	10.9	80	23	3	26	7.11	S.	5.9
October	73.7	77.5	69.3	8.2	80	23	2	25	6.07	N.E.	8.7
November	68.6	73.5	65.3	8.2	81	19	1	20	3.89	N.E.	9.1
December	64.8	69.0	60.8	8.2	81	18	1	19	5.84	N.	11.0
Spring	67.1	....	....	....	80	66	7	73	14.47	N. and S.W.	8.4
Summer	79.5	....	....	....	82	69	8	77	14.92	S. and S.W.	6.2
Autumn	73.4	....	....	....	80	65	6	71	17.07	S. and N.E.	7.9
Winter	63.2	....	....	....	78	55	6	61	16.08	N.W. and N.	7.2
Year	70.8	....	....	....	80	255	27	282	62.54	S. and S.W.	8.4

From the above table it will be seen that the mean temperature for the year is 70.8° F.; for the winter 63.2°, and for the spring 67.1° F. The four months of December, January, February, and March have a mean monthly temperature not varying more than one or two degrees for the several months. The average mean yearly range of temperature is 10° F. The relative humidity is high, the annual mean being 80 per cent. The average rainfall for the year is 62.54 inches. The prevailing winds are from the south and southwest, and, from the personal experience of the writer, are frequent and high.

The average number of fair days in the year is 255, being about the same for each month. The average number of fair and clear days is 282,—considerably over two-thirds. The winter and early spring are the seasons of resort to the islands; the summer being extremely debilitating. The characteristics of the climate, then, are equability, a high degree of moisture, a pure atmosphere free from malaria and fogs, and a large number of fair and clear days.

Although, with the exception of the very damp and warm period, comprised chiefly within the two months of August and September, the degree of elevation attained by the thermometer in Bermuda may indicate a moderate summer temperature, and although the combined features of its climate may indeed render the place an agreeable residence for many persons during the warmer portion of the year, nevertheless, in view of its great humidity, the summer climate can hardly be considered desirable for, and is little likely to be sought by, invalids dwelling in the United States. To many such persons, on the other hand, its mildness and its comparative equability may well recommend the climate of these islands for residence during the whole or during a portion of the winter and spring seasons. There is little doubt that to all persons coming to Bermuda from the severely cold and very changeable winter weather of the Northern United States, the weather of the "Isles of Summer" would appear by comparison delightfully warm and very free from sudden changes of temperature; nevertheless, lest too great and too absolute a standard of equability should be expected by such would-be refugees from our own inclement winter weather, it may be well to remind them that the Bermudas are extra- and not intra-tropical islands.

Bermuda is connected by cable with Halifax, Nova Scotia, from which it is some seven hundred miles distant. The time of passage from New York, which is also about seven hundred miles distant from the island, is from forty-eight to sixty hours, and generally, on account of crossing the Gulf Stream, the voyage is rough and disagreeable. The population of Bermuda, in 1896, was 16,000. The vegetation is of a semi-tropical character, and very luxuriant. In the season one sees everywhere the white lily fields perfuming the air with their fragrance. The oleander bush grows also in great profusion, and is used for hedges; the banana, guava, pomegranate, avocado pear, tamarind, arrowroot, and many other semi-tropical fruits are found here. The onion, potato, and lily bulb are the principal products exported. In the private gardens many tropical fruits are also found. The houses are all built from the coral rock, and are likely to be damp. The accommodations are good, especially at Hamilton, the principal town of the island and the place generally selected by the visitor for his residence. Here there are several large hotels and some boarding-houses. Thanks to the presence, during the winter months, of the British North Atlantic fleet in the harbor, and of the garrison on shore, there is no lack of social attractions. The beautiful coral sea gardens, where one sees this curious product in an infinite variety of shapes and colors; the innumerable excursions by sea and by land; the dingey boat sailing; the golf, the bathing, and the fishing; the bicycling and the yachting—all these things afford an abundance of entertainment and outdoor exercise. There is no rainy season, and hardly ever an entirely wet day. The rain quickly soaks through the porous coral soil. The inhabitants spend the greater part of their life in the open air.

In conclusion I would say that Bermuda is not the sort of place to which patients suffering from phthisis should be sent. Nor is to be selected for cases of chlorosis, general anæmia, functional debility, angina pectoris, or palpitation associated with chlorosis. "The class of invalids most benefited by this climate are those in want of mental or bodily rest, or those who should spend most of their time in the open air; cases of mental disease with excitement; the neuralgic, hysterical, hypochondriacal; those addicted to the opium habit, and those who are sufferers from insomnia or from chronic disease of brain or cord" (Harvey: *loc. cit.*). To the overworked professional or business man of our Northern cities, Bermuda is a veritable paradise.

Edward O. Otis.

BETEL LEAF. See *Piper*.

BETEL NUT. See *Areca*.

BETHLEHEM, N. H., is picturesquely situated on the western slope of the White Mountains, in the northern part of the State. It is seventeen miles west of Mount Washington. It has been named the hub of the White Mountains, as almost all places of interest in this region are in close proximity to it. As it is located upon the west of the mountain range the air is very much dryer

than that to be found on the eastern side; for the humidity from the Atlantic Ocean is deposited on the eastern slope, while the filtered air is what we find in Bethlehem. Then, again, there is a scarcity of lakes and waterways of any extent in the vicinity, and for this additional reason, therefore, the climate contains less moisture than that found in regions where these abound. The normal population of Bethlehem is about 1,500 people, but as the place is a favorite summer resort, the number of inhabitants is increased by from 3,000 to 4,000 visitors during those months. There are ample accommodations for all classes of guests, from the modest New England farmhouse to the well-organized hotel.

Bethlehem is 1,459 feet above the sea level. The prevailing wind is southwest, and there are an unusually large number of clear days, the average for both July and August being 23; and out of 21 days in September, 17 were clear. Even during the days that are called cloudy, one can sit out-of-doors most of the time. The mean temperature for the season of July, August, and September is 62.3° F. The relative humidity, taken from the tables of Dr. W. H. Geddings, is 61 per cent. for the season.

CLIMATE OF BETHLEHEM, N. H.—LATITUDE, 44° 16′; LONGITUDE, 71° 41′. PERIOD OF OBSERVATION, JULY, AUGUST, AND FIRST THREE WEEKS OF SEPTEMBER, 1892, 1893, 1894, 1895, 1896, 1897, AND 1899; ALTITUDE, 1,459 FEET. OBSERVATIONS TAKEN BY C. F. MCGAHAN, M.D. (*Fahrenheit Scale.*)

Month.	Mean temperature from 7 A.M., 2 and 9 P.M. observations.	Mean daily variation in temperature.	Mean temperature from maximum and minimum.	Mean maximum temperature.	Mean minimum temperature.	Absolute maximum temperature. Highest.	Absolute maximum temperature. Lowest.	Absolute minimum temperature. Highest.	Absolute minimum temperature. Lowest.	Relative humidity.* Per cent.	Wind.	Average number of clear days.	Average number of rainy days.	Average number of cloudy days.
July	65.0°	10°	67.7°	79.3°	36.2°	88°	68°	62°	50°	63	S.W.	23	5	3
August	62.5	11	62.9	75.3	50.5	86	69	59	39	60	S.W.	23	4	4
September	59.3	14	61.8	75.4	48.3	83	64	61	36	60	S.W.	17	3	1
Mean	62.3	....	64.1											

* Relative humidity is taken from the observations of the late Dr. W. H. Geddings.

It is here that the Hay Fever Association of the United States holds its annual meeting, and its members state that more of them are exempted from this disease at Bethlehem than at any other place. Even those who do not entirely escape the coryza in Bethlehem are exempt from the asthma; but most of the hay-fever sufferers pass through the summer here without realizing that they had ever been victims of the disease.

For the amusement of the visitors there are two golf links of nine holes each—one at Bethlehem and one at Maplewood Hotel, only a mile from the centre of the village. There is also a fine casino where provision is made for all indoor amusements.

The water supply is derived from a system of mountain springs which are located upon the mountain above the habitations. The water has been analyzed and found to be absolutely pure. The system of sewerage is thoroughly modern.

Charles F. McGahan.

BETOL.—The beta-naphthol ether of salicylic acid, analogous to salol, which is the phenyl ether of salicylic acid. It is obtained by the reaction between beta-naphthol and salicylic acid in the presence of a dehydrating agent. It forms in small, white, brilliant crystals, almost devoid of taste and odor. It is insoluble in water, but dissolves in alcohol and oils. Betol possesses antiseptic and antipyretic properties. It is not acted on in the stomach, but when it reaches the alkaline fluids of the intestines it breaks up into beta-naphthol and salicylic acid. It is recommended as a substitute for salol in rheumatic affections, cystitis, intestinal catarrh, etc. It has the advantage over salol of being composed of less toxic constituents. The dose is from five to eight grains. In combination with salicylate of bismuth it is particularly recommended in the treatment of the summer diarrhœa of children and in typhoid fever. *Beaumont Small.*

BETONY WOOD.—*Stachys Betonica* Benth. (fam. *Labiatæ*) is a perennial herb, 30 to 60 cm. (one or two feet) high, with purple-red flowers, and long-stemmed, mostly radical leaves. These are from 5 to 8 cm. (two to three inches) in length, oblong crenate, heart-shaped at the base, and hairy. The plant is a native of Europe, growing in pastures and woods. The leaves, when fresh, have a faint, disagreeable odor—which mostly disappears upon drying—and a bitter astringent and nauseous taste.

Betony in former times had a high reputation for a variety of troubles; at present it is not in use. Dose of the dried leaves as a "nervine, expectorant, sudorific," etc., is from 1 to 3 gm. (gr. xv. to xlv.). The root is said to be emetic. *W. P. Bolles.*

BEX.—A popular thermal and climatic station in the Canton of Vaud, Switzerland. Famous "*salines.*"

LOCATION.—Bex is beautifully situated in an expansion of the Rhône valley, and is at no great distance from Vevey, on the lake of Geneva. It is 1,427 feet above sea level. The little village is well known in Europe, but only very slightly in America. The writer, having spent several seasons at this resort, knows that it deserves greater recognition than has been hitherto accorded to it in our country. The "salines" themselves are of no

FIG. 479.—View of Bex, Looking toward the Dent du Midi.

mean importance, and the principal bathing establishment is a modern and commodious one. As for milk, whey, and grape cures, there are few places where these

can be more advantageously taken than at Bex. Invalids have also rare opportunities there for beautiful walks through a charming country, and, for the more hardy, distant mountain excursions offer strengthening recreation.

Access.—Bex is a station on the railroad running through the valley of the Rhône. The village and

Fig. 480.—The Valley of the Rhône, Near Bex.

Grand Hotel des Salines are reached by carriage or stage in fifteen minutes. From Paris the route is viâ Geneva.

Analysis.—The brine is conducted to the bathing establishment from the distant salt mines. Ten litres of the brine contain (Bischoff) 1,703 gm. of solids.

The principal ingredients, in ten thousand parts, are:

	Parts.
Chloride of sodium	1,567.0
Chloride of potassium	26.5
Chloride of magnesium	10.8
Sulphate of lime	67.6

Ten to twenty quarts of this brine are used for a bath.

The diluted brine is also employed internally, after having been charged with carbonic acid gas. It contains, in addition to the salts mentioned above, a small proportion of iodides and bromides.

Indications.—Apart from its advantages as a climatic resort, specially emphasized by the late Professor Lebert, Bex is now recognized to be an important bathing station. The climate is about that of Montreux, although, in spite of its mountain-protected position, harsh blasts occasionally sweep through the valley. The annual mean of the temperature is about 50° F.

The following class of cases do well at Bex: The so-called scrofulous affections, rheumatism in its subacute forms, catarrhal affections of the air passages, paretic and paralytic states after diphtheria and other infectious diseases, asthma, neurasthenia of the milder type, and the earlier stages of phthisis. Certain uterine affections, such as metritis, subinvolution, etc., are also benefited by a mild course of the baths. All patients in whom even moderate stimulation of the nervous system is liable to do harm should be warned against using the Bex treatment. The thermal establishment is thoroughly equipped with inhalation cabinets, sprays, douches, and the usual outfit for hydrotherapy. The quality of the grapes used for the cure is excellent.

Accommodation.—The *Grand Hotel des Salines* is an excellent establishment of its kind, situated at some distance from and about one hundred and fifty feet above the village proper. In the latter very reasonable and fairly good board is obtainable. The *Pension du Crochet* is a popular family hotel on a small scale. *Edmund C. Wendt.*

BIARRITZ.—A sea-coast town in the extreme south-western portion of France, in the Department of the Basses Pyrenees, lying upon the shore of the Bay of Biscay, some five miles distant from Bayonne (Lat. 43° 27′ N., Long. 1° 37′ W.). At the present day Biarritz is well known as a fashionable seaside resort, possessing an excellent beach with a good surf, and having abundant and comfortable hotel accommodations and agreeable climate. It is much resorted to by visitors from all parts of France and from other countries during the bathing season, which not only comprises the summer months, but also extends much later into the autumn than is the case with similar seaside stations lying farther to the north. Although, as we are told by Dr. Bennet ("Winter and Spring on the Shores of the Mediterranean," fifth edition, 1875, p. 606), the town of Biarritz "has long been resorted to by the inhabitants of Bayonne and of the Pyrenean district, in summer, for its excellent sea-bathing," yet, as this author goes on to say, "it was all but unknown to fame until the Empress Eugénie brought it into notice by making it her marine autumnal residence." As an evidence of its present popularity we read in the "Encyclopædia Britannica" that "the permanent population of Biarritz, according to the census of 1871, was 3,164"; while, on the other hand, "the autumn visitors are estimated at from 12,000 to 15,000." The coast at Biarritz is decidedly rocky and very picturesque, being in this respect as different as possible from the low-lying and purely sandy shores of the Department of the Landes, which border the Bay of Biscay farther to the north. To the vast extent of sand-covered country constituting the greater portion of this Department (Landes), and comprising in all an area of some 3,700 square miles (Bennet, *op. cit.*), the climate of Biarritz is doubtless indebted for at least a part of that dryness and of that mildness in winter for which it is celebrated. The summer heat at Biarritz is tempered by the prevailing westerly winds, which blow from the Atlantic. The situation of the town, directly upon the shore of the ocean, is also another element in insuring to it a mild and a comparatively equable temperature during the winter months. Its climate at this season is very similar to that of Arcachon, which has already been described in preceding pages of this Handbook (see *Arcachon*).

The reputation of Biarritz as a winter resort is of still more recent date than is its great popularity as a summer bathing station, and doubtless depends in a measure upon the latter. As explained by Dr. Bennet, the very extensive preparations for the entertainment of summer and autumn guests have a tendency to cheapen considerably the cost of living in Biarritz during the colder months which follow; and this cheapness of living is offered by the doctor as an inducement, and in many cases a most important inducement, to attract thither a class of invalids requiring a place of residence for the winter season, which offers the advantage of a mild and equable climate unaccompanied by the high, and too often exorbitant, cost of living which frequently prevails at such sanitaria. "It is impossible," says this author, "that a town situated on the boisterous Bay of Biscay can be equal in point of climate to the Riviera undercliff, or to the east coast of Spain, in cases of severe disease in which the best climate that can be found is required. But still there must be many cases in which the sunshine and mild temperature of the south-western coast of France may be sufficient. Moreover, the question of expense is often, unfortunately, a paramount consideration." Another class of persons to whom Dr. Bennet proposes a sojourn at Biarritz (and in this instance a sojourn not during the winter, but during the bathing season) are such residents in the British Isles as have for various reasons been unable to resort to the seaside stations of their own country during the months of July and August. "Those who cannot resort to our own coasts in July and August, and to whom a mild or warm temperature is essential, have thus the opportunity of still enjoying at Biarritz summer sea-bathing at a time when with us both the sea water and the external atmosphere are becoming chilly." (The time referred to by the doctor in the above-quoted passage is the autumn season, the two months of September and October, of which he had just been speaking.)

Full and detailed statistics for the climate of Biarritz the writer is unable to present. The following statements, both general and particular, respecting the climatic features of the place have been culled from the pages of various authors, and are herewith presented to the reader.

The mean winter temperature at Biarritz is given by Weber (Ziemssen's "Handbuch der Allgemeinen Therapie") as 6° to 8° C. (= 42.8° to 46.4° F.). The "Dictionnaire usuel des sciences médicales" gives the figures of the three months of January, February, and March for a single year (1868) as follows: January, 40.26° F.; February, 40.91° F.; March, 44.62° F. The mean of these would be, of course, 41.93° F., a decidedly lower figure than that just given on Weber's authority, and indicating for the winter of 1868 a temperature probably below the normal, especially if we take into account that this figure (41.93° F.) is the mean for January, February, and March, and not for the three months of winter, viz., January, February, and December. The average spring temperature is placed by Weber at from 11° to 12° C. (= 51.8° to 53.6° F.); that of the summer season at about 64.4° F. Dr. Bennet refers to observations of the temperature made at Biarritz by the Rev. Mr. Crow during the winter of 1862. The average of this gentleman's observations "made at 8 A.M. on a north wall" during January of that year was about 45° F.; the highest temperature being 62° F., the lowest 30° F. "In February there was some very cold weather. During seven days the highest temperature was 34° F. (at 8 A.M.), the lowest 24° F. With the exception of that week, the weather was glorious, the thermometer after January varying from 48° to 62° F." (Bennet, *op. cit.*, p. 612). Lombard speaks of the climate of Biarritz as being a moist one, and Weber gives its relative humidity as about 80.0 per cent. This is no more than we should naturally expect in a place lying so directly upon the shore of the ocean, and so exposed to sea winds. "Biarritz," says Dr. J. Burney Yeo, "lies exposed to all the fury of the Atlantic winds, and has no protection like the pine forest of Arcachon" ("Health Resorts and Their Uses," London, 1882, p. 262). "The wind, when it blows from the southwest or northwest, is often furious" (Bennet, *op. cit.*). The annual rainfall is given by Weber as 49.21 inches. Concerning the rainfall during the winter season, we read in Dr. Bennet's book that "Dr. Chapman, an English physician, who long practised at Biarritz, states that the average rainfall during three years for the seven winter months, from the beginning of October to the end of April, was 25.81 inches on seventy-six days."

The sky at Biarritz is usually clear ("Dict. us. des sc. méd.").

Concerning the class of invalids likely to be benefited by a stay at Biarritz during the winter months, it may be said that in the main they would be such cases as would be improved, or it may be even cured, by residence at the not far distant resort of Arcachon, to which reference has already been made in this article. But it must be borne in mind that Arcachon, lying as it does some miles back from the Atlantic coast, surrounded by extensive sand dunes, and sheltered in some measure from the severity of sea winds by pine forests, is necessarily a somewhat dryer and a more protected spot than is Biarritz. Dr. J. Burney Yeo declares (*op. cit.*, p. 262) that the winter climate of Biarritz is "more bracing and less mild" than is that of Arcachon, and "is by no means so well suited to cases of chest disease." It is, however, he adds, "well suited to some forms of nervous exhaustion and irritability." Dr. Bennet speaks pretty much to the same effect concerning the climato-therapy of Biarritz. He considers the place far less suited to consumptive invalids than the dryer, milder, and more sheltered resorts lying along the Genoese Riviera and upon the Mediterranean coast of Spain, but regards it as probably quite as well, or even better adapted for such cases than are the famous resorts of the Isle of Wight and of other parts of the English south coast.

In conclusion, it may be remarked that over and above its excellent hotel accommodations, the neighborhood of Biarritz abounds in comfortable and attractive villas, often surrounded by gardens, and situated at various points close to, or even directly upon, its picturesquely rocky shores. *Huntington Richards.*

BIBIRU BARK.—*Greenheart Bark, Nectandræ Cortex.* The bark of *Nectandra Rodiæi* Schomb. (fam. *Lauraceæ*). This is a fine forest tree, with a tall, straight stem, attaining a height of twenty-five or thirty metres (seventy-five to ninety feet). It has thick, evergreen, coriaceous, oval leaves, and small axillary clusters of white flowers. The fruit is large, one-seeded.

The greenheart tree is a native of British Guiana, where it is highly prized as a source of the best ship timber. It was proposed as a febrifuge, and its alkaloid pointed out by Dr. Rodie, of Demerara, about fifty years ago.

The bark is imported in large, long, heavy, flat pieces, from 0.5 to 1 cm. in thickness (one-fifth to two-fifths inch). It is hard and brittle, breaking with a coarse, fibrous fracture; it is grayish brown externally, cinnamon brown and striated upon its inner surface. Its cells are seen under the microscope to be thickened, those of the liber curiously dentated. It has a strong bitter taste, *without aroma*—an unusual thing for any member of its family.

The bitterness of this substance is due principally to the alkaloid *buxine* (bibirine, bebeerine—not berberine), which it contains to the extent of one-half or one per cent. It also contains *nectandrine* and one or two other alkaloids, and tannin. The wood, which is also bitter, contains a base similar to that in the bark. The seeds are sometimes made use of as a source of starch. The impure buxine of nectandra is an article of commerce, and generally known as bebeerine. It is a gray or brownish, amorphous, bitter substance, permanent in the air, and very insoluble in water ($\frac{1}{10000}$). One or two of its salts, especially the sulphate and hydrochlorate, are also to be had, and should be preferred for administration on account of their free solubility.

The bark, and especially the alkaloid and its salts, has been offered, and to some extent employed as a febrifuge and antiperiodic; that is, as a substitute for quinine, but in reasonable doses they fall far short of that medicine for the purpose. They are, however, good simple bitter tonics (the bark is astringent as well). Doses: a useful dose of the bark would be large and disagreeable. Buxine or its salts may be given, as a tonic, in pills or solution, up to 2 to 4 dcgm. (0.2 to 0.4 = gr. iij. ad vi.); as a febrifuge, up to 1 or 2 gm. (gr. xv. ad xxx.). *W. P. Bolles.*

BIG BONE SPRINGS.—Boone County, Kentucky.

Access.—Viâ Louisville and Nashville Railroad to Walton; thence seven miles by stage to springs, or by steamer on the Ohio River to Hamilton Landing, thence one mile and a half to springs.

These springs are of the saline-sulphureted variety. No quantitative analysis has been made. It is stated, however, that the waters contain the following ingredients:

Sodium chloride.	Calcium bicarbonate.
Magnesium sulphate.	Magnesium bicarbonate.
Sodium sulphate.	Sodium carbonate.
Aluminum sulphate.	

There is also a large quantity of sulphureted hydrogen gas. *James K. Crook.*

BILE.—*Methods of Obtaining.*—Bile may be obtained for examination either from the gall bladders of men or animals after death, or from biliary fistulæ.

The principal methods of establishing fistulæ in animals for experimental purposes are briefly as follows:

Permanent Fistulæ.—An incision is made over the gall bladder. Through this the common bile duct is tied in two places and a portion excised between the ligatures. The gall bladder is then sewed to the sides of the abdominal wound and opened.

Amphibolic Fistulæ.—The gall bladder is brought to the surface and opened as in the preceding method, but the bile duct is left intact. This method has an advantage over the other inasmuch as the external opening may be plugged and the bile allowed to follow its usual channels into the duodenum, or it may be left open, when the bile will flow externally, and, if not allowed to discharge for too long a time, will be more normal in character.

Temporary Fistulæ.—The common bile duct is exposed and opened, a glass cannula is tied in, and the bile is drawn off through a rubber tube attached.

Quantity of Bile Secreted.—The amount obtained through fistulæ is very variable in different animals, both absolutely and in proportion to the body weight. The rate of flow varies much in the same animal from hour to hour. In human subjects with biliary fistulæ the daily discharge has usually been between 400 and 900 c.c., and the total amount of solids between 5 and 20 gm.

Physical Properties.—Human bile as obtained from the gall bladder is usually of a yellowish or reddish-brown color, but when obtained fresh from a fistula is frequently green. Its reaction is faintly alkaline. The specific gravity varies from 1.005 to 1.010 or over in fistula bile, but is much higher in bile taken from the gall bladder after death, frequently reaching 1.030, or even 1.040. It has a bitter taste with a suggestion of sweet. Human bile has little or no smell; that of the ox and sheep has a faint musk-like odor. As secreted by the liver cells bile is non-viscous; but, during its stay in the ducts and gall bladder, it has added to it the secretions of their mucous membranes, containing mucin (human), or nucleo-albumin (ox), and it acquires a certain viscidity. On spectroscopic examination it may be seen to absorb the violet and some of the blue rays, but shows no definite absorption bands unless post-mortem changes have occurred.

Chemical Composition.—The principal constituents of bile are as follows; water, bile salts, bile pigments, mucin, fats and soaps, cholesterin, lecithin, urea (traces), and inorganic salts. Among the salts the most important are the chlorides of sodium and potassium and the phosphates of calcium, magnesium, and iron. The quantities of these constituents vary considerably, but the analyses contained in the following table may be taken as fair examples of a great number which have been published:

In 1,000 parts of bile.	Human gall-bladder bile. Frerichs. Man of 22 killed by violence.	Human fistula bile. Hammersten. One of three published in Hammersten's "Physiological Chemistry."
Water	859.2	974.6
Solids	140.8	25.4
Bile salts	91.4	9.04
Glycocholate	.....	6.86
Taurocholate	.....	2.18
Mucin and pigments	29.8	5.15
Fat	9.2	.61
Fatty acids from soaps	.....	1.01
Cholesterin	2.6	1.5
Lecithin	.....	.65
Inorganic substances	7.7	7.46

The *bile salts* are the most abundant of the solid constituents and give to the bile its most important properties. The commonest bile salts, and those which have been most studied, are *sodium glycocholate* ($C_{26}H_{42}NaNO_6$), and *sodium taurocholate* ($C_{26}H_{44}NaNSO_7$), the former being most abundant in herbivorous animals and man, and the latter in carnivorous animals. The bile salts are soluble in water and alcohol, but insoluble in ether. If bile be mixed with freshly heated animal charcoal and evaporated to dryness, the bile salts may be dissolved out with absolute alcohol along with several other biliary constituents. If an excess of ether be now added, the bile salts alone are precipitated, forming "*Plattner's crystallized bile.*" Under the microscope this may be seen to consist of bell-shaped masses, star-like clusters of fine needles, or four to six sided prisms. Both the bile salts and their acids are dextro-rotatory to polarized light.

Sodium glycocholate	$(\alpha)\ D = +25.7°$
Glycocholic acid	$(\alpha)\ D = +29.0°$
Sodium taurocholate	$(\alpha)\ D = +24.5°$
Taurocholic acid	$(\alpha)\ D = +25.0°$

In the intestines, the respective acids are set free from the bile salts and then further broken up into a complex non-nitrogenous acid, cholalic acid, and either glycocoll or taurine.

Glycocoll, glycocine, glycine, or amido-acetic acid ($NH_2CH_2.COOH$) is one of the products of the splitting up of sodium glycocholate. It is found free in the intestines in small quantities, and may combine in the body with benzoic acid to form hippuric acid, in which form some of it may leave the body by the urine, especially in the case of herbivorous animals. Glycocoll may be formed from the decomposition of proteids, and is in some cases a precursor of urea. It is probable, however, that glycocoll, taurine, and cholalic acid, when set free in the intestine from the decomposition of the bile salts, are reabsorbed, and combined once more in the liver to form a new supply of bile salts. This cycle of events is known as the "*circulation of the bile salts.*"

Taurine, amido-isethionic acid, or amido-oxyethylsulphonic acid ($NH_2.C_2H_4.SO_2.OH$), is obtained from sodium taurocholate. It differs from glycocoll in containing sulphur. Like glycocoll it is found free in the intestines in small quantities.

Cholalic, or *cholic acid*, ($C_{24}H_{40}O_5$), is set free, as stated above, when either sodium glycocholate or sodium taurocholate is split up, and it is found in the intestinal contents. Certain closely allied acids may replace it in the bile salts, among which the most important are *choleic acid* ($C_{24}H_{40}O_4$) and *fellic acid* ($C_{22}H_{40}O_4$), both of which have been obtained from human bile.

On the presence of cholalic acid depends Pettenkofer's well-known test for bile salts and bile acids.

Pettenkofer's test for bile acids is performed as follows: A small quantity of the solution to be tested, freed from proteids, is placed in a test tube, and two or three drops of a ten-per-cent. solution of cane sugar are added, and the whole shaken. Strong pure sulphuric acid is then added drop by drop, care being taken that the temperature of the mixture does not rise above 70° C. If bile acids are present the fluid first becomes opalescent, then the opalescence clears, and the liquid becomes successively of a pale cherry red, a dark carmine red, and finally a beautiful purple violet tint. The reaction sometimes takes a little time to develop, and it is wise to wait several minutes before drawing a negative conclusion. To make the test perfectly reliable, the colored solution obtained must be examined by the spectroscope, when two absorption bands will be found, one at F, and the other between D and E, near E. This is rendered necessary by the fact that a number of other substances, among which are proteids, oleic acid, amyl alcohol, morphine, and numerous aromatic substances, give a similar color reaction, but may be distinguished by causing different absorption bands.

The Bile Pigments.—The pigments constantly found in human bile are bilirubin and biliverdin.

Bilirubin ($C_{16}H_{18}N_2O_3$) has also been called cholepyrrhin, bilipheein, bilifulvin, and hæmatoidin. It occurs in the biles of all vertebrates, but is most abundant in those of carnivora and man, giving them their yellowish or reddish-brown color. It may be obtained as an amorphous powder, and also as reddish-yellow rhombic plates. It is readily soluble in chloroform, less so in alcohol, and still less so in ether. It is insoluble in water, and exists in bile as a soluble calcium compound, known as bilirubin-calcium. It forms a considerable part of some gall stones, and is present in the blood serum of certain animals (horse), in old blood extravasations, and in the tissues and urine of cases of jaundice. It is derived from the hæmoglobin of broken-down red corpuscles, and is the probable source of the stercobilin of the fæces and of the urobilin of the urine, which are believed now by some to be identical with each other. Under the influence of oxidizing agents bilirubin is converted into biliverdin.

Biliverdin ($C_{16}H_{18}N_2O_4$) is present in all green-colored biles, among which are to be included those of the herbivora and some examples of human. When obtained pure, it usually consists of a dark green amorphous powder, but occasionally crystallizes in green rhombic plates. It is insoluble in water, ether, and chloroform, but soluble in alcohol, glacial acetic acid, and strong sulphuric acid. It is converted by reducing agents into bilirubin, and this change often occurs in the human gall bladder, which explains the fact that bile obtained from that source after death is nearly always of a reddish-brown color, while fresh fistula bile is frequently green.

Hydrobilirubin ($C_{32}H_{44}N_4O_7$), a reduction product of bilirubin, may be formed from it in the laboratory, and is regarded by some as supplying a link between the pigments of bile and those of the fæces and urine.

Tests for Bile Pigments.—Gmellin's test. Spread out a few drops of the suspected liquid on a white plate. Let a drop of fuming nitric acid (containing nitrous acid) fall in the centre. If bile pigments be present a ring of colors, green, blue, violet red, and yellow, will appear. This is due to the oxidation of the pigments, by which bilirubin is changed successively into biliverdin (green), bilicyanin (blue), bilipurpurin (violet red), and choletelin (yellow). The blue pigment bilicyanin, in acid solution, gives a spectrum with two absorption bands, one on either side of the D line, which fuse into one if the solution be very strong. The yellow choletelin gives a single band between b and F, nearer to F.

Huppert's Test for bilirubin. Add to the suspected liquid milk of lime till a precipitate (bilirubin-calcium) is thrown down. After washing this precipitate in water, place it in a test tube, and half fill the test tube with alcohol acidified with hydrochloric or sulphuric acid. Boil for some time, and if the original liquid contained bilirubin, an emerald green or bluish-green color will develop.

Mucin.—As already mentioned, the mucin present in human bile is largely derived from the secretions of the bile ducts and gall bladder. In many animals it is replaced by nucleo-albumin. These substances resemble each other in their viscidity, and are both readily precipitated from bile by acetic acid, but differ in the products of their decomposition. Mucin splits up into a proteid and a carbohydrate; nucleo-albumin, on the contrary, into a proteid and a complex nitrogenous substance, rich in phosphorus, known as nucleic acid.

Fats.—These consist principally of palmitin, stearin, and olein, with the corresponding soaps.

Cholesterin is a complex monatomic alcohol. Its chemical formula is not yet absolutely agreed upon, but is probably $C_{27}H_{45}OH$ (Obermüller). It is present in nearly all animal tissues, especially those of the central nervous system. It is insoluble in water, but freely soluble in ether, chloroform, and hot alcohol. It crystallizes out from alcoholic solutions in colorless transparent plates. From anhydrous ether or chloroform it separates in the form of needles.

Lecithin ($C_{42}H_{84}NPO_9$) is found along with cholesterin in nearly all animal tissues. It yields on decomposition glycerin, a fatty acid, phosphoric acid, and an alkaloid known as cholin.

Action of Bile.—Bile is partly an excretion, and partly a secretion playing a part in digestion and absorption. Its digestive properties depend almost entirely on the presence of the bile salts. In some animals traces of diastatic ferment have been found, but never in sufficient amount to play any important part in digestion. The principal action of bile is on the fats, and depends on the fact that solutions of the bile salts have the power of dissolving free fatty acids. Now the present tendency is to the view that fats are absorbed as fatty acids and soaps, in solution, rather than in the form of emulsion. If this be so, the part played by the bile is very important. After the neutral fats are split up by the pancreatic juice into glycerin and fatty acids, the latter are dissolved by the bile and partly converted into soap by its alkaline salts. Moreover, bile is able to dissolve the soaps of the alkaline earths (calcium) which would otherwise be insoluble. There is an old view, that the bile also exerts a favorable influence on the absorptive functions of the intestinal wall; but, as this has been noted especially in the case of fats, there is little doubt that it depends simply on its power of dissolving them.

The function ascribed to it of preventing putrefaction in the intestine is, no doubt, also to be explained by its aiding fat digestion so that the fatty food is absorbed before it has had time to undergo putrefactive change. Then it must be remembered that the absorption of the fatty portions of the food will expose the other constituents better to the action of the pancreatic juice, so that all the digestive processes will proceed more rapidly.

Lastly, there is satisfactory experimental proof that the several ferments of the pancreatic juice are most active in the presence of bile, although just how it favors their action is not fully explained.

Biliary concretions or gall stones may be divided into two principal types:

1. Dark-colored, hard, non-inflammable stones, consisting principally of calcium compounds of the bile pigments (especially bilirubin-calcium) and calcium carbonate.

2. Lighter-colored soft stones, which will melt and burn in a flame, and consist very largely of cholesterin.

Other constituents often found in gall stones are: bile acids, free bilirubin, phosphates of lime and magnesium, sulphate of lime, sodium, potassium, copper, manganese, silicic acid, mucin, and epithelium. Most gall stones are intermediate in composition and properties between the two extreme types given above, and vary in color from nearly white, through golden or greenish yellow, to reddish brown and black. Many stones vary in color and composition in different layers.

Among possible causes which have been suggested for gall stones the following may be mentioned:

1. Excess of lime and deficiency of sodium salts in the bile, leading to precipitation of the pigments.

2. Presence of chronic catarrh, leading to excessive secretion of mucin.

3. Excess of cholesterin in the blood as a result of excessive brain work, old age, or other causes.

4. Concentration of the bile from stagnation.

5. Naunyn's theory, which now receives much support, combines several of the above, and may be briefly stated thus:

Gall stones are the result of a pathological alteration in the mucous membrane of the gall bladder, usually excited by the presence of microbes, and leading to an increased excretion of lime and cholesterin.

T. Wesley Mills.
William S. Morrow.

BILE PASSAGES. See *Gall Bladder* and *Liver*.

BILHARZIA HÆMATOBIA. See *Trematoda*.

BILIRUBIN. See *Coloring Matters, Animal*.

BIOLOGY.—(βίος, life, and λογος, a discourse.)

DEFINITION.—"The subjects of our inquiry will be the various forms and phenomena of life, the conditions and laws under which this state occurs, and the causes through which it is brought about. The science that occupies itself with these subjects we will designate by the name *biology*, or the science of life." This, in translation, is