Point Comfort, while the entire sea-going commerce of Chesapeake Bay passes it at no great distance on its way to and from the ports of Baltimore, Annapolis, and Alexandria."

Old Point Comfort is a government reservation, and here is situated the famous fortification of Fort Monroe, the largest of its kind in America, commanding the entrance to Hampton Roads and the approach to the navy yard at Norfolk. The very extensive marine view, the attractions of a large military garrison, combined with a mild climate a considerable portion of the year, render this resort one of the most popular ones in the country. Moreover, it is very easily and comfortably reached from the North, and affords excellent accommodations, though expensive.

The accompanying climatic table based upon observations taken at Norfolk, will serve also to illustrate the climate of Old Point and Newport News, for the three places are so near one another that there can be but little difference in their climatic elements.

stable climatic conditions of a Northern spring during these months. One will find at this resort a large amount of sunshine, a comparatively mild temperature, no great amount of rain, and less wind than at Atlantic City. When one considers the ready accessibility of "Old Point" from the North, and its favorable climatic features, its value as a health resort must be regarded as very considerable. The sources of amusement and diversion are also many, and greatly enhance the value of the resort. They are the ever-shifting panorama of the ocean with the constant passing of various craft; the fascination of the military life, such a predominant feature here; the frequent visits of warships; the Normal and Agricultural Institute for colored people and Indians at Hampton, two and a quarter miles distant; and the National Soldiers' Home at the same place; the various shorter or longer excursions by water to Norfolk, Richmond, Virginia Beach, the York River, etc. The Hampton Golf Club and the Country Club are accessible to the guests of the hotels, and are said to be kept in excellent shape. The links overlook the sea, and at the attractive club house there is a tea room and café, and music on Saturday afternoons. There are also sailing, driving, and bathing in the season. Attention should also be called to the great advantage of the beach as a playground for children. Such a climate and such a resort are especially to be recommended for those who with difficulty endure the rigors of a Northern winter, and at the approach of spring find themselves in a depressed condition, physically and mentally, without being seriously ill. It is also to be recommended for convalescents from various acute diseases, for those who are recovering from the effects of an operation, and for scrofulous children. For the aged, the feeble, the neurasthenic, and for weakly children it offers, for a portion of the year at least, a mild and pleasant asylum. It is said to be immune from malaria. It can hardly be recommended for those suffering from any serious disease of the respiratory organs or from renal disease.

CLIMATE OF NORFOLK, VA., LATITUDE, 36° 51′; LONGITUDE, 76° 17′. PERIOD OF OBSERVATION, THIRTEEN YEARS.

	Jan.	Feb.	March.	April.	May.	July.	Oct.	Nov.	Dec.	Spring.	Summer.	Autumn.	Winter.	Year.
Temperature (degrees Fahrenheit)—														
Average or normal	40.8°	42.9°	48.0°	56.3°	67.1	79.6°	61.0°	49.6°	42.2°	57.1°	77.4°	60.4°	41.8°	59.2°
Average daily range	14.8	16.1	16.9	17.5	17.8	18.1	14.5	14.9	14.2	17.4	17.2	14.4	15.0	16.0
Mean of warmest	47.5	53.2	57.7	64.0	75.9	89.0	70.9	58.7	50.9					
Mean of coldest	32.7	37.1	40.8	47.5	58.1	70.9	56.4	43.8	36.7					
Highest or maximum	80.0	81.0	81.0	92.0	98.0	102.5	89.0	80.0	73.0					
Lowest or minimum	8.0	9.0	16.0	27.0	38.0	60.0	31.0	20.0	6.0					
Humidity—														
Average mean relative	75.5%	70.6%	66.4%	68.2%	68.8%	70.3%	74.7%	72.7%	71.8%	67.8%	71.8%	74.8%	72.6%	71.8%
Precipitation—														
Average in inches	3.89	3.85	4.35	4.29	3.54	5.39	3.96	3.58	3.80	12.18	15.65	12.77	11.54	52.14
Wind—														
Prevailing direction	N.	N. E.	N.	S. W.	S. W.	S. W.	N. E.	N.	S. W.	S. W.	S. W.	N. E.	N.	S. W.
Average hourly velocity in miles	7.5	8.7	9.5	8.9	8.0	6.7	7.2	7.7	7.5	8.8	6.8	7.2	7.9	7.7
Weather—														
Average number clear days	8.8	8.6	10.0	9.5	11.0	8.5	13.7	11.2	10.1	30.5	27.1	35.5	27.5	120.6
Average number fair days	11.2	10.9	10.8	10.5	12.3	14.5	9.6	9.8	11.8	33.6	40.9	29.8	33.9	138.2
Average number clear and fair days	20.0	19.5	20.8	20.0	23.3	23.0	23.3	21.0	21.9	64.1	68.0	65.3	61.4	258.8

TEMPERATURE AND RAINFALL AT FORT MONROE, VA. LATITUDE, 37° N.; LONG., 76° 19′ W.

	Feb.	March.	April.	July.	Oct.	Dec.	Spring.	Summer.	Autumn.	Winter.	Year.
Mean temperature (degrees Fahrenheit)	41.81°	49.90°	55.99°	78.73°	61.90°	41.10°	57.34°	77.07°	61.92°	41.77°	59.52°
Maximum temperature	72.00	78.00	91.00	102.00	89.00	69.00					
Minimum temperature	4.00	13.00	31.00	61.00	30.00	17.00					
Mean precipitation in inches	2.72	3.30	2.98	5.34	2.92	4.58	10.17	15.32	10.18	10.67	47.04

A comparison is also given of the temperatures of Norfolk, New York, and Boston for the months of February, March, and April, the season at which "Old Point" is especially resorted to by visitors from the North.

Temperature (degrees Fahrenheit.)	February.			March.			April.			Season.		
	Norfolk.	New York.	Boston.	Norfolk.	New York.	Boston.	Norfolk.	New York.	Boston.	Norfolk.	New York.	Boston.
Average daily maximum	53.2°	40.1°	38.6°	57.7°	45.9°	43.2°	64.0°	56.3°	53.2°	58.3°	47.4°	45.0°
Average daily minimum	37.1	25.9	20.1	40.8	31.3	26.7	47.5	40.5	36.1	41.8	32.5	27.6
Average daily temperature	42.9	31.3	28.1	48.0	36.8	34.2	56.3	46.9	43.9	49.1	38.3	35.4

Like Atlantic City, Old Point Comfort is an all-year-round resort, frequented during the colder seasons of the year more especially by visitors from the North, and during the summer by those from the South. As has been said, and as is the case with Atlantic City, the season of February, March, and April is the popular one for Northern visitors and invalids who desire to escape the unstable climatic conditions of a Northern spring during these months.

As a half-way station between the North and the more Southern resorts in Florida, Georgia, and South Carolina, "Old Point" proves serviceable in the late autumn and in the spring.

There are two large and well-appointed hotels at "Old Point," the "Chamberlain" and the "Hygeia," with enclosed sun piazzas, affording excellent accommodations the year round. It is probable, also, that in the vicinity private boarding-houses and cottages can be found for those desiring less expensive accommodations than these luxurious hotels offer. The methods of reaching this resort are many and good. One can go by rail to Cape Charles and from there by steamer across the bay, or by rail all the way viâ Richmond; or one can make the trip from Boston, New York, Baltimore, and Washington by water.

Newport News, while possessing a similar climate, has less in the way of attractions to offer than Old Point, and is not so popular a resort, though it possesses much of historic interest. Here is located an extensive ship-building plant, with an immense dry-dock. It is also a port of importance. The Hotel Warwick offers good accommodations, and for one who desires a quieter existence than that at Old Point, Newport News would appear to be the more attractive of the two. It is reached by boat from Norfolk.

Virginia Beach is situated eighteen miles east of Norfolk, with which it is connected by rail, and six miles south of Cape Henry. It has a fine and extensive beach, affording good surf bathing, and is protected landward by extensive pine forests. The average winter temperature is 54° F. and the extremes for the year 34° F.

The climate is equable and mild and the soil dry. The Princess Anne Hotel is well appointed and offers excellent accommodations and food. The attractions are boating, bathing, fishing, shooting, and horseback riding. This climate and resort "are adapted for cases of chronic nephritis, bronchitis, overwork, and neurasthenia." (Hinsdale.) *Edward O. Otis.*

OLD SWEET SPRINGS.—Monroe County, West Virginia. POST-OFFICE.—Old Sweet Springs. Hotel.

ACCESS.—Viâ Chesapeake and Ohio Railroad to Alleghany Station, where Concord coaches meet all passengers for the springs. The location of Sweet Springs is more open than is generally the rule in mountain districts. They issue up in a valley of great loveliness, but are surrounded by mountain scenery of surpassing grandeur. The elevation is two thousand feet above the sea level, and the climate during the summer months is of the usual delightful character found in this region. The buildings at the springs are of brick and of a very substantial character, and at the height of the season the place resembles a miniature city. Eight hundred guests are easily entertained at one time. The main building is about three hundred feet in length, and no expense has been spared to make it one of the best summer hotels in the country. The hotel property embraces a grass farm of two thousand acres, which guarantees an abundant supply of dairy products, while neighboring farms furnish the best of poultry, mutton, etc. The water of the Sweet Springs is not unpleasant to the taste, but its temperature (79° F.) renders it rather warm for general use in drinking. For bathing, however, it is very agreeable. Two pools have been provided—one for men, the other for women,—each seventy-five feet long, twenty-five feet wide, and from three to five feet deep. The water is so clear that moss-covered stones on the bottom are distinctly visible. There are also warm and hot steam baths of both mineral and freestone water. The following analysis of the mineral water here was made by Prof. William B. Rogers:

ONE UNITED STATES GALLON CONTAINS:

Solids.	Grains.
Calcium sulphate	13.16
Magnesium sulphate	9.37
Sodium sulphate	6.32
Calcium carbonate	30.05
Magnesium carbonate	.80
Calcium chloride	.15
Sodium chloride	.14
Magnesium chloride	.31
Iron peroxide	.15
Silica	.17
Earthy phosphates	Trace.
Iodine	Trace.
Total	60.62

Gases.	Cu. in.
Carbonic acid	85.86
Nitrogen	4.31
Sulphureted hydrogen	Trace.
Oxygen	Trace.

This is a very good alkaline-calcic water possessing tonic, diuretic, alterative, and mild cathartic properties. It is valuable in functional disorders of the stomach, and is said to be employed with signal benefit in chronic diarrhœa and dysentery. It has also produced good results in rheumatism and in some forms of neuralgia, as well as in renal and urinary disorders. *James K. Crook.*

OLEIC ACID.—Oleic acid ($HC_{18}H_{33}O_2$) is the acid product of the decomposition of olein, the fluid constituent of natural oils and fats. Under the title, *Acidum Oleicum*, Oleic Acid, the United States Pharmacopœia recognizes the acid "prepared in a sufficiently pure condition by cooling commercial oleic acid to about 5° C. (41° F.), then separating and preserving the liquid portion." Such grade of acid is an oily liquid, yellow or brownish-yellow in color, and having an odor and taste as of lard. On exposure to air it absorbs oxygen and darkens in color. Its specific gravity is about 0.900 at ordinary temperatures. It is insoluble in water, but dissolves completely in alcohol, chloroform, benzol, benzin, oil of turpentine, and the fixed oils. On cooling the acid first becomes semi-solid, and at 4° C. (39.2° F.) congeals to a whitish, crystalline mass.

The medicinally valuable property of oleic acid is that while retaining the physical properties of a fixed oil, the acid is yet of high diffusive power, and, accordingly, upon inunction passes through the unbroken skin into the general circulation, and leaves behind a smooth, soft, and supple, but not greasy condition of the integument. Being an acid it forms salts with salifiable bases, many of which salts are soluble in excess of oleic acid. Such solutions of oleates in oleic acid are found to permeate the skin as really as the simple acid, and for this reason such solutions form a class of medicines defined as "oleates," and devised as means of medicating the general circulation through the unbroken skin. Oleic acid is used exclusively for the manufacture of these pharmaceutical "oleates." *Edward Curtis.*

OLFACTORY NERVE.—I. ANATOMICAL PART.—The olfactory nerve is the simplest of the nerves of special sense; indeed in its peripheral relations it is in some respects the simplest and most primitive nerve of the body. Its central relations, on the other hand, are most intricate and cannot be understood without reference to its evolutionary history. In the larva of the lowest vertebrate, the amphioxus (Fig. 3624), the anterior end of the tubular central nervous system opens freely to the outer body surface by a distinct neuropore on the dorso-median surface of the head. In the adult this pore becomes closed, but there persists a pit-like de-

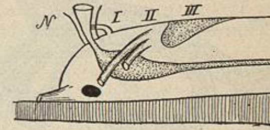

FIG. 3624.—Longitudinal Section Through the Brain of the Larval Amphioxus. *ch*, Notochord; *N*, neuropore, or sensory pit.

pression of the outer skin, reaching in to rest in contact with the surface of the brain. This pit is lined with ciliated epithelium and at this stage of life it is displaced so that it lies on one side of the median line. The appearance of this structure, which is known as the "olfactory pit," is shown in the accompanying figure (Fig. 3625). From this simple beginning the entire olfactory apparatus of higher animals has been developed. The neuropore in embryos of other vertebrates does not actually open to the surface, but its position can sometimes be determined by the appearance of a pit-like forward projection of the brain wall in its most cephalic boundary at a point corresponding to the lamina terminalis of the adult (the lobus olfactorius impar of von Kupffer) (see Fig. 3626). Here, too, there is an invagination from the outer skin in the corresponding region. From this invagination there is produced not only the nasal fossa and the contained sensory epithelium, but also the hypophysis, the latter rotating ventrally through an arc represented by the arrow in the figure.

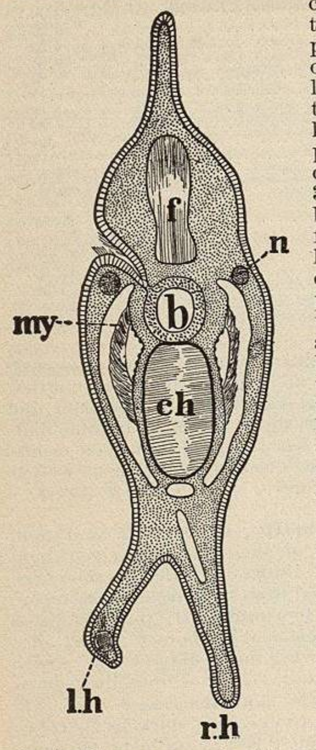

FIG. 3625.—Transverse Section Through Region of Olfactory Pit of Adult Amphioxus. (After Lankester.) The olfactory pit is seen as an ectodermic invagination at the left of the brain, *b*; *ch*, notochord; *f*, lymph space; *my*, first myotom; *n*, second cranial nerve.

The fact that the olfactory sensory thickening appears in the olfactory depression at a very early stage in its invagination has led to many attempts to homologize the olfactory organ with other sensory organs of ectodermal origin. In some of the fishes the adult olfactory mucosa is broken up into sensory patches resembling superficially the taste buds, and Blaue has assumed that these "olfactory buds" are the derivatives of one of the lateral line series of sense organs which has wandered into the olfactory fossa and there proliferated. In spite of the inherent improbability of this from theoretical grounds, his view has found its way into many of the current text-books of embryology. As a matter of fact, however, Blaue was ignorant of the development of the olfactory organ of these fishes, and the embryological history disproves his theory, for the olfactory sensory epithelium does not exhibit the "olfactory buds" until a very late stage in the ontogeny, showing that these are of secondary rather than primary significance. The truth is, that the phylogenetic origin and relationships of the olfactory organ must be left for future research to determine.

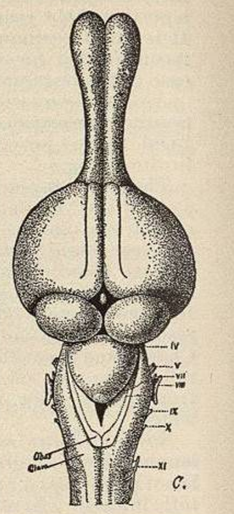

FIG. 3627.—Dorsal View of the Brain of a Young Alligator. (After C. L. Herrick.)

The later phylogenetic history is fortunately much clearer, and it is moreover of fundamental importance to our theories of the origin of the cerebrum, for the whole of the secondary prosencephalon in the lowest vertebrates seems to be related to this olfactory organ. As the optic lobes, geniculata, etc., have been evolved in response to the requirements of the organ of vision, so the olfactory bulbs and the earliest cerebral cortex seem to have been called forth by the necessities of the olfactory sense. Then later in the evolutionary process the prosencephalic roof, or pallium, became the seat of secondary connections for other nerve systems, until in man and other microsmatic mammals the olfactory function has been quite overshadowed by these secondarily acquired functions of a higher order. The distinction between the rhinencephalon and the remainder of the prosencephalon becomes more and more marked as we ascend the animal series.

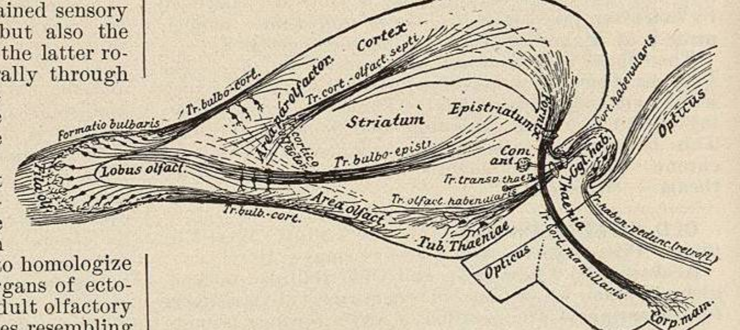

FIG. 3628.—Diagram of the Olfactory Connections of the Lizard, as seen in Sagittal Section. (After Edinger.)

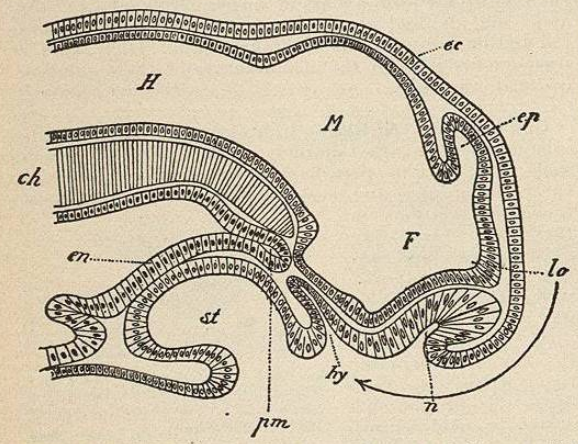

FIG. 3626.—Median Sagittal Section Through the Head of Ammocœtes. (After von Kupffer.) *ch*, Notochord; *ec*, ectoderm; *en*, entoderm; *ep*, epiphysis; *F*, primary forebrain; *H*, primary hindbrain; *hy*, hypophyseal invagination; *lo*, lobus olfactorius impar; *M*, primary midbrain; *n*, nasal invagination; *pm*, pre-oral gut; *st*, stomodœum.

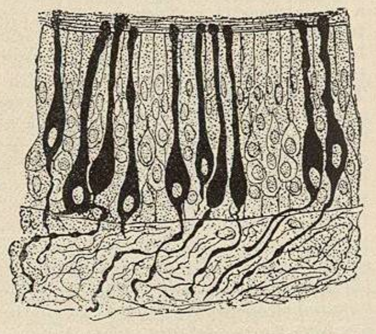
FIG. 3629.—Section of the Olfactory Mucous Membrane. (After von Brunn.) The specific olfactory cells are in black.

Edinger and others have brought forth anatomical evidence to show that the first truly functional cortex, or pallium, to appear in the phylogenetic scale is the hippocampus, which is connected chiefly with the olfactory sense. With this is to be correlated the fact that the olfactory conduction path becomes medullated earlier in the development of the human cerebrum than that of any other special sense. Since the psychic functions in higher animals are associated mainly, if not exclusively, with the cerebral cortex, it follows with great probability that the olfactory group of sensations was among the first to emerge into clearly defined consciousness. This olfactory cortex appears first in the Amphibia as a crescent of superficial nerve cells in the caudal and lateral border of the cerebrum. In the reptiles there is true cortex over the whole of the forebrain in addition to a simple but typical hippocampal formation. In these forms the olfactory nerve is the largest in the body and the whole system is enormous. It is, moreover, laid down according to the same general plan as in higher animals. The relations between olfactory bulbs and cerebrum in the reptiles are indicated by the accompanying figure of the brain of the alligator (Fig. 3627) and by the diagram of the olfactory connections in the lizard (Fig. 3628). This latter scheme applies also with no important changes save in the relative size of the parts, to all vertebrates above the reptiles in the zoological scale. In man, however, the sense of smell is relatively so unimportant and the higher cortical centres are so highly developed that it has proven a matter of the greatest difficulty to unravel the olfactory connections.

Anatomically the olfactory nerve differs from all of the other nerves of the body in that its fibres arise from perikaryons, or cell bodies, lying in the sensory epithelium (Fig. 3629). In other words, the root ganglion for this nerve does not lie adjacent to the central nervous system, but its cells are in the periphery, diffusely scattered among the indifferent supporting cells of the sensory mucosa of the nasal organ. This condition we find in the case of no other nerve among the higher vertebrates, but it appears to be a survival of a primitive invertebrate condition. (See *Cranial Nerves.*)

The specific olfactory cells are distributed over a relatively small area of the nasal mucosa (about 2.5 sq. cm.) in the upper narrow part of the nasal sinus, partly on the superior turbinated bone, and partly on the nasal septum adjacent. Unlike the remainder of the nasal mucosa this portion is non-ciliated. It is yellowish in color and exceedingly vascular. The specific olfactory cells are commonly described as ending in a short stiff bristle. Recently Jagodowski has found (*Anat. Anzeiger*, vol. xix., p. 257) in the fishes that each of these cells is provided with a single long thread-like filament which projects outward into the mucus of the nose and which may be more than twice the length of the cell body from which it springs. The appearance of the fila olfactoria arising from these cells is indicated in Fig. 3630. These fibres passing from the olfactory mucosa to the olfactory bulb are commonly called the olfactory nerves, but it is evident that if the so-called specific cells from which they spring really correspond to the root ganglion cells of the other nerves, then the fila olfactoria correspond rather to root fibres. These fibres are non-medullated and are gathered into about twenty bundles, which enter the cranium by separate apertures in the cribriform plate of the ethmoid bone. The several strands enter the olfactory bulb and here terminate in peculiar arborizations in the glomeruli (Fig. 3631).

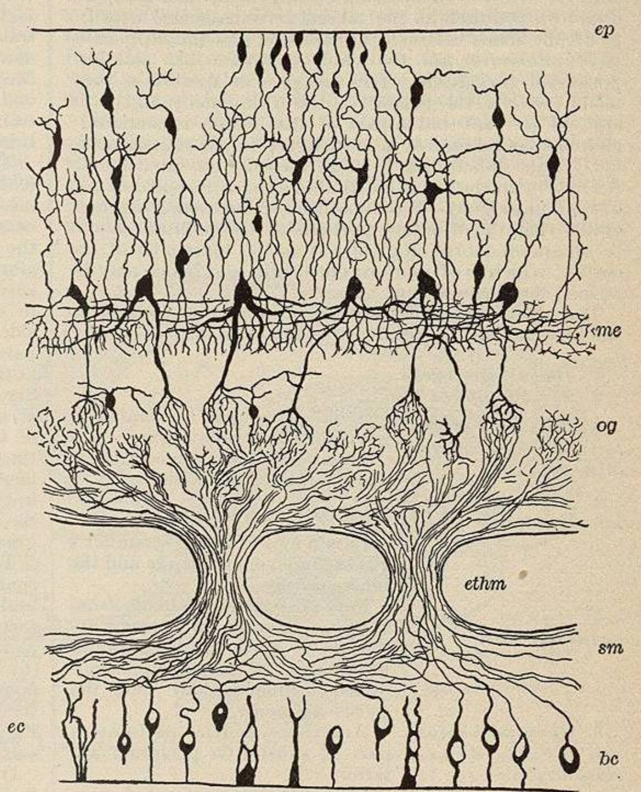

FIG. 3631.—Structure of the Olfactory Filaments and Bulb. (After Ramón y Cajal.) *bc*, Bipolar cells of the olfactory mucous membrane; *sm*, submucosa; *ethm*, cribriform plate of the ethmoid; *og*, olfactory glomeruli; *me*, mitral cells; *ep*, epithelium of the olfactory ventricle; *ec*, epithelial cells of the olfactory membrane.

Jacobson's organ (a peculiar diverticle of the nasal sac) in some animals receives a special twig of the olfactory nerve, which rarely, as in Amblystoma, arises from the brain farther back (caudad) than the rest of the nerve and pursues a distinct course to its terminus.

The comprehension of the central relations of the olfactory nerves is greatly impeded by a confused and very inconsistent nomenclature. The term rhinencephalon was first used in neurology by Owen as a name for the olfactory bulb and its peduncle. It has since been extended by different writers to include various parts of the cerebrum which are concerned in the olfactory function, with, however, no uniformity in the extent of this application. The only logical course is (as pointed out by G. Elliot Smith, *Jour. Anat. and Physiol.*, xv., 1901) either to retain Owen's limited application of the term or

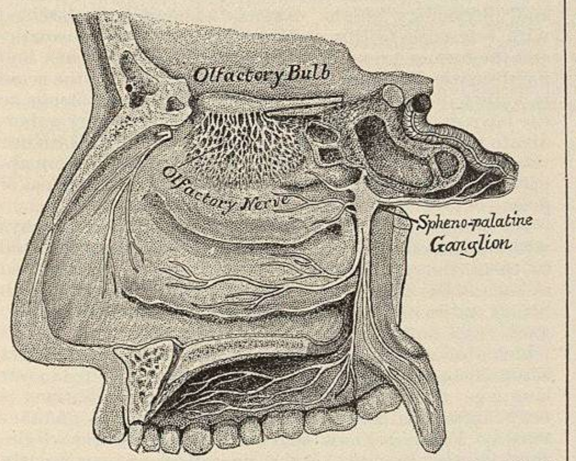

FIG. 3630.—The Right Olfactory Nerve on the Outer Wall of the Nasal Fossa. (Adapted from Hirschfeld.)

to extend it to include all parts of the forebrain, which are directly connected with the olfactory function, viz., the olfactory bulb, tract (or peduncle), tuber, the area perforata, "paraterminal body" (a term introduced by Elliot Smith for the area extending backward from the olfactory peduncle to the lamina terminalis and upward to fill the space between the callosum and the hippocampal commissure), and the whole pyriform lobe and hippocampal formation. This usage will doubtless commend itself to the majority of working neurologists, in spite of the fact that a part of that which is commonly reckoned as pallium is here included in the rhinencephalon. This difficulty is in large measure obviated by Elliot Smith in the paper cited above, by a reconsideration of the phylogeny of the pallium, from which he concludes that the olfactory portions of the pallium should be separated morphologically from the remainder of the cortex, which is of more recent origin and hence may be termed the "neopallium."

The classification of the rhinencephalon, according to Retzius, has been tabulated by Barker as follows:

1. *Bulbus olfactorius.*	
2. *Tractus olfactorius.*	
3. *Trigonum olfactorium* (gyrus tuberis olfactorii).	Stria olfactoria lateralis to gyrus olfactorius lateralis. Stria olfactoria medialis to gyrus olfactorius medialis.
4. *Gyrus olfactorius medialis.*	Area parolfactoria Brocæ.
5. *Gyrus olfactorius lateralis.*	Pars anterior—Eberstaller's gyrus transversus insulæ and the limen insulæ. Pars posterior. Extends from angulus lateralis to anterior extremity of gyrus hippocampi and terminates in the gyrus semilunaris rhinencephali and the gyrus ambiens.
6. *Gyrus perforatus* (*seu intermedius*) *rhinencephali.*	Anterior, much perforated, part of substantia perforata anterior. Posterior, less perforated, part of substantia perforata anterior.
7. *Gyrus diagonalis rhinencephali.*	Corresponds to the diagonal band of Broca, which extends from the gyrus subcallosus to the anterior end of gyrus hippocampi.

8. *Other portions of rhinencephalon.*
   (*a*) *Gyrus hippocampi.*
   (*b*) *Uncus.*
   (*c*) *Gyrus dentatus.*
   (*d*) *Gyrus intralimbicus.*
   (*e*) *Gyrus fasciolaris.*
   (*f*) *Gyri Andreæ Retzii.*
   (*g*) *Indusium griseum* (including the *striæ longitudinalis medialis et lateralis*).
   (*h*) *Gyri subcallosi.*

Reference to Fig. 3631 will render unnecessary a detailed exposition of the primary olfactory connections. The glomeruli are entangled knots of fibres, partly the terminal arborizations of the fila olfactoria and partly the dendritic tips of the neurones of the second order, whose nuclei lie in the zone of mitral cells. Each mitral cell usually sends a dendrite (in man) to but one glomerulus, where it receives the terminal arborizations of many fila olfactoria. The structures within the olfactory bulb are stratified, the following layers being encountered as we pass inward. First, a layer of fila olfactoria, bounded within by the glomeruli arranged in a single series. Then, after an interval containing chiefly nerve fibres constituting the so-called molecular layer, are the mitral cells, arranged in a thin layer typically but one cell deep. Within this is the granular layer containing very many cell bodies of the olfactory granules. These are minute cells with feebly developed dendrites directed toward the ventricular surface, and much branched neurites passing out between the bodies of the mitral cells to arborize just within the zone of glomeruli. Their functional significance is unknown. Within this layer is the zone of nerve fibres, containing the tracts directed toward the cortex and composed chiefly of neurites of the mitral cells. Olfactory impressions entering by the fila olfactoria are transferred to the dendrites of the mitral cells and by the neurites of these neurones (the mitral cells constituting the primary intracranial centre) are carried to their secondary centres viâ the olfactory tracts. These secondary connections, which are very diverse and intricate, can be briefly summarized as follows:

The olfactory tract connecting the bulb with the secondary centres contains three sets of fibres, the lateral and mesial olfactory striæ superficially placed, and the deep, or ental, or precommissural tract. On their way part of the latter fibres terminate in the gray matter distributed along its course, while others run to the anterior commissure, forming its anterior or olfactory part, and terminate in various parts of the rhinencephalon of the opposite side. The mesial olfactory stria terminates in the area parolfactoria and other gray centres near the median line at the attachment of the crus olfactorius, effecting secondary connections with the hippocampus through the indusium griseum of the callosum and by other paths. Others of these fibres pass into the septum pellucidum and ultimately reach the hippocampus viâ the fornix. The larger portion of the secondary olfactory fibres pass back in the lateral olfactory stria to terminate in the cortex of the uncus, giving off collaterals on the way to adjacent gray centres.

The reflex connections between the cortical olfactory centres in the hippocampus and the lower regions of the brain are too complicated to be summarized here. The fornix is the chief pathway for these fibres, and their most important connections are the mammillary bodies (by way of the corpus fornicis, the *Tr. Cort. mammillaris* of Fig. 3628), and the nucleus habenulæ (by way of the stria medullaris thalami, marked *Cort. habenularis* on Fig. 3628). For the general relations of these tracts consult Fig. 3632.

One is at once struck by the peculiar way in which these olfactory tracts are distributed by widely divergent paths to secondary centres, which are far separated in space (though morphologically related). Upon comparison with the connections within the reptilian brain (Fig. 3628) the explanation is plain. There practically the entire forebrain is devoted to olfactory connections, and the cortical additions of higher types have been intercalated in such a way as to separate tracts and centres which were primarily juxtaposed.

II. Physiological Part.—The sense of smell in human beings, as compared with many of the lower animals, is very feebly developed, as will be made clear by even a cursory examination of the comparative anatomy and physiology of the organ. Animals are classified with reference to this sense as osmatic and anosmatic, and the former group is subdivided into macrosmatic and microsmatic divisions, depending upon whether the sense is highly developed or but feebly so. Man belongs to the microsmatic group, this sense playing a very subordinate rôle, either physiological or psychological, in our vital economy. Its unimportance is, however, more apparent than real and is to be explained, as Zwaardemaker points out, on psychological grounds.

As a matter of fact, olfactory sensations are always with us and our daily actions are profoundly influenced by them, though this influence is largely unrecognized as such. For these sensations are, in the case of human beings, intimately connected with the somatic and organic functions, and have a strong emotional content which obscures the process of ideation. This imperfect comprehension of olfactory impressions is reflected in our language, for our vocabulary of olfactory sensations is very limited and almost all borrowed from that of other senses. For our knowledge of the outer world we depend chiefly upon the other special senses, particularly sight. With the macrosmatic animals, on the other hand,

the sense of smell is undoubtedly in some cases more potent in the elaboration of knowledge of the outer world than any other sense.

The physiology of the sense of smell is less perfectly known than that of any of the other special senses, and the same remark holds true of its psychology. While our knowledge of the anatomical arrangements of the paths of olfactory conduction to and within the brain has been greatly extended of late, we are yet ignorant of the means even by which the olfactory nerve termini are stimulated by the odorous substances. In particular, the physiological process underlying the difference between smell and taste is obscure. It is commonly stated that we taste substances in solution or in liquid form, while only gases are perceived by the sense of smell. While this is in general true, it nevertheless must be remembered that the odorous gases do not come into direct contact as such with the sensory end organs in the nose, either in fishes, where the nasal cavities are filled with water, or in air-breathing vertebrates, whose olfactory mucous membranes are always bathed with mucus in which the odorous substance must always be dissolved before it can irritate the sensory endings. Again, some sapid substances, such as hydrochloric acid, are also solutions of gases, and some solids in a state of fine division seem to give rise to distinct olfactory impressions. The fact that when the nostrils are filled with water carrying an odorous substance in solution the odor cannot be perceived does not necessarily imply that the failure is due to the fact that the substance is in solution, but rather to an irritating effect of the liquid upon the olfactory organ. This is indicated by two facts: First, that all olfactory sensation may be temporarily enfeebled or even entirely abolished for some time after the close of the experiment; and second, that if normal salt solution instead of water be used as a solvent, then the dissolved substance can in some cases still be smelled.

Tyndall discovered that odorous vapors have a considerable capacity for absorbing heat, and that very minute quantities of the odorous substance in the air experimented upon would produce surprising effects. At the close of a table giving the absorptive powers of different odorous vapors, he remarks: "We find that the least energetic in the list produces thirty times the effect of air, whilst the most energetic produces one hundred and nine times the same effect." The significance of these facts is still obscure. We certainly are not able to affirm as yet, with Ramsay, that the sense of smell is excited by vibrations of a lower period than those which give rise to the sense of light or heat, though it may well be that characteristic molecular vibrations give to various substances their distinctive odors. But in any case these movements seem to be incapable of transference to the receptive sense organ by the medium of ethereal vibrations, and direct contact of the odorous particles with the nervous organ seems indispensable. The ultimate stimulus is probably electro-chemical—a matter of ions.

Olfactory sensations are aroused with difficulty or not at all by irritation of the peripheral end organ by thermal, electrical, mechanical, or other stimuli than the normal gaseous media, though tumors or other irritants of the central olfactory apparatus may call forth vivid sensations of smell. It is hardly true, as often stated, that air containing odorous particles must be in motion in order to stimulate the olfactory organ. The truth is that in ordinary respiration the air currents do not strike the sensory surface directly, and hence olfactory impressions are called forth by such particles only as diffuse themselves upward from the respiratory portion into the olfactory fossa, while in sniffing the direction of the air currents is altered so as to pass more directly over the specific sensory area.

We are not as yet able to give a natural classification of smells, nor have we any secure basis for such a classification. Even the division into agreeable and disagreeable is subject to so great variation from one individual to another that it would be of small value, even if it were admissible on other grounds. Accordingly, the names

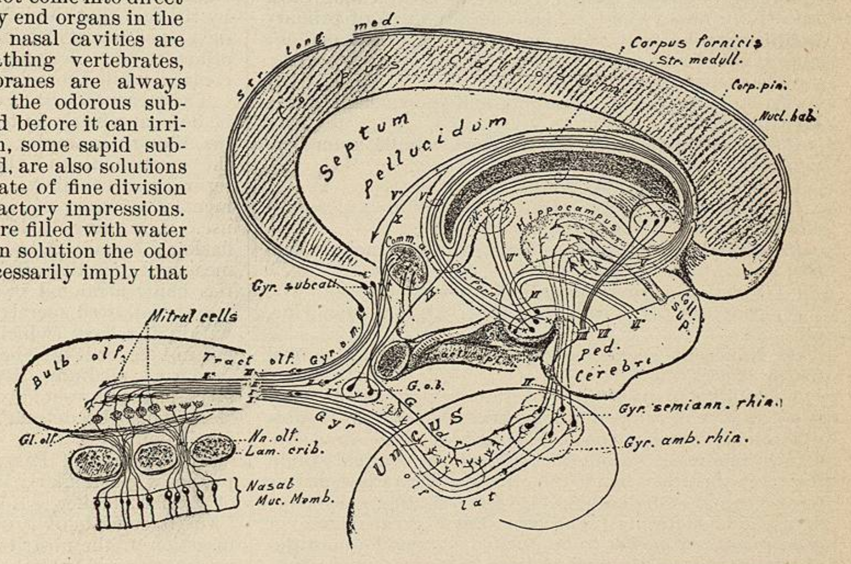

FIG. 3632.—Schematic Representation of Some of the Principal Neurone Systems of the Olfactory Conduction Path. Projected into sagittal plane. (After Barker.) *Bulb. olf.*, Bulbus olfactorius; *Col. forn.*, columna fornicis; *Col. sup.*, colliculus superior; *Comm. ant.*, commissura anterior cerebri; *Corp. mam.*, corpus mammillare; *Corp. pin.*, corpus pineale; *G. o.b.*, ganglion opticum basale; *Gl. olf.*, glomeruli olfactorii; *Gyr. amb. rhin.*, gyrus ambiens rhinencephali; *Gyr. olf. lat.*, gyrus olfactorius lateralis; *Gyr. o. m.*, gyrus olfactorius medialis; *Gyr. semiann. rhin.*, gyrus semilunaris rhinencephali; *Gyr. subcall.*, gyrus subcallosus; *Lam. crib.*, lamina cribrosa; *N. a. th.*, nucleus anterior thalami; *Nn. olf.*, nervi olfactorii; *Nucl. hab.*, nucleus habenulæ; *Ped. cerebri*, pedunculus cerebri; *Str. long. med.*, stria longitudinalis medialis; *Str. medull.*, stria medullaris; *Tract. olf.*, tractus olfactorius; *Tract. opt.*, tractus opticus; *I*, axones of mitral cells going to stria olfactorius lateralis; *I′*, axone of mitral cell terminating in gray matter of trigonum olfactorium; *II*, axone of mitral cell terminating in gray matter, whence axone goes to commissura anterior cerebri; *II′*, axones to anterior commissure; *II″*, centrifugal fibre terminating in bulbus olfactorius; *III*, axone of mitral cell terminating in gyrus olfactorius medialis; *IV*, axones of neurones connecting the olfactory portion of the uncus (gyrus ambiens and gyrus semilunaris) with the hippocampus; *V*, axones from hippocampus to fornix; *V′*, axone to commissura hippocampi; *V″*, axones from fornix to septum pellucidum; *V‴*, axones from fornix to corpus mammillare; *V⁗*, axone from fornix to nucleus habenulæ by way of the stria medullaris; *VI*, fasciculus mammillaris princeps; *VI′*, fasciculus thalamomammillaris Vicq d'Azyri; *VI″*, fasciculus pedunculomammillaris, pars tegmentalis (*Haubenbündel* of von Gudden); *VII*, fasciculus pedunculomammillaris, pars basilaris (pedunculus corporis mammillaris); *VIII*, fasciculus retroflexus Mynerti extending from the nucleus habenulæ to the ganglion interpedunculare.

of smells are usually taken from the objects which give rise to them, with little attempt at classification or correlation of similars.

The number of smell qualities is very large. Some of those commonly recognized are compound, though authorities differ as to the extent to which such mixture is possible, or whether it is possible at all. If two distinct odors are mingled under experimental conditions, there often results, not a fusion of the two into a blended odor, as occurs with tastes, colors, and tones, but the stronger will supplant the other completely, or there will be an oscillation between the two. With some odors, again, there appears to be a true compensation. Thus, if two different olfactory stimuli of unequal strength are applied simultaneously, one will usually overpower the other completely; but if the stronger scent be diminished while the weaker is strengthened, a point may be found where the two blend into a single mixed odor. In other cases, however, a point is found where there is no sensation, *i.e.*, the odors are perfectly compensated. An increase of either stimulus results in the sensation appropriate to it and there is no mixture whatever. The olfactory organ is easily fatigued, more so by some odors than by others, and it is found that when completely fatigued for one odor it may be insensible to some other odors, partially so to another group and wholly unaffected in its sensibility with reference to still another group.

Such experiments suggest points of departure for the study of olfactory qualities, and enough progress has already been made to suggest that the modalities of smell can be grouped into several graded series. The number of such groups will quite certainly be greater than those known for taste, where we have simply the four primary qualities, sweet, sour, salty, and bitter. Zwaardemaker's nine smell classes are as follows:

(1) Ethereal scents: Fruit odors.

(2) Aromatic scents: Camphor and spicy smells, anise, lavender, etc.

(3) Balsamic scents: Flower odors, vanilla, gum benzoin, etc.

(4) Ambrosiac scents: Amber, musk.

(5) Alliaceous scents: Garlic, ichthyol, vulcanized rubber, asafœtida, bromine, chlorine, etc.

(6) Empyreumatic scents: Toast, tobacco smoke, naphtha, etc.

(7) Valeric, or hircine scents: Cheese, sweat, etc.

(8) Narcotic, or virulent scents: Opium, cimicine, etc.

(9) Nauseous scents, or stenches: Decaying animal matter, fæces, etc.

The ability to discriminate different intensities of odors is not highly developed; in general, the least observable difference between two smell intensities of the same substance amounts to about one-third of the original stimulus. On the other hand, the olfactory organ is sensitive to exceedingly small amounts of the irritating substance, or as Ladd states it: "The sense has a great degree of 'sharpness,' or power to be excited by small quantities of stimulus, as distinguished from 'fineness,' or power to distinguish minute variations in the sensations." There are many familiar illustrations of this "sharpness." It is stated, for example, that in a litre of air 0.000005 gm. of musk can be perceived, 0.000001 gm. of sulphureted hydrogen and 0.000000005 gm. of oil of peppermint. The sense is more delicate if the air containing the odorous substance is warmed.

It is learned by suitable tests that the sensibility of the organ of smell is much more acute than the perception of odors. It was found in one series of tests, for example, that upon the average 9 parts of camphor dissolved in 100,000 parts of water could be sensed by the nose, but without the perception of a definite odor, it requiring a solution of more than four times this strength before the specific odor could be recognized. Experiments made to determine the relative sensitiveness of men and women in this respect have thus far yielded conflicting results. With children it has been found that the sensibility (in the sense used above) increases up to the age of six years and then progressively diminishes. The delicacy of perception, on the other hand, measured by graded solutions of camphor, increases progressively with advancing age.

One source of perplexity in the classification of odors is the fact that some substances which have powerful odors in a state of great dilution are less effective in a state of high concentration. For some perfumes there appears to be an optimum vapor density below or above which the excitation is less strong. It has also been suggested that for unknown phylogenetic reasons some odors may have greater affective values than others, or it may be that fatigue of the sense of smell is *cæteribus paribus* less for those odors which have an element of utility to the species.

It must not be forgotten that some odorous substances affect the terminals of the trigeminus nerve in the respiratory part of the nasal passages, giving rise to tactile or other general sensation which may be combined with the olfactory sensations. This can be proven by plugging the olfactory sinus, when the trigeminal stimulus alone is perceived. Classification is further impeded by the universal confusion of tastes and odors. We say a substance "smells sweet," when as a matter of fact experiment shows that the modality sweetness can be perceived only by the sense of taste; and conversely most of the tastes of common experience are greatly affected by odors simultaneously sensed.

In the majority of persons (Toulouse and Vaschide) the left side of the nose is more sensitive than the right. With most of the other senses, on the other hand, there is an asymmetry in one-fifth of the cases in favor of the right side (van Biervliet). The difference is explained by the fact that the left side of the brain is more highly developed (in right-handed persons) and that the central olfactory tract does not cross before reaching its cortical centres, while those for the other senses do cross.

The measurement of olfactory sensations cannot easily be done absolutely in terms of the strength of the stimulus, though examples of the results of some attempts at the measurement of the threshold for smell in absolute terms are given above. To arrive at a relative measurement of olfactory values there are two methods chiefly in use. According to the method of Passy a number of flasks of equal size are provided and into each is put a measured quantity of the odorous substance, the quantities being arranged in a graded series. The substance may be allowed merely to diffuse itself through the air within the flask (which must be kept stoppered when not in use), or it may be dissolved in water or some other inodorous medium. By the use of a sufficiently extensive series, threshold values of different odorous substances may be determined and various other researches carried out.

The method of Passy is very laborious and for most purposes, particularly in clinical work, the olfactometer of Zwaardemaker is more convenient. In its simplest form it consists of a glass tube, curved at one end for insertion in the nostril and bearing a scale (preferably in centimetres), which slides with easy friction into a slightly larger tube which is lined with the odorous substance to be tested. The inner tube passes through a screen near its curved end. Now, when the outer tube is slipped completely over the inner tube so that its odorous lining is wholly covered by the latter, air drawn into the nostril through the inner tube will carry no odorous particles. If, however, the outer tube is slowly slipped off from the inner tube, the air current will pass over more and more of the exposed surface of the odorous substance before entering the inner tube, until a point will be reached at which the substance is just perceivable to the sense of smell. In this way the normal threshold can be determined for various substances and numerous tests of physiological and pathological interest carried out.

This simple apparatus has been modified in various ways. A very simple instrument which has the advantage of relative permanence of adjustment can be constructed by using a section of ordinary red rubber tubing for the outer tube. This should be slipped inside of a larger glass tube to prevent the odor from escaping from the outer side of the rubber, and the odor given off from the inner surface of the rubber tubing will remain quite constant for many months. For other odors the outer cylinder may be made of porous earthenware, whose pores may be filled with a solution of the odorous substance. Commonly the olfactometer is made double with a separate cylinder and breathing tube for each nostril, and for the study of the compensation of odors Zwaardemaker has constructed a very elaborate apparatus with two separate cylinders (one for each of the odors to be employed) connected with a single breathing tube and so adjusted that the amount of odorous surface exposed in each tube may be easily varied during the

experiment. With the varying adjustments one odor or the other appears in consciousness alone until the proper compensation point is reached, when both odors vanish. The apparatus is provided with self-registering apparatus for recording on the kymograph the force of respiration in each cylinder and other data of the experiment.

The unit in all of these experiments is the "olfactie," or the stimulus necessary to produce the least perceivable sensation. The position on the scale of the olfactometer having been determined for this minimal value, this value is taken as the unit, or olfactie, and other stimuli are measured in multiples of this.

For the fuller consideration of the subject of this article, see the work by H. Zwaardemaker, "Die Physiologie des Geruchs" (Leipsic, 1895), and the article by the same author entitled, "Les sensations olfactives, leurs combinations et leurs compensations," in *L'Année Psychologique*, vol. v., 1899, pp. 202–225. A complete bibliography of the organ and sense of smell up to January, 1901, has been compiled by Bawden, in *The Journal of Comparative Neurology*, vol. xi., No. 1, April, 1901.

C. Judson Herrick.

OLIBANUM.—*Frankincense. Thus. Gummi, resina olibani.*—A gum resin obtained from *Boswellia Carterii* Birdw. and other species of *Boswellia* (fam. *Burseraceæ*).

Olibanum is collected in northeastern Africa, chiefly by the Somali natives, and is mostly exported viâ India. It is produced by small trees similar to those which yield myrrh, and is chiefly obtained from incisions made for the purpose. It exudes as a thick milky juice, hardening into the tears described below, which preserve their white color much longer than those of other similar substances.

Olibanum occurs in irregularly oval or subglobular tears, separate, or occasionally somewhat agglutinated in the poorer grades, usually 1.25 cm. (0.5 in.) or less in diameter, from almost pure white to yellowish-white, occasionally reddish-brown when long kept, the surface powdery; breaking readily with a nearly flat, waxy, lustrous surface, translucent in thin fragments; odor balsamic, slightly like turpentine; softening between the teeth, aromatic and somewhat bitter. Triturated with water, it forms a white emulsion and is almost wholly soluble in alcohol. When burned, it emits a very strong and pleasant odor, on account of which it is used as incense.

Olibanum consists principally of resin, usually from 60 to 70 per cent., or occasionally 75 per cent., with from 30 to 35 per cent. of gum and from 3 to 8 per cent. of volatile oil. Its bitter principle has not been examined. The volatile oil, which is an article of commerce for perfuming purposes, combines a slight lemon-like odor with that of the drug, and is of complex composition. The resin is divisible into two portions, namely, *Boswellic* or *Boswellinic acid* and *olibano-resin*. The gum is more like acacia than like tragacanth.

From a medicinal point of view, the uses of olibanum are quite unimportant. It is no longer official in any leading pharmacopœia and is but little used in professional medicine.

Owing to its fragrant properties, it is with some a favorite ingredient of plasters and ointments, and it is elsewhere used for odorizing purposes. It has mild counter-irritant and disinfectant properties, leading to its use as a vulnerary. Internally, it possesses the ordinary stimulating diuretic and expectorant properties of the oleoresins, and it also has a considerable use, especially among the laity, based chiefly on religious fancy, as an emmenagogue. The dose is from 1 to 3 gm. (gr. xv.–xlv.). It is used chiefly, perhaps, in the form of the emulsion, although the tincture is to be preferred.

Henry H. Rusby.

OLIGÆMIA.—A decrease in the total mass of the blood. The term is often used incorrectly as a synonym for anæmia. The latter term is used to indicate a deficient supply of blood to a part, or a deficiency in the total amount of blood within the body, or, most commonly, to designate a decrease in the number of the red cells or a diminution of the hæmoglobin. The expression *general anæmia* may, therefore, be regarded as expressing the same idea as that conveyed in oligæmia. The decrease in the total mass of blood may be due to a number of causes, and the following varieties may be distinguished:

Oligæmia Vera.—True oligæmia is due to a sudden loss of blood through hemorrhage. A loss of half of the total mass of the blood is invariably fatal, and hemorrhages of even less degree may cause death. The red cells may drop after a single large hemorrhage as low as two million. After such a loss of blood there is a rapid fall in blood pressure, the pulse becoming very small, frequent, and irregular. In cases of hemorrhage of slight degree, but continued through a long period of time, the deficiency is partly made up by an increase in the fluids of the blood, the true oligæmia becoming thus converted into a hydræmic oligæmia.

Oligæmia Hydræmica or Serosa.—An oligæmia with increase of water in the blood, the red cells and albumin being diminished, occurs after all hemorrhages, particularly in the case of oft-repeated or prolonged hemorrhages of slight degree, as in bleeding piles, excessive menstruation, etc., also in conditions characterized by loss of albumin, as in chronic nephritis, dysentery, chronic suppurations, prolonged lactation, tumor cachexias, scurvy, malaria, etc. The hydræmic condition of the blood leads to pathological changes in the blood-vessel walls, favoring the passage of fluids and the increased production of lymph (œdema). Hydræmia is, however, not the direct factor in the production of œdema, but only a favoring one.

Oligæmia Sicca (*Inspissatio Sanguinis, Anhydræmia*).—A thickening of the blood through loss of water may lead to a decrease of the total mass. Such a condition may occur in cholera, dysentery, severe diarrhœas, excessive sweating, insufficient supply of water, etc. The highest degree of oligæmia sicca occurs in Asiatic cholera. As a result of the circulatory disturbances thus produced, and an insufficient supply of blood to the nervous centres, the characteristic symptoms of severe anæmia may arise, although the total number of red cells and total amount of salts and albumin in the blood are not decreased. The thickened blood becomes tea-like, the blood serum is richer in albumin and in salts. The body tissues become very dry, and non-encapsulated serous exudates are resorbed.

Oligæmia Oligocythæmica.—A decrease in the total blood mass due to a diminution in the number of red cells (see *Oligocythæmia*).

Oligæmia Hypalbuminosa.—A decrease of the blood mass due to a decrease in the albumin of the blood. As a result of such loss of albumin the blood becomes more watery; the condition is therefore practically a form of oligæmia hydræmica. (See also *Blood, Anæmia*, etc.)

Aldred Scott Warthin.

OLIGOCHROMÆMIA.—A decrease in the amount of hæmoglobin in the blood. This is one of the commonest changes in the blood, and may occur either when the red cells are normal in number or in association with an oligocythæmia. A simple loss of hæmoglobin is the chief change in chlorosis and the secondary anæmias. In chlorosis the number of the red blood cells may be nearly normal, while the hæmoglobin may be greatly reduced, even to twenty or twenty-five per cent. or less. In the secondary anæmias the number of red cells is also diminished, but the hæmoglobin is reduced to a relatively greater extent; thus, for example, if the number of red cells be diminished to 2,500,000, the hæmoglobin is usually found to be lower than fifty per cent. The individual red cells are, therefore, deficient in hæmoglobin. This is shown microscopically by the presence of a central clear area in the red cell. This area may be of varying size and shape; in severe cases the hæmoglobin-containing portion of the cell may be reduced to a narrow ring, enclosing a clear and transparent central area. In very extreme cases some cells may contain no hæmoglobin at all