ing a new portion between. Moths and butterflies remain in the larval condition for periods varying from three years, as in the Goat Moth (*Cossus ligniperda*), to a few weeks, as in the Cabbage Butterfly (*Pieris brassicæ*), which usually has two broods in the season, while many species whose larvæ leave the egg in autumn, as the Blue Butterfly (*Polyommatus alexis*), remain torpid throughout winter at this stage, and waken up to resume feeding in spring. During this period they increase enormously in weight; thus the larva of the Privet Hawk Moth (*Sphinx ligustri*) which casts its sixth and last skin on the twenty-second day after emerging from the egg, attains its greatest size ten days after, having in the meantime increased to 11,312 times its original weight; while the Goat Moth (*Cossus ligniperda*), which remains in the larval condition for three years, has grown in that period 72,000 times heavier. Having attained its full growth the instincts of the caterpillar undergo a change; it ceases to eat and begins to weave a couch or cocoon by which it is more or less enclosed. It then throws off its skin and appears as a pupa or chrysalis incapable of eating or of locomotion, the only apparent sign of life which it manifests being a convulsive twitching when irritated. Examined more closely, however, life is seen to be exerted in very great intensity in this stage of apparent quiescence. The immense digestive system of the caterpillar dwindles greatly, the rudiments of wings begin to show themselves, forming slight prominences on each side of the chrysalis shell, while the organs of the masticatory mouth are being transformed into those of the suctorial. In assuming the pupa condition caterpillars dispose of themselves in a great variety of ways. Many, like the common Cabbage Butterfly, ascend walls and palings, to which they attach themselves by a silken belt, others, as silkworms, spin around them a solid cocoon of pure silk; while the majority of Sphinx Moths form burrows in the ground, which they line with silk and afterwards varnish to keep out the moisture,—one of these (*Sphinx ligustri*) remaining thus buried from August till June. Those larvæ which feed on the wood of trees, as *Cossus ligniperda*, generally form tough cocoons of chips of wood and of silk within the tunnels which they have bored in the tree, and their pupæ have the power of forcing themselves along those passages till they reach the bark, where they remain until about to emerge from the egg, when they pierce it also. The cocoon of the Puss Moth (*Cerura vinula*), composed of the same materials as in the preceding instance, is usually placed in a crevice of the bark of a tree, where by exposure to the atmosphere it becomes hard as horn, the moth only making its escape after discharging a liquid by which one end of the cocoon is softened. Hairy caterpillars are usually deficient in silk, and in forming their cocoons mix what they have of this with the hairs of their body. A beautiful net-like cocoon is woven by a South American moth belonging to the *Bombycidæ*, which it suspends from the top of an outstanding leaf. "When the caterpillar," says Bates, "begins its work it lets itself down from the tip of the leaf which it has chosen by spinning a thread of silk, the thickness of which slowly increases as it descends. Having given the proper length to the cord (about 6 inches) it proceeds to weave its elegant bag, placing itself in the centre and spinning rings of silk at regular intervals, connecting them at the same time by means of cross threads, so that the whole when finished forms a loose web with quadrangular meshes of nearly equal size throughout." The duration of the pupa stage varies from a few weeks to several months; it varies also in the same species according to the season at which it becomes encased; thus the pupa of *Vanessa urticæ* at the beginning of summer usually develops in fourteen days, and at midsummer in eight or nine days, while if it becomes encased in autumn it remains a pupa during the winter. By applying heat the process can be accelerated, and it can be equally retarded by refrigeration. When mature the pupa case cracks towards the anterior end, and the butterfly or moth crawls forth with wings which, though at first small and crumpled up, in a few hours attain their full size. The male insect goes in search of the female, and when the latter has deposited her eggs the main object in the life of the imago is attained and both sexes die. Among the *Bombycidæ* this occurs in two or three days, owing to the atrophied condition of the organs of the mouth. With butterflies courtship is generally a more prolonged affair, several males pursuing the same female, and breaking each others wings in the conflicts that thus frequently ensue. Butterflies appear in many cases to be gregarious, flying in great flocks. Bates states that at one place in South America he noticed eighty different species flying about in enormous numbers in the sunshine, and these, with few exceptions, were males, the females remaining within the forest shades. Darwin also describes a "butterfly shower," which he observed ten miles off the South American coast, extending as far as the eye could reach; "even by the aid of the telescope," he adds, "it was not possible to see a space free from butterflies. That they are occasionally migratory as well as gregarious is borne out by the observations of Sir J. Emerson Tennent, who witnessed in Ceylon a mighty host of butterflies of a white or pale yellow hue, "apparently miles in breadth and of such prodigious extension as to occupy hours and even days uninterruptedly in their passage."

The food of Lepidopterous insects consists chiefly of the sweet liquids drawn from the nectaries of flowers, which they reach by means of their long proboscis or tongue. Many of the *Sphingidæ* are said to do this without settling on the flowers, and one of these, the Humming Bird Hawk Moth of South America (*Macroglossa titan*), in its mode of flight and of poising itself before a flower while extracting the juice, bears such close resemblance to certain of the smaller humming birds inhabiting the same district, that Bates often shot it for one of the latter, and it was only after considerable experience that he learnt to distinguish the bird from the moth when on the wing. Although their food is thus usually the sweetest liquids drawn from loveliest vessels, still some of the most brilliant species seem to prefer more vulgar fare. Thus the showy Purple Emperor (*Apatura iris*) prefers above all things to suck the juices of putrid animal substances, and the surest way to secure specimens of this butterfly is by setting such baits near its haunts. Mr Wallace states that in Malacca he caught a large and brilliant butterfly which had settled on the dung of some carnivorous animal, where he had also observed it on the previous day, and he adds that it is a habit of many of the finest butterflies to suck up the liquid from muddy spots on the roadside.

Butterflies and moths are widely distributed all over the globe, occurring, however, in greatest variety and abundance in tropical lands. They are found as far north as Spitzbergen, on the Alps to a height of 9000 feet, and to double that height on the Andes. In Britain there are only 66, and in the whole of Europe 390 species of butterflies; while within one hour's walk of Pará in Brazil, Bates found no fewer than 700 species. There are 1910 species of British moths, the majority of which are nocturnal and crepuscular; while in tropical America day-flying moths seem to be most common, and may be seen in company with the sunshine-seeking butterflies. This paucity of nocturnal moths has been attributed to the great number of night-flying or crepuscular insectivorous bats and birds which haunt those regions. Many species both of moths and of butterflies have a very wide distribution; the Painted Lady (*Vanessa*

cardui), a common British species, being found in every quarter of the globe; and our finest butterfly, the Swallow Tail (*Papilio machaon*), occurring throughout Europe, Asia as far as the Himalayas, and South Africa. Other species are extremely local, as the Scotch Argus (*Lycæna artaxerxes*), confined to a few Scottish hillsides. Keferstein estimates the total number of *Lepidoptera* at 66,000 species—6000 butterflies and 60,000 moths. That such estimates, however, are not to be relied on is sufficiently proved by the fact that Bates gives the number of species as above 200,000. The geographical distribution of certain groups of *Lepidoptera* has been well wrought out by Mr Wallace and other naturalists who have studied them in their native homes; but the division of this great order into geographical zones has still to be satisfactorily accomplished. Koch has recently proposed to place them in five such groups—(1) the European or Western fauna, including Northern Asia, the North of Africa (a region exceedingly poor in *Lepidoptera*, owing probably to the want of great forests, and to the marshy nature of vast tracts of land), and the northern parts of North America; (2) the African fauna, allied to the preceding; (3) the South Asiatic or Indian; (4) the Australian and Polynesian, allied to the Indian; and (5) the American fauna, distinguished by its exceeding richness.

Butterflies.—Linnæus included all butterflies under the single genus *Papilio*, but later writers have divided them into several well-defined families, and into numerous genera. The largest and most magnificent species belong to the *Ornithoptera* or "Bird-winged Butterflies," a genus of *Papilionidæ*, whose wings, measuring fully 7 inches across, are of a velvety black and brilliant green colour, the latter in such species as *Ornithoptera cræsus* being replaced by fiery orange, while the body is golden, and the breast crimson. They are distributed over the islands of the Malay Archipelago, reaching, according to Mr Wallace, their maximum of size and beauty in the Moluccas. The *Papilios* are a closely allied group, smaller in size but equally brilliant in the colour and form of their wings. They are exceedingly numerous and are widely distributed over both hemispheres. One species only is found in Britain, the handsome Swallow Tail (*Papilio machaon*) (Plate XXVII. figs. 1, 2), formerly abundant in many parts of England, but now confined to the fen districts of Cambridgeshire, Norfolk, and Huntingdon. When alarmed the larvæ of this and of other species of Papilios protrude from the upper part of the neck a soft forked horn that usually diffuses a penetrating and unpleasant odour. One of the most elegant of exotic species is the Malayan *Papilio memnon*, with black and blue wings, 6 inches in expanse, and with the edges of the hind pair gracefully scalloped. This butterfly, though common enough in collections, has recently gained additional interest from the fact, discovered by Mr Wallace, of the remarkable variety in the form of the females, a variety which has led to their being described under several specific names. In one group the females resemble the males in shape, though differing greatly—as many female butterflies do—in colour. In another group they differ both in colour and in the form of the hind-wings. These, Mr Wallace says, are "lengthened out into large spoon-shaped tails, no rudiment of which is ever to be perceived in the males or in the ordinary form of the females." He also found that in shape and colouring those tailed females when on the wing, closely resembled another butterfly belonging to a different section of the same genus, *Papilio coön*, which he considers is thus mimicked by the erratic females of *Papilio memnon*. Strange to say both forms of female are produced from the eggs of either form. The genus *Parnassius*, which seems peculiar to the Alpine or subalpine countries of Europe and the North of Asia, belongs also to the *Papilionidæ*. One species, *Parnassius apollo* (Plate XXVII., fig. 3), has semi-transparent wings, spotted with black and vermilion, and is common in most of the mountain ranges of Europe, where it forms a very striking object. The Brimstones (*Gonepteryx*), the Clouded Yellows (*Colias*, Plate XXVII. fig. 4), and the White Butterflies (*Pieris*, Plate XXVII. fig. 6), many of which are abundant in Britain, and the larvæ of which in most cases make great havoc among garden vegetables, belong to the family *Pieridæ*. That the caterpillars of this group are not fatal to the very existence of certain of our most useful vegetables is due solely to the ravages of the ichneumon flies, the larvæ of which are parasitic upon these caterpillars, to such an extent that in every hundred larvæ of the common Cabbage Butterfly, there are probably not more than two or three entirely free from the ichneumon fly (*Microgaster glomerata*), and few caterpillars so attacked ever reach maturity. The species belonging to the family *Nymphalidæ* have only four legs fitted for walking, the anterior pair being rudimentary. They include the majority of the showy butterflies of temperate regions, as the Peacock Butterfly (*Vanessa io*, Plate XXVII. fig. 9), conspicuous from the "eyes" on the upper surface of its wings. The brilliant colouring of the upper surface is in marked contrast to the sombre hues of the under, which give it when resting on the branch of a tree the appearance of a dried leaf, and so is to a considerable degree protective. The Fritillaries (*Argynnis*, Plate XXVIII. fig. 2) have the under surfaces of the wings ornamented with shining silvery disks, and, except a few tropical species, are the only butterflies which have the under surface more gaily coloured than the upper. The Purple Emperor (*Apatura iris*) is one of the largest and most striking of British species. It is a powerful flyer, frequenting the tops of the highest trees, and is thus difficult of capture unless when brought near the ground by the attraction of some putrid carcase. To the same family belongs *Nymphalis jasius* (Plate XXVIII. figs. 7 and 9), one of the most beautiful of European species. The *Heliconidæ* (Plate XXVII. fig. 7) are a family of South American butterflies, so numerous both in species and in individuals, and of such showy colours on both surfaces of the wings, as to form, says Bates, "a feature in the physiognomy of the forest compensating for the absence of flowers." Their wings are long and narrow, they fly lazily, and might thus be supposed to be specially liable to the attacks of insectivorous animals. As already stated, such is not the case, these insects being apparently protected by the nauseous character of their juices. It is this group which is chiefly mimicked in South America, finding imitators in several species of *Leptalis*, a genus of butterflies belonging to the family *Pieridæ*, also in several species of *Erycinidæ*, and in no fewer than three genera of day-flying moths all belonging to edible groups. The family *Morphidæ* (Plate XXVIII. fig. 8) contains the largest and most splendid of the South American butterflies. Their wings, often 7 inches in expanse, are generally of a brilliant metallic blue, which, as the insect flies, flashes in the sunlight so as to be visible, it is said, a quarter of a mile off. They are found most abundantly in forest glades, through which they sail, only flapping their wings at considerable intervals at a great height, "seldom," says Bates, "descending nearer the ground than 20 feet." The *Satyridæ* (Plate XXIX. fig. 6) are found in every quarter of the globe, and seem equally at home on open plains, in forests, and on the slopes of mountains. Their larvæ feed chiefly on grass, and have the almost unique habit of remaining concealed by day and of coming forth at night to feed. The Marbled White (*Arge galathea*) is the species oftenest met with in Britain. The *Hetairæ* of Brazil, the wings of which are partly transparent, belong to this

family. One of these, *Hetaira esmeralda*, says Bates, "has one spot only of opaque colouring on its wings, which is of a violet and rose hue; this is the only part visible when the insect is flying low over dead leaves in the gloomy shades where alone it is found, and it then looks like the wandering petal of a flower." The *Hesperidæ* or Skippers (Plate XXIX. figs. 13 and 15), so called from their jerky hesitating mode of flight, show, in the thickness of their bodies, the only partially erect way in which they hold their wings when at rest, and the enclosure of their pupa in a cocoon, a distinct approach to the other great division of the *Lepidoptera*—the moths.

Moths.—The vast collection of species included under this term form eight principal groups, divided into numerous families.

1. The *Sphingina* or Sphinx Moths (Plate XXX. figs. 5 and 6), so called from the curious habit which the larvæ have of raising the anterior segments of their bodies, and remaining motionless in this position for hours, thus bearing a fanciful resemblance to the fabled Sphinx, are for the most part crepuscular and day-flying. They are also known in the type family as Hawk-Moths from the strength and velocity of their flight. In common with the vast majority of moths they are furnished with a spine or strong bristle on the anterior margin of the inferior wings, which being received by a process of the under surface of the superior pair, maintains them in a horizontal or somewhat inclined position in repose. They are also usually provided with a greatly elongated tongue, with which they sip their food from flowers, and some species have the power of producing a humming sound. To this group belong the clear-winged moths, *Sesiidæ* (Plate XXX. fig. 12) and *Ægeriidæ*, all day-fliers, and looking more like the bees, wasps, and ichneumons which they are supposed to imitate, than moths; also the family *Uraniidæ* (Plate XXIX. figs. 9 and 14), the species of which are among the most brilliant of *Lepidoptera*,—their wings being of velvety black, relieved by numerous bars of golden green, and the inferior pair prolonged into an elegant tail, closely resembling the same appendage in many of the Papilios. They are all day-fliers, and this, together with their gay colouring and airy forms, led to their being at first classed among butterflies, a position which fuller acquaintance with them in the larva and pupa stages showed to be untenable. The typical species occur in tropical America, where they fly with amazing rapidity and perform annual migrations. The Death's-Head Moth (*Acherontia atropos*) is the largest of European Sphinges, and owing to the peculiar squeaking sound which it utters when alarmed, the death's-head-like markings on the upper surface of its thorax, and its sudden appearance in districts where it may not have been noticed for years, it has for centuries been an object of superstitious dread to the uneducated. Its beautifully marked larvæ feed upon the leaves of the potato, and bury themselves in the ground preparatory to undergoing metamorphosis. The Death's-Head is fond of honey, in search of which its instinct leads it to enter hives, the inmates of which do not attempt to drive it out by means of their stings, but make every endeavour to raise a waxen wall between the moth and their food stores. It is widely distributed over Europe, Asia, and Africa, while closely allied, but still larger forms occur in Australia.

2. The *Bombycina* (Plate XXX. figs. 14, 20–25) are nocturnal moths, with the organs of the mouth in many cases so atrophied as to be unfit for use. These live but a few days, during which the male seeks the female and the latter deposits her eggs. They include the silkworm moths, so important to man from the silken cocoons in which they enclose their pupæ. The silk-producing species are very numerous, but only a few of them have as yet been turned to useful account. The chief of these are the common Silkworm Moth (*Bombyx mori*), a native of China, where its cocoons appear to have been utilized by man from time immemorial. During the 6th century it was introduced into Europe, where it soon flourished wherever the mulberry tree, the leaves of which are the sole food of the silkworm, abounded. On these the larvæ feed for thirty days, after which they begin to spin an oval cocoon of a close tissue of the finest silk, usually of a golden yellow colour, but sometimes white, and which when unravelled forms a continuous thread 1100 yards long. In order to obtain a fresh supply of eggs, the silkworm breeder allows a few of the pupæ to develop into moths; and such is the change wrought upon this species by centuries of domestication that, it is said, they rarely if ever attempt to use their wings. They pair, and the female at once settles on the leaves provided for her, where she deposits her eggs and dies. The Arrindy Silkworm (*Attacus cynthia*), so called from the native name of the castor-oil plant on which its larvæ feed, is a native of India. The cocoon is very large, but the thread is too fine to be readily wound off, and it is therefore usually carded, the yarn being woven into a coarse silk cloth of great durability. The Tussch or Tussur Moth (*Antheræa mylitta*) is also a native of Upper India, occurring abundantly in the jungles, where its cocoons, so concealed by the leaves as only to be detected by the presence of the dung of the larvæ on the ground, are collected. The Tussch silk is darker and coarser than that of the common silkworm, but resembles it in being readily wound off. In China there are two oak silkworms from which a coarse silk is obtained, used for the clothing of the Chinese poorer classes; but the most important of the oak-feeding species is the Yama-mai (*Antheræa yama-mai*) of Japan, the silk produced from which was, at least until lately, reserved for the use of the Japanese imperial family. This moth is a beautiful insect, about 6 inches across the wings, of a brilliant golden-yellow colour, with a transparent spot or "eye" near the centre of each wing. Its cocoon is nearly as large as a pigeon's egg, and is of a silvery white within, although externally of a yellowish green. In 1861 it was introduced into France, where it now flourishes, and there is good reason to believe, from the nature of its food and its hardiness, that the Yama-mai may yet be profitably reared in Great Britain. *Tropæa luna*, which feeds upon the liquid-ambar trees in the southern parts of the United States, with wings of a lemon colour, each with a "transparent eye," and the hind pair prolonged into an elegant tail, is one of the loveliest species of *Bombycina*. Its cocoon is formed of the finest silk. Other well-known forms are the Eggars (*Lasiocampa*, Plate XXX. fig. 26); the Processional Moth (*Cnethocampa processionea*), so called from the habit its caterpillars have of congregating in companies of several hundreds, and of marching to their feeding-grounds in regular columns; the Vapourers (*Orgyia*, Plate XXXI. figs. 2, 3, 4), whose females being almost wingless, deposit their eggs on the outside of their cocoons; and the Psyches (*Psychidæ*), whose females in many cases have neither wings, legs, nor antennæ, and never leave the tubes in which they have passed the larva and pupa stages.

3. The *Noctuina* (Plate XXXI. figs. 9 and 14) form an exceedingly large group of nocturnal moths, although even here there are a few exceptional instances of day-flying species. They are distinguished by their stout bodies and narrow forewings, under which when reposing they conceal the inferior and in many cases more brightly-coloured pair. The majority of the species are small and dull in their colours, while a few are among the largest of known insects—the Great Owl Moth of Brazil (*Erebus strix*) measuring nearly a foot from tip to tip of its wings.

4. The *Geometrina* (Plate XXXI. figs. 13 and 15) in the larval condition have only four prolegs, the usual number being ten, and in moving these are brought close up to the last pair of thoracic limbs, thus giving the caterpillar a looped appearance, hence the term "loopers" usually applied to these moths; they then hold on by the prolegs, and releasing those in front carry the body forward until the arched appearance is gone. They thus move by an alternate process of looping and straightening their bodies. The larvæ of Geometers have also the curious habit of fixing themselves by their hind feet to the branch of a shrub, throwing the remainder of their bodies out, and remaining motionless in this position for hours, thus exhibiting an enormous amount of muscular energy. They are all protectively coloured, and in the attitude just described so resemble the surrounding twigs as to be readily mistaken for them. Geometers are to be found in sunshine and by night, in midsummer and at midwinter, the Early Moth (*Hybernia rupicapraria*) being caught in January.

5. The *Pyralidina* (Plate XXXI. figs. 17, 19, 20, 23) are a group of small moths readily distinguished by their long slender bodies and large forewings. One of these, *Pyralis vitis*, is very destructive to vines, and another, *Pyralis farinalis*, feeds upon meal and flour. The *Galleridæ*, a family of Pyralidine moths, deposit their eggs in the hives of bees, where the caterpillars, enclosed in silken cases, devour the wax; but the *Hydrocampidæ* (Plate XXXI. fig. 12), which also belong to this section, are probably the most wonderful of all Lepidopterous insects, their larvæ being aquatic, living and feeding in the water, and many of them breathing by gills similar to those of caddis-worms.

6. The *Tortricina* (Plate XXXI. fig. 16) include a great number of small moths exceedingly injurious to orchard and other trees. They are known as "leaf-rollers" from the habit which most of their larvæ have of rolling up the leaves on which they feed, and thus forming a shelter for themselves. The Green Tortrix (*Tortrix viridana*) occurs in the larva state on the oak, to which it often does great injury by stripping the trees of their leaves in the month of June. Throughout Southern Europe the vine is liable to the ravages of another species, *Œnectra pillariana*, while few of our fruit trees are exempt from the occasional attacks of some species or other of the *Carpocapsidæ*, the fruit-eating family of this group.

7. The *Tineina* (Plate XXXI. figs. 21, 24, 25) contain the smallest of the *Lepidoptera*, and are best known as clothes moths. These clothe themselves at our expense in the warmest woollen garments, which they traverse in all directions, leaving behind a gnawed and worn-out path, so thin and bare as to yield to the slightest pressure. They also destroy furs, hair, feathers, and many other articles of domestic economy, and are the exterminating pests of zoological museums. To them we no doubt owe the destruction of the most perfect specimen of the Dodo known, which was once preserved in the Ashmolean Museum of Oxford. By means of their maxillæ these little larvæ shear down the surface of various substances, and uniting the particles by means of their glutinous silk, they thus form protecting habitations, which partake of the nature of the woollen or other stuffs on which the foresight of their parents has placed them. When they themselves increase in bulk, so as to find their abodes as inconvenient as a strait waistcoat, they split them down the middle, and interpose a piece proportioned, no doubt, to their expected as well as actual increase. They add to the length also by fresh materials to the anterior end. The *Tinea granella* lives in granaries, where it forms an abode for itself by enveloping several grains in a silken web. These it afterwards eats.

8. The insects of the remaining group, *Pterophorina*, are remarkable from the peculiar conformation of their wings. Each of these organs is split longitudinally into several branches, all of them delicately fringed. In the genus *Pterophora* (Plate XXXI. fig. 26) the fore wings are divided into two, and the hind wings into three branches; while in *Orneodes* (Plate XXXI. fig. 27) each wing is split into six, and these when the insect is at rest are folded together after the manner of a fan.

Collection and Preservation of Lepidoptera.—Butterflies affect special localities with which it is well for the collector to make himself acquainted. A suitable hunting ground having been selected, the following apparatus is necessary:—a bag-net made of gauze or some equally light material, with a wooden or metal ring and a handle, which may also be used as a walking-stick, for capturing the specimens; pill boxes into which to transfer them from the net; and a wide-mouthed glass stoppered bottle, into which about forty leaves of the common laurel, bruised and cut into shreds, have been previously put. Exposure for a short time to the fumes arising from these shreds will cause the death of the inmates of the pill boxes. They may also be readily killed by pressing the thumb-nail against their thorax. For "setting" Lepidoptera, which if possible should be done before the insect stiffens, entomological pins are required, and these should be gilt in order to prevent the appearance of verdigris at the point where the pin enters the specimen; also a setting-board, with an upper layer of cork, and having a groove in which to lay the body of the insect; and small triangular strips of cardboard known as braces with which to set the wings. The process of drying should not be artificially hastened, as by exposure to heat the wings are certain to warp and the body to shrivel. Should the insect have stiffened before setting, or have been badly set, it can readily be softened again by placing it, as is done in the British Museum, in a shallow earthen vessel containing a layer of damp sand, and covering it with a close-fitting lid until sufficiently soft for resetting. Day-flying moths must be sought for in much the same way as butterflies, while nocturnal species may be regularly met with on the sallow, the honeysuckle, the lime-tree, and the ivy, when these are in flower; and when these and similar natural sources fail, the moth-collector has in *sugar* and *light* two admirable devices for securing specimens. A quantity of the coarsest brown sugar reduced by the addition of beer and water to a syrup, and to which a little rum is added as required, is applied with a brush to the sheltered aspect of the trunks of trees on the outskirts of woods or in the neighbourhood of heaths. At nightfall the collector, lamp in hand, visits the sugared locality, and if the evening be favourable, that is, if it be warm and dull, he is almost certain to have his pains rewarded by an abundance of specimens, chiefly belonging to the *Noctuina*. Moths, it is well known, are readily attracted by light, and in a country or suburban house, in the vicinity of trees, a lamp placed outside an open window, which is sheltered from the wind, with another lamp in the interior of the room, will, if the night be close and dark, be almost certain to attract numbers of moths. Mr Wallace adopted this plan while collecting in Borneo, and he states that in twenty-six nights he collected 1386 moths, "but that more than 800 of these were collected on four very wet and dark nights." In towns moths may often be caught flying about lamp-posts. In preserving the larger moths, especially the *Sphingina*, it is necessary to slit up their stout bodies and remove the contents, replacing these with wadding or paper. The drawers of cabinets containing *Lepidoptera* should be provided with a layer of cork and then papered, with a small bag of camphor attached to a corner to ward off the attacks of the dust-lice, or "mites" as they are usually, but incorrectly, called, the

presence of which is made known by the appearance of a fine powder lying underneath the infected specimens. Insects in this condition should be thoroughly soaked in a solution of spirits of wine and camphor. The appearance of grease on thick-bodied moths is by no means uncommon, but may be removed by dipping the insect in spirits of turpentine and embedding it in calcined magnesia till dry. The collector should be careful to keep a register of all his specimens, giving the localities where they were found, and recording any observations that may have been made at the time on their food, habits, &c. A small ticket attached to the pin of each specimen, and bearing its number in the register, is the best way of connecting the specimens in the cabinet with the entries in the register (J. G.)

BUTTMANN, Philipp Karl (1764–1829), a German philologist, was born at Frankfort-on-the-Main in 1764. He was educated at the gymnasium in his native town and at the university of Göttingen. In 1789 he obtained an appointment in the library at Berlin, and for some years he edited *Spener's Journal*. In 1796 he became professor at the Joachimsthal Gymnasium, a post which he held for twelve years. In 1806 he was admitted to the Academy of Sciences, and in 1811 was made secretary of the Historico-Philological Section. He died in 1829. Buttmann's writings gave a great impetus to the scientific study of the Greek language, and his grammar is still a work of value. The first edition of the *Griechische Grammatik* appeared in 1792, and in 1863 the book was in its 21st edition. It has been translated into English. The *Lexilogus*, a valuable study on some words of difficulty occurring principally in the poems of Homer and Hesiod, was published in 2 vols., 1818–25. The English translation by Fishlake has passed through five editions Buttmann's other works were *Ausführliche Griechische Sprachlehre*, 2 vols., 1819–27; *Mythologus*, a collection of essays, 1828–9; and editions of some classical authors. Of these last the most important are *Demosthenes in Midiam*, 1823, and the continuation of Spalding's *Quintilian*.

BUTTON, from the French *bouton*, a small piece of metal or other material used to connect different parts of a garment together by means of a button-hole, and also used for ornamentation. These apparently insignificant articles have produced a great alteration in our style of dress, for without them it would have been impossible to have reduced the flowing robes of our forefathers into our present simple costume. By this process we have lost the picturesque, as far as our garments are concerned, but have gained in compactness and utility. Indeed, the occupations of the present age could not be carried on in the togas and dresses of ancient times. The button manufacture did not assume any special form until towards the close of the reign of Elizabeth. In paintings, commencing with the 14th century, studs or buttons appear as ornaments on the dresses of both sexes; but they were ornaments merely, being drawn without button-holes, and placed where they could serve no practical purpose. They are in general represented as of gold or ivory. At the commencement of the 17th century the trade had greatly increased, but the making of buttons by the needle seems to have been the principal method.

Matthew Boulton, who became the senior partner in the afterwards celebrated firm of Boulton and Watt, as early as 1745, introduced great improvements in the manufacture of buttons, particularly inlaid and steel. When the Soho Works were established near Birmingham, one of the departments was occupied in making steel buttons with facets, that produced a hundred and forty guineas the gross. Gilt buttons came into fashion shortly after the accession of George III. A large shipping trade in buttons was then carried on with the Continent and America, and the workmen's wages at Birmingham averaged from £2 to £4 per week. John Taylor, originally a cabinetmaker, appears to have had a principal hand in promoting improvements in this industry at that time, as far as gilt, plated, and lacquered buttons are concerned. The value of those turned out weekly in his establishment is said to have been about £800. Ralph Heaton improved the making of shanks, a separate branch, shortly before the commencement of the present century.

The metal button trade was in a very flourishing condition. when, indirectly, Lord Nelson may be said to have been the means of overthrowing it. The late B. Sanders was in easy circumstances in Denmark when he was ruined by the bombardment of Copenhagen under our great naval commander. Sanders then came to Birmingham to seek such competence as energy and perseverance could afford. He started in the button manufacture, at first in a small way, introducing a covered button made of cloth or lasting, with an iron shank. His son, of the same name, invented a flexible shank button, that is, one with a tuft of canvas protruding from the back instead of a shank, through which the needle could pass in any direction. It was patented in 1825 and had an enormous sale. The Sanders took out another patent for a similar button covered with silk. A fancy silk button with a central ornament was patented by William Elliott in 1837, which had a great run, so much so that sixty looms were employed in London in making the special material required; and Elliott secured a fortune, although his patent was contested and many imitations were started. But all these kinds of buttons were found to wear on the edges, to remedy which John Chatwin patented a corded edge button. It is said that horn buttons were used as early as 1801, but we find from old Birmingham directories that there were horn-button makers as far back as 1777. At the former period the commonest qualities were 5½d. per gross. Hutton in his *History of Birmingham* refers to "our grandmothers" wearing horn buttons nearly the size of a crown piece. The hoof or horn button is cut into form and dyed and pressed into beautiful designs. This great improvement, however, appears to have been effected by M. Emile Bassot of Paris, who introduced important changes resulting in material progress. The manufacture is still prosecuted in England, but it is of secondary importance.

The materials of which buttons are made are as various as their forms. Gold, silver, and other metals, glass, porcelain, horn, bone, india-rubber, mother-of-pearl, and other nacreous productions of shell-fish,[1] various woods, vegetable ivory, &c.,[2] are employed; and for covered buttons, lasting, brocade, twist, velvet, silk, mohair, &c. The Birmingham *Directory* for 1784 mentions paper buttons; and, according to the same authority, a button was produced by "an artist of eminence," which was inlaid with divers other metals; it was first attempted about sixty years previously; and then, "though in no respect so complete as at present, met with great and merited encouragement." Buttons have been often expensively jewelled, and the gold and silver are plain or ornamented, sometimes resembling drops in filigree-work. There was one in use in England about the middle of the last century

[1] The shells are brought from various parts of the world, and vary considerably in price. The white-edged Macassar are the best; the yellow-edged Manilla the next. Those from the Persian Gulf and Red Sea vary much in value, which depends upon the purposes to which they can be applied. Those from the Pacific are beautiful, but, being generally dark in colour, their value is much affected by the turns of fashion. The "Panama shells" are the least valuable, and are generally only used for inferior sorts of buttons.

[2] Vegetable ivory is not very suitable for buttons; it is too soft, and the unavoidable waste in manufacture renders it expensive.

formed of polished brass and ruled with such fine lines that light was reflected in prismatic colours. Some buttons have fetched enormous prices, even when made of what is now a common material. Mother-of-pearl buttons have been sold at a guinea each. In 1790 Henry Clay of Birmingham patented a method of manufacturing buttons of slate or slit stone; and, in 1800, Joseph Barnett introduced a button with two shanks or other fastenings on one button.

Such was the origin of the button industry in England, and other nations have not been behind. The *Scientific American* gives the following account of its commencement in the United States:—

"The first manufacturer of buttons in this country was Samuel Williston. While he was dragging along as a country storekeeper,—his eyes having failed him while studying for the ministry,—his wife bethought her that she could cover by hand the wooden buttons of the time, and thus earn an honest penny. From this the couple advanced in their ambition until they had perfected machinery for covering buttons, the first employed in this country. From this sprang an immense factory, and then others, until Samuel Williston made half the buttons of the world. His factories are still running at Easthampton, coining wealth for the proprietors. . . . . He is now (1871) between seventy and eighty years of age, is worth five or six millions, and has given four hundred thousand dollars to Easthampton for a seminary and for churches; two hundred thousand dollars to South Hadley Female seminary; and two hundred thousand dollars to Amherst College, besides lesser gifts."

The factories of Samuel Williston & Co., above referred to, at Easthampton, Massachusetts, were established about the year 1848, and give employment to about 250 operatives. The annual cost of the materials used is estimated at $75,000, and the value of the produce exceeds $200,000. The button manufacture is also carried on extensively in New York and Philadelphia, and at Waterbury (Conn.). Buttons are also imported extensively. There are five importers in New York (1876). Joel Hayden of Haydenville began to make flexible buttons in the States in the year 1834.

Other countries have not been backward in this branch of industry. Bohemia, particularly at Prague and the neighbouring towns, is the great seat of the glass button manufacture, and great numbers are made in France. The porcelain button manufacture has been taken possession of by France, Minton and Co., the celebrated Staffordshire firm, who worked the invention of R. Prosser of Birmingham, having been driven out of the field by the good work, attended by greater cheapness, of the foreign makers. There is one factory at Milan, and great numbers of the cheaper kinds of buttons are made in the Rhenish provinces of Prussia. Vienna has suppressed the competition of English makers in some kinds of pearl buttons. Its operations in this branch are of a most extensive character, quite rivalling those of Birmingham.

"Button making," says the Birmingham *Directory* for 1777, "was originally a very tedious and expensive process. The button consisted of one solid piece of metal; and the ornaments upon the face of it were the work of an engraver. To obviate this, the press, stamp, and engine for turning the moulds were invented. This led to other improvements, the bones and hoofs of animals were introduced into the manufacture; by these various means the prices of buttons were reduced."

In the manufacture of covered buttons the sheet-iron is first scaled by the use of acids, and then cut into proper shape and size by a machine. The neck or collet of the button is japanned after having been stamped and cut. The hollow between the neck and shell is filled in with brown paper or button board. When the parts are put together they are pressed, which brings them into shape and consolidates them.

It would be impossible in the space that could be devoted to the subject here, to describe in detail the various modes in which the numerous forms of buttons are manufactured,—especially as it would require elaborate illustration. We must, therefore, confine ourselves to noticing some of the special and more recent patents, referring the reader to works where he can obtain such further information as he may require. In 1840 Joseph Parkes took out a patent for improvements in the manufacture of covered buttons made by dies and pressure, by the application of horn as a covering material. Harris's patent for improvements in horn buttons and their dies was obtained in April 1841. This invention related to applying flexible shanks to horn buttons, a mode of ornamentation by inlaying the front surfaces, and also gilding or silvering their surfaces, and to a mode of constructing dies so as to facilitate the process of engraving, the die being also so formed that the horn or hoof employed could not be expressed outside the circumference of the button. Hugh Willoch's patent, dated 5th May 1874, related to a button with a removable head to enable the shank to pass through the button-hole. The head is hollow and is partly filled with caoutchouc. It is perforated to admit the shank top, a short transverse bar which, on being turned one-fourth round, falls into an internal groove in the material of the button head, and is retained in that position by the elasticity of the india-rubber. Empson and Palmer's patent, dated 4th July 1874, refers to improvements in linen buttons, and is also applicable to buttons covered with other fabrics. They are composed of a front and back shell, with a bar formed across the face of a raised concentric circle from the back shell (which is all the metal that need be visible in the finished button), the shells permitting ample room for the covering fabrics to be gathered in and held between them. They are considered to resist the injury common to linen buttons during the processes of washing, mangling, and ironing. Tylor's patent, of 13th July 1874, relates to polishing ivory, bone, and similar buttons in a revolving drum with revolving brushes inside. Harrison's invention (8th September 1874) consists in arranging the piercing tools, so that the thread holes for the buttons are made in the pierced metal in front of the shaping and cutting-out tools, and the metal around the groups of piercings is shaped or "domed," and cut out. The result is that at each descent of the compound tool three or more groups of the thread holes are pierced in the sheet metal, and three or more finished buttons are made. The piercings in the sheet metal made by the last descent of the compound tool form the thread holes of the buttons made by the next descent of the said compound tool. When the thread-holes of the button are made in a central depression, a shaping tool for making the said depression is placed between each piercing tool and cutting-out tool. This invention is also applicable to the manufacture of washers, rings, links for chains, and other like articles from sheet-metal. The patent of G. F. Champorez of Berlin, Prussia, relates to improvements in the manufacture of steel or iron and steel dies, and to certain contrivances for producing the same, the said dies being in depression or relief, without recourse to the hitherto universally employed engraving tool. Cole's patent (10th February 1875) relates to a composition for dress-fastenings generally, consisting of black composition of equal parts by weight of gas tar or tar varnish, whiting or chalk or clay, and lamp black or vegetable black. For a coloured composition transparent varnish, or the waste refuse of it, is substituted for gas tar or tar varnish, and a powdered pigment of the required colour is added. The materials should be thoroughly mixed and converted into a plastic, pasty mass, which is consolidated and hardened by rolling and drying. To give