and prolonged anterior part of the body, which is termed the "neck," and terminates in a very small head. The eye is small, with round pupil, which is so much contracted by the light when the snake is taken out of the water that the animal becomes blinded and is unable to hit any object it attempts to strike. The tongue is short, and the sheath in which it lies concealed opens near to the front margin of the lower jaw; scarcely more than the two terminating points are exserted from the mouth when the animal is in the water. The mouth shuts in a somewhat different way from that of other snakes: the middle of the rostral shield is produced downwards into a small lobule, which prevents the water from entering the mouth; there is generally a small notch on each side of the lobule for the passage of the two points of the tongue. Cantor says that when the snake is out of the water and

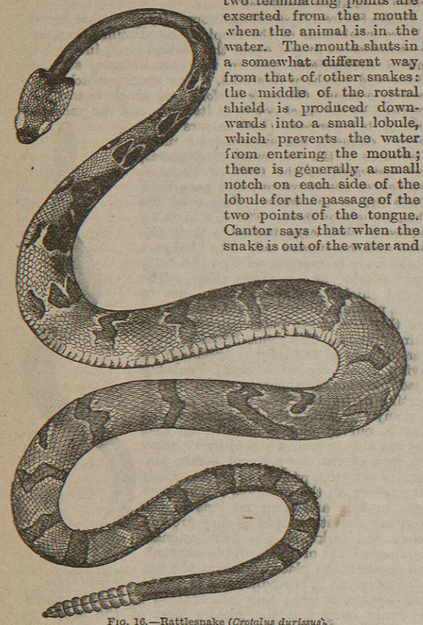

FIG. 16.—Rattlesnake (*Crotalus durissus*).

blinded by the light it freely makes use of its tongue as a feeler. The food of sea snakes consists entirely of small fish; the present writer has found all kinds of fish in their stomach, among them species with very strong spines (*Apogon*, Siluroids). As all these animals are killed by the poison of the snake before they are swallowed, and as their muscles are perfectly relaxed, their armature is harmless to the snake, which commences to swallow its prey from the head, and depresses the spines as deglutition proceeds. There cannot be the slightest doubt that sea snakes belong to the most poisonous species of the whole order. Russell and Cantor have ascertained it by direct observation: tortoises, other snakes, and fish died from their bite in less than an hour, and a man succumbed after four hours. Accidents are rarely caused by them, because they are extremely shy and swim away on the least alarm; but, when surprised in the submarine cavities forming their natural retreats, they will, like any other poisonous terrestrial snake, dart at the disturbing object; and, when out of the water, they attempt to bite every object near them, even turning round to wound their own bodies (Cantor). They cannot endure captivity, dying in the course of two or three days, even when kept in capacious tanks. The greatest size to which some species attain, according to positive observation, is about 12 feet, and therefore far short of the statements as to the length of the so-called sea serpents (see SEA-SERPENT). The largest examples the present writer has seen measured only 8 feet.

Passing over Rattlesnakes (fig. 16) and Vipers, which are treated of in separate articles, we notice the following types of the fourth sub-order, the *Ophidii viperiformes*.

The sole representative of the sub-order in Australia is the Death Adder (*Acanthophis antarctica*), a short stout snake having a similar habitus and habits to vipers and scarcely attaining 3 feet in length. It differs from the

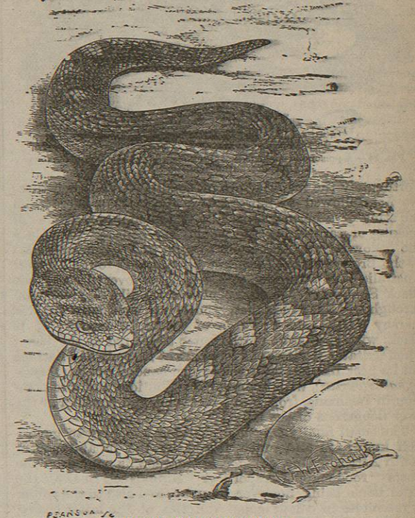

FIG. 17.—*Echis carinata* (India).

other Viperines in having the poison-fang permanently erect. Although much feared, and justly, there is reason to believe that its bite is not so dangerous as has been represented, and that the majority of the fatal accidents ascribed to it are in fact caused by other snakes, probably *Hoplocephalus curtus*. It occurs throughout the whole of Australia, except Tasmania and perhaps South Australia. Generally it is of a uniform grey colour, relieved by some forty dark rings of irregular outline.

The "tic-polonga" of the Singalese (*Daboia russellii*) is beautifully marked: on a light chocolate ground colour three series of large black white-edged rings run along the back and sides of the body, a yellow line borders the surface of the head on each side, the two lines being convergent on the snout. It attains to a length of 50 inches, and occurs locally in abundance in southern India, where it is called "cobra monil"; in Bengal, where it is called "jessur"; in the plains of central India, as well as in the Himalayas to an altitude of 6000 feet; and in Burmah. It is highly poisonous, probably causing many deaths

Fortunately its loud hissing when disturbed warns those who come within dangerous proximity to it.

The small Viperine snake, *Echis carinata* (fig. 17), which scarcely exceeds a length of 20 inches, shares with the preceding part of its range, being found in the arid districts of southern India, and extending through the intervening parts of Asia to North Africa. It is a desert type, having the lateral scales curiously arranged, strongly keeled, with the tips directed downwards. It produces with their aid a rustling sound. Whilst some observers deny that fatal consequences have resulted from its bite, Dr Imlach reports that it (the "kuppur") is "the most deadly poisonous snake

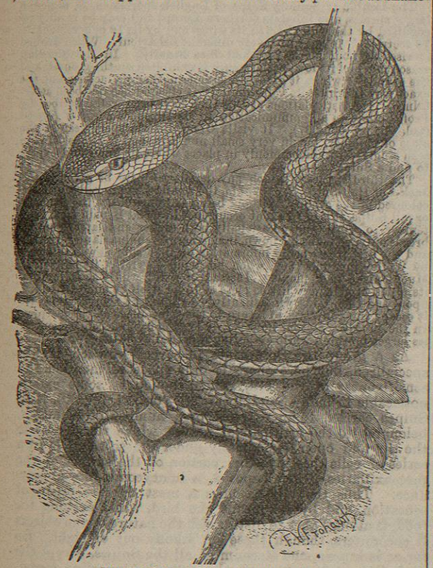

FIG. 18.—*Trimeresurus erythrurus* (India).

in Sind." This desert type is replaced farther south in Africa where vegetation flourishes by a closely allied genus, *Atheris*, which, however, possesses a prehensile tail and vivid coloration and has assumed truly arboreal habits.

Of the pit vipers without rattles the largest and most formidable inhabit tropical America. *Trigonocephalus lanceolatus*, and *T. lanceolatus* attain to a length of 6 feet, the first two being common in Brazil and northwards to Central America. The last is limited to some islands in the West Indies, especially Martinique and St Lucia, and is generally known by the name of "fer de lance," which has been given to it from the markings on its head. It infests the sugar-plantations, and has greatly multiplied in consequence of the protection which the cover of the cane-fields afforded it, and the abundance of food supplied by the rats which swarm on the plantations. Thus, whilst it did a certain amount of good by the destruction of vermin, it caused a great number of deaths among the black labourers who were engaged in the fields. These three species of *Trigonocephalus* are surpassed in size by *Lachesis mutus*, probably the largest of terrestrial poisonous snakes, which is said to exceed a length of 10 feet, and is bulky in proportion. It is confined to the hottest parts of tropical America. Similar snakes, but smaller in size, inhabit the warmer and temperate parts of North America, viz., the Copper-head (*Cenchris contortrix*) and the Crater-mocassin (*C. piscivorus*), the former of terrestrial habits, the latter being always found near water and feeding chiefly on aquatic animals. Both are much feared and cause accidents more frequently than rattlesnakes, being more aggressive and striking the intruder without previously warning him of their presence. In the Indian region this type of pit vipers without rattles is likewise well represented, one genus (*Trimeresurus*) being adapted for an arboreal life, like *Atheris* among the *Viperidæ*. Their body (fig. 18) is not more elongate than that of other ground Crotalines, but their tail is prehensile, and their colour generally resembles that of the bright foliage among which they live. Sometimes bright yellow or red markings render these snakes still more pleasing to the eye. Accidents caused by them are of not uncommon occurrence, but fortunately only a few individuals exceed a length of 2 feet, and the consequences of their bite are less to be dreaded than of that of other allied genera. Indeed, numerous cases are on record which show that the constitutional symptoms caused by their poison were of short duration, lasting only from two to forty-eight hours, and being confined to nausea, vomiting, and fever. The bite of larger specimens, of from 2 to 3 feet long, is more dangerous and has occasionally proved fatal. They feed on frogs, mammals, and birds. (A. C. G.)

SNAKE-STONE, a name sometimes applied to Water-of-Ayr stone (see HONE, vol. xii. p. 134). Certain stones reputed, on insufficient grounds, to possess efficacy as antidotes to snake-bites are known as snake-stones (see above, p. 192). The term is also popularly applied to ammonites and certain other fossils which, owing to their spiral shape, were formerly regarded as petrified snakes.

SNEEK, a town of the Netherlands, in the province of Friesland, 18 miles south-south-west of Leeuwarden, with which it is connected by canal and (since 1885) by rail. It is one of the great butter and cheese markets of the country and has communal buildings (1863), a town-house, a court-house, an orphanage, a synagogue, and several churches, in one of which (the Groote or Maartenskerk) is the tomb of the naval hero Lange Pier (Long Peter). The population of the town was in 1870 8466; that of the commune, which numbered only 3253 in 1714, was 9248 in 1870 and 10,496 in 1880.

Sneek appears in the list of Frisian towns in 1268. It was almost reduced to ashes in 1295, and again in 1417 and 1457. In 1515 it was attacked and in 1517 formally besieged by the Burgundians. A diet met in the town in the close of this latter year; and long after, in 1672, Sneek was again the seat of an assembly of the states. In 1570 and in 1825 there were severe inundations.

SNELL, WILLEBRORD (1591-1626), commonly known as SNELLIUS, astronomer and mathematician, was born at Leyden in 1591. In 1613 he succeeded his father as professor of mathematics in the university of Leyden. In 1615 he planned and carried into practice a new method of finding the dimensions of the earth, by determining the distance of one point on its surface from the parallel of another, by means of a triangulation. His work *Eratosthenes Batavus*, published in 1617, describes the method and gives as the result of his operations between Alkmaar and Bergen-op-Zoom a degree of the meridian equal to 55,100 toises = 117,449 yards. (A later recalculation has given 57,033 toises = 121,569 yards, after applying some corrections to the measures indicated by himself.) Snell also distinguished himself as a mathematician, and discovered the law of refraction, which,

however, is generally attributed to Descartes, who made it more widely known. Snell died at Leyden on 30th October 1626.

In addition to the *Eratosthenes Batavus* he published *Cyclometrica sive de circuli dimensione* (Leyden, 1621, 4to), and edited *Cæli et siderum in eo errantium observationes Hassiacæ* (ibid., 1618, 4to), containing the astronomical observations of Landgrave William IV. of Hesse. About his *Tiphys Batavus s. Histiodromice, de navium cursibus et re navali* (1624), see NAVIGATION, vol. xvii. p. 255, note. A trigonometry (*Doctrina triangulorum*) by him was published a year after his death.

SNIPE (Anglo-Saxon *Snite*, Icelandic *Snípa*, Dutch *Snip*, German *Schnepfe*), one of the commonest Limicoline birds, in high repute no less for the table than for the exciting sport it affords. It is the *Scolopax gallinago* of Linnæus, but by many later writers separated from that genus, the type of which is the WOODCOCK (*q.v.*), and hence has been variously named *Gallinago cælestis*, *G. media*, or *G. scolopacina*. Though considerable numbers are still bred in the British Islands, notwithstanding the diminished area suitable for them, most of those that fall to the gun are undoubtedly of foreign origin, arriving from Scandinavia towards the close of summer or later, and many will outstay the winter if the weather be not too severe, while the home-bred birds emigrate in autumn to return the following spring. Of late years British markets have been chiefly supplied from abroad, mostly from Holland.

The Snipe is fortunately too well known to need description, for a description of its variegated plumage, if attempted, would be long. It may be noticed, however, as subject to no inconsiderable variation, especially in the extent of dark markings on the belly, flanks, and axillaries, while examples are occasionally seen in which no trace of white, and hardly any of buff or grey, is visible,—the place of these tints being taken by several shades of chocolate-brown. Such examples were long considered to form a distinct species, the *S. sabinii*, but its invalidity is now generally admitted. Other examples in which buff or rust-colour predominates have also been deemed distinct, and to these has been applied the epithet *russata*. Again, a slight deviation from the ordinary formation of the tail, whose rectrices normally number 14, and present a rounded termination, has led to the belief in a species, *S. brehmi*, now wholly discredited. But, setting aside two European species, to be presently noticed more particularly, there are at least a score, more or less nearly allied, belonging to various parts of the world, for no considerable territory is without its representative. Thus North America produces *G. wilsoni*, so like the English Snipe as not to be easily distinguished except by the possession of 16 rectrices, and Australia has *G. australis*, a larger and somewhat differently coloured bird with 18 rectrices. India, while affording a winter resort to multitudes of the common species, which besides Europe extends its breeding range over the whole of northern Asia, has the so-called Pin-tailed Snipe, *G. stenura*, in which the number of rectrices is still greater, varying from 20 to 28, it is said, though 22 seems to be the usual number. This curious variability, deserving more attention than it has yet received, only occurs in the outer feathers of the series, which are narrow in form and extremely stiff, there being always 10 in the middle of ordinary breadth.

Those who only know the Snipe as it shows itself in the shooting-season, when without warning it rises from the boggy ground uttering a sharp note that sounds like *scape*, *scape*, and, after a few rapid twists, darts away, if it be not brought down by the gun, to disappear in the distance after a desultory flight, have no conception of the bird's behaviour at breeding-time. Then, though flushed quite as suddenly, it will fly round the intruder, at times almost hovering over his head. But, if he have patience, he will see it mount aloft and there execute a series of aerial evolutions of an astounding kind. After wildly circling about, and reaching a height at which it appears a mere speck, where it winnows a rambling zigzag course, it abruptly shoots downwards and aslant, and then as abruptly stops to regain its former elevation, and this process it repeats many times. A few seconds, more or less according to distance, after each of these headlong descents a mysterious sound strikes his ear—compared by some to drumming and by others to the bleating of a sheep or goat,[1] which sound evidently comes from the bird as it shoots downwards, and then only; but how the sound is made is a question on which many persons are still undecided. There are those who maintain that it proceeds from the throat, while some declare it is produced by the wings, which sharp-sighted observers say they can see in tremulous motion. Others, again, assert that it is caused by the vibration of the webs of the outer rectrices, and these last have in support of their opinion the fact that a similar sound may be made by affixing those feathers to the end of a rod and drawing them rapidly downwards in the same position as they occupy in the bird's tail while it is performing the feat.[2] But, however it be produced, the air will also ring with loud notes that have been syllabled *tinker, tinker, tinker*, while other notes in a different key, something like *djepp, djepp, djepp* rapidly uttered, may be heard as if in response. The nest is always on the ground and is a rather deep hollow wrought in a tuft of herbage, and lined with dry grass-leaves. The eggs are four in number, of a dark olive colour, blotched and spotted with rich brown. The young when freshly hatched are beautifully clothed in down of a dark maroon, variegated with black, white, and buff.

The Double or Solitary Snipe of English sportsmen, *S. major*, a larger species, also inhabits northern Europe and may be readily recognized by the white bars in its wings and by its 16 or occasionally 18 rectrices. It has also a very different behaviour. When flushed it rises without alarm-cry, and flies heavily. In the breeding season much of its love-performance is exhibited on the ground, and the sounds to which it gives rise are of another character; but the exact way in which its "drumming" is effected has not been ascertained. Its gesticulations at this time have been well described by Prof. Collett in a communication to Mr Dresser's *Birds of Europe* (vol. vii. pp. 635-637). It visits Great Britain every year at the close of summer, but in very small numbers, and is almost always seen singly—not uncommonly in places where no one could expect to find a Snipe.

The third species of which any details can here be given is the Jack-[3] or Half-Snipe, *S. gallinula*, the smallest and most beautifully coloured of the group. Without being as numerous as the common or full Snipe, it is of frequent occurrence in Great Britain from September to April (and occasionally both earlier and later); but it breeds only, so far as is known, in northern Scandinavia and Russia; and the first trustworthy information on that subject was obtained by Wolley in June 1853, when he found several of its nests near Muonioniska in Lapland.[4] Instead of rising wildly as do most of its allies, it generally lies so close as to let itself be almost trodden upon, and then takes wing silently, to alight at a short distance (if it escape the gun), and to return to the same place on the morrow. In the breeding-season, however, it is as noisy and conspicuous as its larger brethren while executing its aerial evolutions.

As a group the Snipes are in several respects highly specialized, but here there is only space to mention the sensitiveness of the bill, which, though to some extent noticeable in many Sandpipers (see vol. xxi. p. 260), is in Snipes carried to an extreme by a number of filaments, belonging to the fifth pair of nerves, which run almost to the tip, and open immediately under the soft cuticle in a series of cells that give this portion of the surface of the premaxillaries, when exposed, a honeycomb-like appearance. Thus the bill becomes a most delicate organ of sensation, and by its means the bird, while probing for food, is at once able to distinguish the nature of the objects it encounters, though these are wholly out of sight. So far as is known, the sternum of all the Snipes, except the Jack-Snipe, departs from the normal Limicoline formation, a fact which tends to justify the removal of that species to a separate genus, *Limnocryptes*.[5] (A. N.)

[1] Hence in many languages the Snipe is known by names signifying "Flying Goat," "Heaven's Ram," as in Scotland by "Heather-bleater."

[2] Cf. Meves, *Efvers. K. Vet.-Akad. Förh.*, 1856, pp. 275-277 (transl. *Naumannia*, 1858, pp. 116, 117), and *Proc. Zool. Society*, 1858, p. 202, with Wolley's remarks thereon, *Zool. Garten*, 1876, pp. 204-208.

[3] Though this word is clearly not intended as a nickname, such as is the prefix which custom has applied to the Daw, Pie, Redbreast, Titmouse, or Wren, one can only guess at its origin or meaning. It may be, as in Jackass, an indication of sex, for it is a popular belief that the Jack-Snipe is the male of the common species; or, again, it may refer to the comparatively small size of the bird, as the "jack" in the game of bowls is the smallest of the balls used, and as fishermen call the smaller Pikes Jacks.

[4] His account was published by Hewitson in May 1855 (*Eggs Br. Birds*, 3d ed., ii. pp. 356-358).

[5] The so-called Painted Snipes, forming the genus *Rhynchæa*, demand a few words. Four species have been described, natives respectively of South America, Africa, India with China, and Australia. In all of these it appears that the female is larger and more brilliantly coloured than the male, and in the Australian species she is further distinguished by what in most birds is emphatically a masculine property, though its use is here unknown,—namely, a complex trachea, while the male has that organ simple. He is also believed to undertake the duty of incubation.

SNORRO STURLUSON (Snorri, son of Sturla) (1179-1241), the celebrated Icelandic historian, born in 1179, the youngest son of a chief in the Vestfirðir (western fiords), was brought up by a powerful chief, Jon Loptsson, in Odda, who seems first to have awakened in him an interest for history and poetry. His career begins with his marriage, which made him a wealthy man; in 1206 he settled at Reykjaholt, where he constructed magnificent buildings and a bath of hewn stones, preserved to the present day, to which water was conducted from a neighbouring hot spring. He early made himself known as a poet, especially by glorifying the exploits of the contemporary Norse kings and earls; at the same time he was a learned lawyer, and from 1215 became the "lögsögumaðr," or president of the legislative assembly and supreme court of Iceland. The prominent features of his character seem to have been cunning, ambition, and avarice, combined with want of courage and aversion to effort. By royal invitation he went in 1218 to Norway, where he remained a long time with the young king Hakon and his tutor Earl Skuli. When, owing to disputes between Icelandic and Norwegian merchants, Skuli thought of a military expedition to Iceland, Snorro persuaded him to give up this plan, promising to make the inhabitants submit to Hakon of their own free will. Snorro himself became the "lendrmaðr," vassal or baron, of the king of Norway, and held his lands as a fief under him. On his return home Snorro sent his son to the king as a hostage, and made peace between Norway and Iceland, but his power and influence were used more for his own enrichment and aggrandizement—he was "lögsögumaðr" again from 1222 to 1232—than for the advantage of the king. Hakon, therefore, stirred up strife between Snorro's kinsman Sturla and Snorro, who had to fly from Reykjaholt in 1236; and in 1237 he left the country and went back to Norway. Here he joined the party of Skuli, who was meditating a revolt. Learning that his cousin Sturla in Iceland had fallen in battle against Gissur, Snorro's son-in-law, Snorro, although expressly forbidden by his liege lord, returned to Iceland in 1239 and once more took possession of his property. Meanwhile Hakon, who had vanquished Skuli in 1240, sent orders to Gissur to punish Snorro for his disobedience either by capturing him and sending him back to Norway or by putting him to death. Gissur took the latter course, attacked Snorro at his residence, Reykjaholt, and slew him on 22d September 1241.

Snorro is the author of the *Edda* and of the *Sagas of the Norwegian Kings*. The *Edda*, now called the Prose Edda, to distinguish it from the Poetic or Sæmund's Edda, was finished in 1222, and consists of three parts. (1) The *Gylfaginning*, or the Delusion of Gylfi, with a short preface, gives a summary of the ancient Norse mythology, founded on the *Völuspá* and other mythical poems; the author gives a euhemeristic account of the ancient gods, regarding them as chiefs versed in witchcraft who had immigrated to the north and there introduced their special religion. (2) The *Skáldskaparmál*, or Art of Poetry, gives, under the form of a dialogue between the god Bragi and the giant (jötun) Ægir, an explanation of all figurative mythological expressions of the ancient poetry, and the rules for using them. (3) The *Háttatal*, or Enumeration of Metres, is a running commentary on three poems composed by Snorro in 1222 in honour of Hakon and Skuli, the stanzas of which, numbering about a hundred, are each in a different metre. In the MSS. the *Edda* has received many additions, which are wrongly ascribed to Snorro. For different editions see EDDA. The *Sagas of the Norwegian Kings* gives a connected series of biographies of the kings of Norway down to Sverri in 1177; here the author stops, because the history of Sverri and his successors had already been written. The work opens with the *Ynglinga Saga*, a brief history of the pretended immigration into Sweden of the Æsir, of their successors in that country, the kings of Upsala, and of the oldest Norwegian kings, their descendants. Next come the biographies of the succeeding Norwegian kings, the most detailed being those of the two missionary kings Olaf Tryggvason and St Olaf. Snorro's sources were partly succinct histories of the realm, as the chronological sketch of Ari; partly more voluminous early collections of traditions, as the *Noregs Konungatal* (*Þiðrekskonu*) and the *Jarlasaga*; partly legendary biographies of the two Olafs; and, in addition to these, studies and collections which he himself made during his journeys in Norway. All these he worked up with great independence and critical sagacity into an harmonious whole. His critical principles are explained in the preface, where he dwells on the necessity of starting as much as possible from trustworthy contemporary sources, or at least from those nearest to antiquity,—the touchstone by which verbal traditions can be tested being contemporary poems. He inclines to rationalism, rejecting the marvellous and recasting legends containing it in a more historical spirit; but he makes an exception in the accounts of the introduction of Christianity into Norway and of the national saint St Olaf. Snorro's style is peculiar to himself. He strives everywhere to impart life and vigour to his narrative, to express the sentiments and feelings of the actors, and he gives the dialogues in the individual character of each person. Especially in this last he shows a tendency to epigram and often uses humorous and pathetic expressions. Besides his principal work, he elaborated in a separate form its better and larger part, the *History of St Olaf* (the great *Olaf's Saga*). In the preface to this he gives a brief extract of the earlier history; and, as an appendix, a short account of St Olaf's miracles after his death; here too he employs critical art, as appears from a comparison with his source, the Latin legend.

The *Sagas of the Norwegian Kings* has been preserved in several MSS. of the 13th century; the oldest of these, no longer extant, had lost at an early period its first leaf containing the preface, and thus came to begin with the words, *Kringla heimsins* (= orbis terrarum), which caused first this MS. and later (about 1700) the whole work to be called the *Heimskringla*. Editions:—by Peringskiöld, 3 vols. fol., Stockholm, 1697; by Gerhard Schöning and Skule Thorlacius, 3 vols. fol., Copenhagen, 1777-1783; by C. R. Unger, 1 vol. 8vo, Christiania, 1868. Modern translations:—into Danish, by N. F. S. Grundtvig, 1818-22; Norwegian, by Jacob Aall, 1838-39, and by P. A. Munch, 1849; Swedish, by Richert, 1816-29, and by H. Hildebrand, 1869-71; German, by Wachter, 1835-36; English, by Laing, 1844. (G. S.)

SNOW. See METEOROLOGY, vol. xvi. p. 154; also GEOLOGY, vol. x. pp. 280-281.

SNOWDROP, *Galanthus nivalis*, is the best-known representative of a small genus of Amaryllids, all the species of which have bulbs, linear leaves, erect flower-stalks, destitute of leaves but bearing at the top a solitary pendulous bell-shaped flower. The white perianth is six-parted, the outer three segments being larger and more convex than the inner series. The six anthers open by pores or short slits. The ovary is three-celled, ripening into a three-celled capsule. The snowdrop is a doubtful native of Great Britain, but is largely cultivated for market in Lincolnshire. There are numerous varieties, differing in the size of the flower and the period of flowering. The double form is probably the least attractive. Other distinct species of snowdrop, not to be confounded with the varieties before mentioned, are the Crimean snowdrop, *G. plicatus*, with broad leaves folded like a fan, and *G. Elwesii*, a native of the Levant, with large flowers, the three inner segments of which have a much larger and more conspicuous green blotch than the commoner kinds. All the species are very graceful, and as universal favourites amply repay cultivation.

SNOW-SHOES are a kind of foot gear used by Indians and trappers in Canada for travelling over the frozen surface of snow. In the long North-American winters they are the sole means of locomotion when railways and roads are snowed up, as the frozen surface of snow is not sufficiently consistent to support the weight of the human body without artificial aid. The snow-shoer protects his feet by wearing moccasins of moose-skin. The framework of a snow-shoe consists of a long narrow piece of pliable hickory wood, placed edgeways and then bent round with an oval-shaped front, and is adorned on the sides with tufts of crimson wool. The ends taper gradually to the rear, where they are fastened firmly to each other. The total length is about 39 inches and the width from 13 to 16 inches. Across the oval, and fitted into the inside of the framework by mortices, are two battens of wood, 5 or 6 inches clear of both ends. Over the front one at an open space a deerskin thong is fastened, forming an aperture for the reception of the great toe. The thong is then crossed over the top of the foot, passed round and tied to the sides. This leaves the heel free to move up and down on the shoe and rests the weight of it on the toes. Over the remainder of the oval

is stretched a network of tightly drawn strips of leather. At a convention held in Montreal on 30th December 1871 a rule was passed that a "pair of racing shoes, including strings, shall not weigh less than 1½ lb nor measure less than 10 inches of gut in width." The motion of a snow-shoer in the distance is curious and resembles that of some ungainly web-footed animal. On using the implements the knees must be turned inwards and the fore part of the feet outwards to avoid wounding the ankles with the frameworks. At first the fatigue and consequent stiffness are great; but with practice this wears off and the motions become easy. The speed attained as compared to that in skating is not quick. The following are the best recorded times in Montreal, Canada, with shoes of regulation size and weight:—100 yards, 12 sec.; 220 yards, 26 sec.; ¼ mile, 1 min. 7⅗ sec.; ½ mile 2 min. 33 sec.; ¾ mile, 4 min. 21 sec.; 1 mile, 5 min. 42½ sec.; 2 miles, 11 min. 52¾ sec.; 3 miles, 20 min. 18 sec.; 4 miles, 27 min. 10 sec.; 4½ miles, 30 min. 36 sec.; 5 miles, 33 min. 49½ sec. The best history of the pastime and its records is *Montreal Snow-shoe Club*, sm. 8vo, Montreal, 1882.

SNUFF. See TOBACCO.

SNYDERS, FRANZ (1579-1657), painter of animals and still life, was born at Antwerp in 1579. In 1593 he was studying under Peter Breughel, and afterwards he received instruction from Henry van Balen, the first master of Vandyke. He devoted himself to painting flowers, fruit, and subjects of still life, but afterwards turned to animal-painting, and executed with the greatest skill and spirit hunting pieces and combats of wild animals. His composition is rich and varied, his drawing correct and vigorous, his touch bold and thoroughly expressive of the different textures of the furs and skins of the animals represented. His excellence in this department excited the admiration of Rubens, who frequently employed him to paint animals, fruit, and still life in his own pictures, and he assisted Jordaens in a similar manner. In the lion and boar hunts which bear the name of Snyders the hand of Rubens sometimes appears. He was appointed principal painter to the archduke Albert, governor of the Low Countries, for whom he executed some of his finest works. One of these, a Stag-Hunt, was presented to Philip III., who commissioned the artist to paint several subjects of the chase, which are still preserved in Spain. Snyders died at Antwerp in 1657.

SOAP may in general terms be defined as a chemical compound resulting from the union of fatty oils and fats with alkaline bodies. In a scientific definition the compounds of fatty acids with basic metallic oxides, lime, magnesia, lead oxide, &c., should also be included under soap; but, as these compounds are insoluble in water, while the very essence of a soap in its industrial relations is solubility, it is better to speak of the insoluble compounds as "plasters," limiting the name "soap" to the compounds of fatty acids with soda and potash. Soap both as a medicinal and as a cleansing agent was known to Pliny (*H.N.*, xxviii. 51), who speaks of two kinds—hard and soft—as used by the Germans. He mentions it as originally a Gallic invention for giving a bright hue to the hair ("rutilandis capillis"). There is reason to believe that soap came to the Romans from Germany, and that the detergents in use in earlier times and mentioned as soap in the Old Testament (Jer. ii. 22; Mal. iii. 2, &c.) refer to the ashes of plants and other such purifying agents (comp. vol. x. p. 697).

Till Chevreul's classical researches on fatty bodies (1811-23) it was believed that soap consisted simply of a binary compound of fat and alkali. Claude J. Geoffroy in 1741 pointed out that the fat or oil recovered from a soap solution by neutralization with a mineral acid differs from the original fatty substance by dissolving readily in alcohol, which is not the case with ordinary fats and oils. The significance of this observation was overlooked; and equally unheeded was a not less important discovery by Scheele in 1783. In preparing lead plaster by boiling olive oil with oxide of lead and a little water—a process palpably analogous to that of the soap-boiler—he obtained a sweet substance which, called by himself "Oelsüss" ("principium dulce oleorum"), is now known as "glycerin." These discoveries of Geoffroy and Scheele formed the basis of Chevreul's researches by which he laid bare the constitution of oils and the true nature of soap. (See OILS, vol. xvii. p. 740, and GLYCERIN, vol. x. p. 697.) In those articles it is pointed out that all fatty oils and fats are mixtures of glycerides, that is, of bodies related to the alcohol glycerin $C_3H_5(OH)_3$, and some fatty acid such as palmitic acid $(C_{16}H_{31}O_2)H$. Under suitable conditions

$$\underset{\text{Glycerin.}}{C_3H_5(OH)_3} + 3\underset{\text{Palmitic Acid.}}{(C_{16}H_{31}O_2)H} \text{ give } \underset{\text{Palmitin.}}{C_3H_5(C_{16}H_{31}O_2)_3} + 3\underset{\text{Water.}}{H_2O}$$

The corresponding decomposition of palmitin into palmitic acid and glycerin takes place when the glyceride is distilled in superheated steam, and similarly it can be realized by boiling in water mixed with a suitable proportion of caustic potash or soda. But in this case the fatty acid unites with the alkali into its potash or soda salt, forming a soap—

$$\underset{\text{Palmitin.}}{C_3H_5(C_{16}H_{31}O_2)_3} + 3\underset{\text{Soda Hydrate.}}{NaOH} = 3\underset{\text{Soap.}}{NaC_{16}H_{31}O_2} + \underset{\text{Glycerin.}}{C_3H_5(OH)_3}$$

Of the natural fats or glycerides contained in oils the most important in addition to palmitin are stearin and olein, and these it may be sufficient to regard as the principal fatty bodies concerned in soap-making.

The general characters of a soap are a certain greasiness to the touch, ready solubility in water, with formation of viscid solutions which on agitation yield a tenacious froth or "lather," an indisposition to crystallize, readiness to amalgamate with small proportions of hot water into homogeneous slimes, which on cooling set into jellies or more or less consistent pastes. Soaps give an alkaline reaction and have a decided acrid taste; in a pure condition—a state never reached in practice—they have neither smell nor colour. Almost without exception potash soaps even if made from the solid fatty acids are "soft," and soda soaps, although made with fluid olein, are "hard"; but there are considerable variations according to the prevailing fatty acid in the compound. Almost all soda soaps are precipitated from their watery solutions by the addition of a sufficiency of common salt. Potash soap with the same reagent undergoes double decomposition—a proportion being changed into a soda soap with the formation of chloride of potassium. Soap when dissolved in a large amount of water suffers hydrolysis, with formation of a precipitate of alkaliferous fatty acid and a solution containing free alkali. Its cleansing power is ordinarily explained by this reaction; but it is difficult to see why a solution which has just thrown off most of its fatty acids should be disposed to take up even a glyceride. It is more likely that the cleansing power of soap is due to the inherent property of its solution to emulsionize fats.

Resin soaps are compounds of soda or potash with the complex acids (chiefly abietic) of which coniferous resins consist. Their formation is not due to a true process of saponification; but they occupy an important place in compound soaps.

MANUFACTURE.—The varieties of soaps made are numerous; the purposes to which they are applied are varied; the materials employed embrace a considerable range of oils, fats, and other bodies; and the processes adopted undergo many modifications. As regards processes of manufacture soaps may be made by the direct combination of fatty acids, separated from oils, with alkaline solutions. In the manufacture of stearin for candles, &c., the fatty matter is decomposed, and the liquid olein, separated from the solid fatty acids, is employed as an ingredient in soap-making. A soap so made is

not the result of saponification but of a simple combination, as is the case also with resin soaps. All other soaps result from the combination of fatty oils and fats with potash or soda solutions under conditions which favour saponification. The soap solution which results from the combination forms soap-size and is a mixture of soap with water, the excess alkali, and the glycerin liberated from the oil. In such condition ordinary soft soaps and certain kinds of hard soap are brought to the market. In curd soaps, however, which form the basis of most household soap, the uncombined alkali and the glycerin are separated by "salting out," and the soap in this condition contains about 30 per cent. of water. Soap may be framed and finished in this state, but almost invariably it receives a further treatment called "refining" or "fitting," in which by remelting with water, with or without the subsequent addition of other agents to harden the finished product, the soap may be made to contain from 60 to 70 per cent. of water and yet present a firm hard texture.

Among the raw materials used by the soap-boiler the principal fatty bodies are tallow, lard, palm oil, palm-kernel oil, olive oil, cotton-seed oil, sesame oil, and cocoa-nut oil for hard soaps, and fish oils, linseed oil, marrow fat, and the lower qualities of other oils obtained by extraction, &c., for potash or soft soaps. Almond oil, spermaceti, cocoa-butter, ground-nut oil, and some others form the basis of certain toilet and medicinal soaps. Resin and colophony form essential ingredients in yellow soaps. The alkalis are used almost exclusively in the condition of caustic lyes,—solutions of their respective hydrates in water. Caustic soda is now obtained direct from the soda manufacturer, and one operation, causticizing the soda, is thus spared the soap-boiler. Potash lyes are, however, principally sharpened or causticized by the soap-boiler himself from potash carbonate, the process for which is described under POTASSIUM METALS (vol. xix. p. 589).

The process of soap-boiling is carried out in large iron boilers called "soap pans" or "coppers," some of which have capacity for a charge of 30 tons or more. The pan proper is surmounted by a great cone or hopper called a *cap*, to provide for the foaming up of the boiling mass and to prevent loss from overflowing. Formerly the pans were heated by open firing from below; but now the almost universal practice is to boil by steam injected from perforated pipes coiled within the pan, such injection favouring the uniform heating of the mass and causing an agitation favourable to the ultimate mixture and saponification of the materials. Direct firing is used for the second boiling of the soap mixture; but for this superheated steam may with advantage be substituted, either applied by a steam-jacket round the pan or by a closed coil of pipe within it. In large pans a mechanical stirring apparatus is provided, which in some cases, as in Morfit's steam "twirl," is formed of the steam-heating tubes geared to rotate. Closed cylinders in which the materials are boiled under pressure are also employed for certain soaps.

Curd Soap.—The oil mixture used differs in the several manufacturing countries, and the commercial name of the product is correspondingly varied. In Germany tallow is the principal fat; in France olive oil occupies the chief place and the product is known as Marseilles or Castile soap; and in England tallow and palm oil are largely used. But in all countries a mixture of several oils enters into the composition of curd soaps and the proportions used have no fixity. For each ton of soap to be made from 12 to 16 cwts. of oil is required. The soap pan is charged with the tallow or other fat, and open steam is turned on. So soon as the tallow is melted a quantity of weak lye is added, and the agitation of the injected steam causes the fat and lye to become intimately mixed and produces a milky emulsion. As the lye becomes absorbed, a condition indicated by the taste of the goods, additional quantities of lye of increasing strength are added. After some time, the contents of the pan begin to clear and become in the end very transparent. Lye still continues to be poured in till a sample tastes distinctly alkaline,—a test which indicates that the whole of the fatty acids have been taken up by and combined with the alkali. Then without further addition of alkali the boiling is continued for a few minutes, when the soap is ready for salting out or "graining." Either common salt or strong brine in measured quantity is added to the charge, and, the soap being insoluble in such salt solution, a separation of constituents takes place: the soap collects on the surface in an open granular condition, and the spent lye sinks to the bottom after it has been left for a short time to settle. Supposing now that a pure soap without resin is to be made—a product little seen in the market—the spent lye is run off, steam is again turned on, pure water or very weak lye run in, and the contents boiled up till the whole is thin, close, and clear. The soap is from this again grained off or salted out, and the underlye so thrown down carries with it coloured impurities which may have been in the materials or which arise from contact with the boiler. Such washing process may have to be repeated several times when impure materials have been used. The spent lye of the washing being drained off, the soap now receives its strengthening boil. Steam is turned on, and, the mass being brought to a clear condition with weak lye or water, strong lye is added and the boiling continued with close steam till the lye attains such a state of concentration that the soap is no longer soluble in it, and it will separate from the caustic lye as from a common salt solution. The contents of the pan are once more allowed to cool and settle, and the soap as now formed constitutes a pure curd soap, carrying with it some proportion of uncombined alkali, but containing the minimum amount of water. It may be skimmed off the underlye and placed direct in the frames for solidification; but that is a practice scarcely at all followed, the addition of resin soap in the pan and the subsequent "crutching in" of silicate of soda and adulterant mixings being features common to the manufacture. The lye from the strengthening boil contains much alkali and is used in connexion with other boilings.

Mottled Soap.—A pure curd soap always carries with it into the cooling frame a considerable amount of coloured impurity, such as iron sulphate, &c. When it is permitted to cool rapidly the colouring matter remains uniformly disseminated throughout the mass; but when means are taken to cause the soap to cool and solidify slowly a segregation takes place: the stearate and palmitate form a semi-crystalline solid, while the oleate, solidifying more slowly, comes by itself into translucent veins, in which the greater part of the coloured matter is drawn. In this way mottled or marbled soap is formed, and such mottled appearance was formerly highly valued as an indication of freedom from excess of water or other adulteration, because in fitted soaps the impurities are either washed out or fall to the bottom of the mass in cooling. Now, however, the most perfect mottle can be produced by working colouring matter into the soap in the frame, and mottling is very far from being a certificate of excellence of quality.

Yellow Soap consists of a mixture of any hard fatty soap with a variable proportion—up to 40 per cent. or more—of resin soap. That substance by itself has a tenacious gluey consistence, and its intermixture in excess renders the resulting compound soft and greasy. The ordinary method of adding resin consists in stirring it in small fragments into the fatty soap in the stage of clear-boiling; but a better result is obtained by separately preparing a fatty soap and the resin soap, and combining the two in the pan after the underlye has been salted out and removed from the fatty soap. The compound then receives its strengthening boil, after which it is fitted by boiling with added water or weak lye, continuing the boil till by examination of a sample the proper consistency has been reached. On settling a dark-coloured "nigger" or underlye separates out, which, because it contains some soap and alkali, is saved for future use.

Marine Soap.—Cocoa-nut oil behaves as regards saponification quite differently from all other oils and fats in relation to the caustic alkalis. It does not form an emulsion with weak alkalis; these even under prolonged boiling have no influence on the fat. With strong alkaline solutions, on the other hand, it saponifies with the utmost readiness even without heat, and forms without the separation of any underlye a soap of stiff firm consistence notwithstanding the presence of a very large percentage of water. Such soap is not insoluble in a strong solution of salt; hence it forms a lather and can be used for washing with sea-water, from which peculiarity it derives its name "marine soap." Being thus soluble in salt water it cannot of course be salted out like common soaps; but if a very concentrated salt solution is used precipitation is effected, and a curd soap is separated so hard and refractory as to be practically useless. Cocoa-nut soap is usually prepared by the so-called cold method, in which the fat heated to 80° C. is treated with a calculated quantity of caustic soda solution of sp. gr. 1·350, the two constituents being stirred together till the setting and hardening of the combination prevents further agitation. The property that cocoa-nut soap possesses of absorbing large proportions of water, and yet presenting the appearance of a hard solid body, makes the material a favourite basis for highly sophisticated compounds, in which water, sulphate of soda, and other alkaline solutions, soluble silicates, fuller's earth, starch, &c., play an important and bulky part. Cocoa-nut soap is little prepared by itself; but it forms a principal ingredient in compound soaps meant to imitate curd and yellow soaps. Two principal methods of preparing such compound soaps are employed. In the first way the ordinary oil and the cocoa-nut oil are mixed and saponified together with such a measured quantity of alkaline solution as serves to produce a hard soap without any salting out or separation of underlye. According to the second plan, the ordinary oil is treated as for the preparation of a curd soap, and to this the cocoa-nut soap separately saponified is added in the pan and both are boiled together till they form a homogeneous soap.

Silicate Soaps.—A further means of enabling a soap to contain large proportions of water and yet present a firm consistence is found in the use of silicate of soda. The silicate in the form of a concentrated solution is crutched or stirred into the soap in a mechanical mixing machine after the completion of the saponification, and it appears to enter into a distinct chemical combination with the soap. While silicate soaps bear heavy watering, the