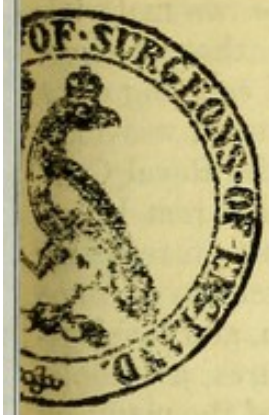
On the raw materials from the animal kingdom, displayed in the Great Exhibition of the Works of Industry of All Nations / by Richard Owen.



LECTURE II.

DEC. 10, 1851.

ON THE RAW MATERIALS FROM THE ANIMAL KINGDOM, DISPLAYED IN THE GREAT EXHIBITION OF THE WORKS OF INDUSTRY OF ALL NATIONS.

BY

RICHARD OWEN, F.R.S.

In coming before you this evening with some observations on the "Animal Substances used in Manufactures, displayed in the Great Exhibition of the Works of Industry of all Nations," I am actuated rather by a deference to the august source of the suggestion that originated the present series of lectures, and by the desire to comply with the request with which the Council of this Society have honoured me, than by any confidence in the worth of what I may have to say. My habitual studies have, truly, left me little leisure for their extension beyond the structure, developement, and purely scientific relations of those parts of animal bodies which mankind have converted to their outward use; and as for their applications to the arts and manufactures, and the various processes to which they are thereto subjected, I must confess myself herein a poor scholar merely, and a very recent one, owing such elementary information as I may possess to opportunities afforded during the present year by the Great and happily-conceived Exhibition; from which every one, no matter what his social or intellectual grade, must have derived, if he availed himself of it at all, lasting instruction and benefit. No one could feel more conscious than myself of my want of all that special knowledge and experience which might have been looked for in a Juror for the Class (IV.) of "Vegetable and Animal Substances used in Manufactures, as Implements, or for Ornaments;" and I was aware that the only grounds on which my name could have suggested itself to the Council of the Great Exhibition, as that of one likely to serve them in that capacity, were my known devotion to the science of the organization of animals.* It was, however, urged, that such scientific knowledge would help in guiding to

* "Official, Descriptive, and Illustrated Catalogue" (List of Jurors), vol. i. p. 45.

right conclusions on the nature and relative perfections of the raw materials assigned to the inspection of Jury IV.; and I need not say, that whatever aid it was thought I might contribute towards the successful carrying out a design, enlisting the warmest sympathies of every Englishman, was most heartily rendered, to the best of my ability, at the call of the Royal Commission. In the present concluding scene of that Act of the Great Industrial Drama in which I have been a humble performer, I must entreat your kind indulgence whilst I offer you, what alone I feel competent to do, some results, namely, of investigations into the nature, organization, and development of the "Animal Substances chiefly used in Manufactures, as Implements or for Ornaments," being fully conscious that most of the members of this highly useful and distinguished Association know much better than I can pretend to do the art-and-manufacture relations of the subjects of the present discourse.

For the "raw materials" from the vegetable and animal kingdoms, adapted for manufactures, mankind owes more to the powers and operations of Nature than to the inventions and appliances of Art; and in the series of the various organic products of almost every climate which were exposed to view in the Exhibition of the Works of Industry of all Nations, the relative excellence of the objects to be compared might be deemed to be due rather to peculiarities of soil and sky than to the individual merits of the exhibitors. Almost every vegetable or animal substance may, however, be modified, and in relation to its utility to man, improved, by a change of the circumstances under which it is naturally developed, such change or improvement being suggested by a patient study of the respective influence of those circumstances upon the useful properties of the substance. A further improvement may be effected by carefully defending the raw material during the progress of its developement from all external influences calculated to deteriorate or injuriously affect it. The value of every organic product in commerce is much influenced by the mode of its collection, or removal from the animal or plant when developed, and by the processes for separating the useless or less valuable parts, or heterogeneous matters, from the marketable constituent; and, in the sense in which the term "raw material" was extended in its application to that section of the Exhibition assigned to Jury IV., great scope for both chemical and mechanical skill was afforded in the extraction and preparation of several of the vegetable and animal substances applied "in Manufactures, as Implements, or for Ornaments."

In the examination and comparison of the very numerous and diversified substances confided to their judgment, the Jury IV., over which I had the honour to preside, were guided and influenced by the consideration of the invention, ingenuity, skill, and industry manifested in the amelioration and perfection of these several substances, and by the degrees in which unfavourable conditions of soil and climate had been thereby overcome; and in deciding on individual merits, they were careful to take into account the natural facilities which favoured, and the natural difficulties which opposed, the realization of the desired qualities in the raw produce transmitted for exhibition. After a preliminary general survey of their field of operations had shown its vast extent and the great practical importance of the objects to be compared, the Jury, having regard also to the earnest desire expressed for expedition in their decisions, resolved themselves into

two Committees, one for the Vegetable, the other for the Animal Kingdom; reviewing and testing from time to time in general meetings the evidence of the special examinations confided to those Committees.

The subjects selected for this evening's lecture, and on which I shall now proceed to speak, are the most valuable and important of those "raw materials" which fell under the survey of the Committee for the "Animal Kingdom." And, first, of the animal substances used for textile products and clothing.

Wool.

The raw material of most importance and in most general use for the above purposes is wool. This is a peculiar modification of hair, characterized by fine transverse or oblique lines, from 2000 to 4000 in the extent of an inch, indicative of a minutely imbricated scaly surface, when viewed under the microscope, on which, and on its curved or twisted form, depends its remarkable felting property, and its consequent value in manufactures.

Most quadrupeds possess the woolly variety of hair as an under-clothing, but in a small proportion, and hidden by the smooth, exterior, coarser, and straighter kind of hair. In the wild sheep (*e. g.* the argali of Central Asia, *Ovis ammon*, and the mouflon or musmon of Sardinia and Corsica, *Ovis musimon*), the woolly variety of hair is developed in excess; and in the domesticated races the fleece has been modified and improved, in various degrees, by crossing the breeds, by choice of climate and pasture, and by careful attention and defence during its growth, until not only has the original coarse character of the product disappeared, but qualities of wool of different kinds and of different degrees of superiority have been obtained, generally divisible into two classes, one better adapted for "carding," the other for "combing," and both available for a great variety of useful and elegant textile fabrics.

In judging of these qualities in the wools exhibited, the Jury tested the fineness and elasticity of the fibre, the degrees of imbrication of the scaled surface of the fibre as shown by the microscope, the quantity of fibre developed in a given space of the fleece, the comparative freedom of the fleece from extraneous matters, and the skill and care employed in preparatory processes; such, for example, as that termed "scouring" the fleece, upon which depends its liability or otherwise to mat at the bottom of the staple.

Probably a more extensive, varied, and instructive collection of wools was never brought together under one roof for inspection and comparison than that which was contributed to the Great Exhibition; and it exemplified in a remarkable degree the extent to which pastoral life—commenced, according to oldest records, in Central Asia, the habitat of the argali—has since been spread over the globe. From the provinces of Chinese Tartary, from Thibet, and India, in the East, to the lately redeemed tracts of the United States, in the far West; from Iceland and Scandinavia, in the North, to the Cape of Good Hope, Australia, and Tasmania, in the South, specimens of the staple of the flocks there, and in almost every intermediate latitude and longitude, preserved and multiplied under the fostering and modifying influence of civilized man, had been transmitted for inspection and comparison.

If the test of the value of a domestic animal be the numbers on the preservation of which human care is bestowed, and on the extent of the habitable globe over which mankind has diffused the species, then the sheep takes the first rank. With regard to an animal so essentially related to the welfare of mankind, every fact in its natural history is of special interest, and we are particularly concerned in the endeavour to trace the origin of the domesticated variety to which we owe so much.

The recent progress of palæontology, or the science of fossil organic remains,—remarkable for its unprecedented rapidity,—adds a new element to the elucidation of this question, which was so ably discussed by Buffon, and the naturalists of the last century. At present, however, the evidence which palæontology yields is of the negative kind. No unequivocal fossil remains of the sheep have yet been found in the bone-caves, the drift, or the more tranquil stratified newer pleiocene deposits, so associated with the fossil bones of oxen, wild boar, wolves, foxes, otters, beavers, &c., as to indicate the coevality of the sheep with those species, or in such an altered state as to indicate them to have been of equal antiquity. I have had my attention particularly directed to this point in collecting evidence for a "History of our British Fossil Mammalia." Wherever the truly characteristic parts, viz. the bony cores of the horns, have been found associated with jaws, teeth, and other parts of the skeleton of a ruminant, corresponding in size and other characters, with those of the goat and sheep in the formations of the newer pleiocene period, such supports of the horns have proved to be those of the goat.* No fossil horn-core of a sheep has yet been anywhere discovered: and so far as this negative evidence goes, we may infer that the sheep is not geologically more ancient than man; that it is not a native of Europe; but has been introduced by the tribes who carried hither the germs of civilization in their migrations westward from Asia.

Natural history, as yet, possesses no facts or principle adequate to the satisfactory solution of the question, whether the domesticated sheep—the *Ovis aries* of Linnæus—was created as such, in special relation to the exigencies of man; or whether it was the result of man's interference with the habits and wild mode of life of the argali (*Ovis ammon* of Linnæus), or other untamed and unsubdued species of sheep. Analogy would point to the latter hypothesis as the more probable one. Domesticated varieties of animals have been established from wild originals for the behoof of mankind, within a comparatively recent period in his history, of which the turkey, introduced and diffused over Europe and Asia since the discovery of America, is an example. Permanent varieties of the *Ovis aries* itself have been instituted by the art and interference of man, of which I shall presently have to recount the chief circumstances of a very recent and remarkable instance. The most ancient records of our race, both sacred and profane, tell us of the sheep as already an animal domesticated for the food and clothing of man; and it is a significant fact, that both the Scythians of the elevated plains of Inner Asia,—who, according to Hero-

* A characteristic fossil of this kind, found associated with remains of the mammoth and leptorhine rhinoceros, in the newer fresh-water pleiocene of Walton, in Essex, is figured in my "History of British Fossil Mammalia," p. 489, cut 204.

dotus, obtained felt,* and, according to Strabo,† food from their flocks—and the patriarchal Hebrew shepherds of the plains of Mesopotamia—the earliest instances of pastoral life—dwelt in that part of the earth where the wild argali (*Ovis ammon*) still exists in greatest numbers.

The ancient Hebrews were wholly an agricultural and pastoral people. Their pastures are described, in the 65th Psalm, as being "clothed with flocks." The religious metaphors of the Bible are chiefly derived from pastoral life, and in no part more touchingly than in the sacred poems ascribed to the Royal Psalmist:—"The Lord is my shepherd. I shall not want. He maketh me to lie down in green pastures; he leadeth me beside the still waters.—Yea, though I walk through the valley of the shadow of death, I will fear no evil; for thou art with me; thy crook and thy staff, they comfort me." (Ps. xxiii. 1, 2, 4.) And again, how beautiful a pastoral picture is portrayed in the following few and simple words: "He shall feed his flock like a shepherd; he shall gather the lambs with his arm, and carry them in his bosom, and shall gently lead those that are with young." (Is. xl. 11.) It is not, however, from the records of a people so exclusive as the Jews that we can trace the course of the diffusion of domesticated flocks from the Asiatic centre where history points to the beginning of pastoral life. The classical authors of Greece and Rome, however, afford sufficient indication of the channels by which this element of civilization was diffused. We learn from Strabo that sheep-breeding had extended to Northern Africa; and that, in his time, the dry and hot climate of Æthiopia exercised the same influence on the growth of wool as at the present day: "The Æthiopian sheep," he says, "were small, and instead of being woolly were hairy like goats."‡ Of the numbers of the domesticated sheep in Northern Africa at the time of Pindar we may form an idea from the epithet "πολύμηλος,"—"abounding in flocks," applied by that poet§ to distinguish Lybia.

It appears, by quotations from Hipponax—a poet of Ephesus, who flourished about 540 years before Christ, and who alludes to the woollen fabrics of the Coraxi, who occupied part of modern Circassia—as well as from contemporary reference to the commerce of Miletus, at that period the greatest commercial city next to Tyre and Carthage, that the progress of sheep-breeding, towards the north-west, was across the Euxine Sea, and the straits connected with it, into Europe. Thrace is called by Homer "the mother of flocks;"‖ and this is the earliest record of the domestic sheep in Europe. From Thrace we trace them to Thessaly, and thence to Greece, where they were so generally and successfully reared and tended, that "Arcadia" became the scene of all that the poets sing of the beautiful in pastoral life. Here the god Pan was feigned to be born—Pan the god of Arcadia; and to trace his worship from Greece to the

* Herodotus, iv. 73, "They live under trees, covering the tree in winter with strong and thick undyed felt, and removing the felt in summer."

† "They do not till the ground, but derive their sustenance from sheep and fish, after the manner of the nomadic Scythians."—Strabo, xi. cap. viii. p. 486. Both cited by Mr. Yates in his classical work, "Textrinum Antiquorum."

‡ Cap. ii. sec. 1, 3, cited in "Textr. Ant.," p. 94.

§ Pyth. ix. 11, ibid. p. 25.

‖ Iliad, A. 222.

colonies settled in Italy and Spain is to follow the progress of the diffusion of the domesticated flocks and the pastoral people over whom Pan especially presided.

From Spain and Italy the breeding of sheep extended into Germany and Gaul; and Cæsar found abundant cattle (*pecoris magnus numerus*), which may be inferred to include sheep, amongst the aborigines of Cantium or Kent, whom he describes as being "the most advanced in civilization of all the ancient Britons." I shall here quit the history of the diffusion of the domestic sheep, with the remark that some of those procedures, which are now most influential in improving the staple of the fleece, were practised in ancient times. Varro* speaks of the custom of the Athenian shepherds of covering their sheep with skins, in order to improve the fleece; and the Cynic Diogenes, in reference to a similar practice amongst the shepherds of Megaris, whose children were allowed to run about naked, says, "he would rather be the ram, than the son, of a Megarensian."†

The continuance of these arts of ancient pastoral life, combined with suitable climate and locality, and the exercise of skill and tact in crossing and breeding from the best varieties of the domesticated sheep, have combined to produce the fine qualities of the staple, which were so remarkably illustrated in the specimens exhibited in the Crystal Palace.

After the comparison of the wools exhibited by the growers of different nations, our Jury were unanimous in making the first mention of those transmitted from Germany as being pre-eminent in the qualities of highest value.

Under "German Wools" were included those from Austria and Austrian Silesia, Hungary, Prussia, Saxony, and Polish Silesia. In Austria, the Jury made first mention of the specimens exhibited under No. 90, by Messrs. Figdor and Sons. The fleeces exhibited by this firm presented in a high degree the desired qualities of substance and trueness in the staple, due to the equality of size, and to the fineness and elasticity of the component fibres, the spiral curves of which were close and regular, and were immediately resumed after being obliterated by stretching the fibre, the length of which was also considerable for wool of this "felting" quality, the most valuable for the finest descriptions of cloth.

Under No. 92 Count H. Larisch Moennich exhibited the product of a fine and well-known flock, from Silesia, by four fleeces, which presented similar excellent qualities to those of No. 90.

The fine and high-bred fleeces of a pure stock merino, from Silesia, exhibited under No. 91 by Count Anton von Mittrowski, showed the valuable qualities of fineness and elasticity of fibre in an eminent degree.

No. 89, sent by Count Joseph Hunyady von Ketheley, was a fleece from a flock in Hungary, an unwashed specimen, but of a very fine quality of fibre; it was a little inferior to the best Silesian examples only in being somewhat thinner or poorer in substance. The fine imbrication and elastic properties of the fibre were, however, remarkably characteristic of this fleece.

From the difficulty of arriving at a correct judgment of the degrees of individual merit, especially from samples giving an uncertain indication of

* De Re Rusticâ, ii. 2. ("Textr. Ant.," p. 40.)
† Diog. Laert. vi. 41. (Ib. p. 42.)

the average value of the produce of the flocks, the Jury, whilst awarding the prize medal to the best exhibitors, came to the conclusion of testifying their sense of the peculiar value and excellence of the felting or carding wools, adapted to the manufacture of the finest kinds of cloth, which were exhibited in the Austrian department, by recommending the transmission of a Council medal to the Government of that empire.

In the Zollverein, the fleeces transmitted by E. Lübbert from Zweybrodt, near Breslau, were very remarkable for those qualities which, like the Austrian Silesian wools, adapt them for the fabrication of the finest cloths. The merino fleeces of two-year-old ewes, from Bromberg, exhibited by Legations-Rath Kuepfer, were characterized by the fineness and regularity of the staple, and favourably illustrated the advance of the improvement of wool in the Prussian districts of the Middle Vistula. I must also mention the specimens exhibited under Nos. 45 and 46 by the Oberburggraf von Brünneck, viz. the fleeces of a ram and one ewe from a merino flock at Bellschwitz, and the specimens of wool indiscriminately taken from a merino flock at Rosenberg; for these, though rather inferior in quality to the finest Silesian wools, manifested a fineness, softness, and elasticity of fibre, and a regularity of staple, which in the opinion of the Jury merited an award to the exhibitor of the prize medal. The Bellschwitz flock was procured by the Oberburggraf in Spain in 1814, and afterwards improved by additions of the finest Saxon and Silesian races in 1820 and 1824.

In America, the wool transmitted by Mr. J. H. Ewing, from Washington, Pennsylvania, was remarkable for the good substance of the fleece, as well as for the quality of the fibre, and the Jury awarded to him the prize medal. One of the able Experts, who rendered valuable aid to the Jury, was of opinion that "the wools shown by America most approximated to the character of the German wools."

In Russia, the specimens of wool from Livonia exhibited by N. N. Schloss-Wikaten, appeared to be derived from a flock of Silesian origin, and exhibited all those characters of the fibre which adapt it for good clothing purposes.

The wool from the merino sheep from Spain, for which that country was once so famous, showed all those characters which distinguished it a century ago; but not the advance and improvement made by the sheep-breeders who have since introduced the same variety into suitable localities in Saxony, Prussia, Austria, Hungary, and Austro-Silesia.

The best examples of Spanish wool were exhibited under No. 230, by Don Justo Hernandez. Of black and white wool from Salamanca, four samples were transmitted by this exhibitor:—1. Unwashed wool for clothing purposes; 2. Unwashed wool for worsted; 3. Wool washed before shearing, in the Saxon manner; 4. Wool sheared in February 1851. Don Hernandez had introduced into Spain the custom of clothing the sheep from the beginning of December to the end of May; and amongst the specimens transmitted to the Exhibition, was a fleece which had been so defended, and one that had been exposed to the direct influence of the atmospheric agencies. The difference in the quality was remarkable, and spoke decidedly in favour of the temporary protection of the fleece.

In France, the specimens of wool selected as meriting the reward o the prize medal were those exhibited under No. 1249, by Le Généra Girod de l'Ain. The fleeces of merino wool, from this exhibitor's flock at Nuz, although of a thin staple, and apparently not full grown, mani fested the qualities adapting it for the finer descriptions of cloth in an excellent degree. No. 1080, from the "National Sheep-fold of Rambouillet," showed similar qualities in four fleeces of the true merinos. No. 1312, E. Lefevre: the specimens of wool in tufts transmitted by this exhibitor from Gevrolles (Côte d'Or) were long in the staple and very sound, forming a very superior description of combing wool. No. 354, F. Richer: the two fleeces of rams, of pure merino breed, two years old, transmitted from Gouvix, Calvados, exhibited praiseworthy care and skill in the management of the flocks.

Amongst the series of wools shown in the French department were specimens characterized by a well-skilled English expert as "a wool of singular and peculiar properties; the hair glossy and silky, similar to mohair, retaining at the same time certain properties of the merino breed." This wool was exhibited under No. 245, by J. L. Graux, of the farm of Mauchamp, Commune de Juvincourt (Aisne), as the produce of a peculiar variety of the merino breed of sheep.

The Jury entered into an inquiry, not only into the commercial value and application, but into the particulars of the production of this new kind of wool, and found it to be one of the very few instances in which the origination of a distinct variety of a domestic quadruped could be satisfactorily traced, with all the circumstances attending its developement well authenticated. The following is a brief statement of this interesting case.

In the year 1828, one of the ewes of the flock of merinos in the farm of Mauchamp produced a male lamb, which, as it grew up, became remarkable for the long, smooth, straight, and silky character of the fibre of the wool, and for the smoothness of its horns: it was of small size, and presented certain defects in its conformation, which have disappeared in its descendants. In 1829 M. Graux employed this ram with a view to obtain other rams having the same quality of wool. The produce of 1830 included only one ram and one ewe having the silky quality of the wool; that of 1831 produced four rams and one ewe with the fleece of that quality; in the year 1833 the rams with the silky variety of wool were sufficiently numerous of themselves to serve the whole flock. In each subsequent year the lambs have been of the two kinds; one preserving the characters of the ancient race, with the curled, elastic wool, only a little longer and finer than in the ordinary merinos; the other resembling the rams of the new breed, some of which retained the large head, long neck, narrow chest, and long flanks of the abnormal progenitor, whilst others combined the ordinary and better formed body with the fine silky wool. M. Graux, profiting by this partial resumption of the normal type of the merino in certain of the descendants of the mal-formed original variety, at length succeeded, by a judicious system of crossing and interbreeding, in obtaining a flock combining the long fine silky fleece with a smaller head, shorter neck, broader flanks, and more capacious chest. Of this breed the flocks have become sufficiently numerous to enable the proprie-

tor to sell examples of the breed for exportation. The crossing of the Mauchamp variety with the ordinary merino has also produced a valuable quality of wool, known in France as the "Mauchamp merino." The fine, silky wool of the pure Mauchamp breed is remarkable for its qualities as combing wool, owing to the strength as well as the length and fineness of the fibre. It is found of great value by the manufacturers of Cashmere shawls, being second only to the true Cashmere fleece in the fine flexible delicacy of the fabric, and of particular utility when combined with the Cashmere wool, in imparting to the manufacture qualities of strength and consistence in which the pure Cashmere is deficient.

Although the quantity of the wool yielded by the Mauchamp variety is less than in the ordinary merinos, the higher price which it obtains in the French market (25 per cent above the best merino wools), and the present value of the breed, have fully compensated M. Graux for the pains and care which he has manifested in the establishment of the variety. Our Jury, therefore, taking into consideration the quality of invention which had been superadded to the skill and industry requisite for obtaining the finer qualities of wool under any circumstances, in the developement of the new variety of sheep yielding the specimens exhibited in No. 245, recommended that the Council medal should be awarded to M. J. L. Graux.

The comparatively moist climate of England is unfavourable to the developement of the highest qualities of wool. We are essentially a practical people, and it does not pay to give the sheep the extensive range, or allow them the length of life, which are amongst the conditions to be added to climate for the acquisition of the finest fleece. The interminable plains and mountain-ranges of Australia and Tasmania, where the flocks graze under the most favourable of skies, serve to produce for us the wools required for our manufacturers cheaper than they could be developed at home. Our business is to breed sheep for mutton, not for wool: to improve the stocks which in the shortest time put the most meat on the smallest bones. The fleece must always, therefore, be a secondary object with a good farmer. Nevertheless, very respectable samples of wool were exhibited in the English department of the Great Exhibition.

The samples of wool transmitted from Chichester by Mr. C. Dorrien gave evidence of a very high-bred flock, and manifested qualities of fibre for which the Jury awarded the prize medal.

The specimens of wool from the South Down sheep, transmitted by Mr. J. G. Rebow, also presented qualities of such excellence as to call for the award of the prize medal.

The fleeces of Cheviot wool, grown at an elevation of 2600 feet above the level of the sea, exhibited by Mr. Henderson, of Wooler, Northumberland, were remarkable for the fine silky quality of the fibre, which is well adapted for the blanket manufactory.

Perhaps many who are now present may recollect an object of curiosity which was shown in the south gallery of the English department. It was a South Down ewe, stuffed, seven years old, which had never been shorn. The weight of the accumulated annual fleeces was 36 lbs. This specimen was exhibited by Mr. J. Moore, of Littlecott Farm, Pewsey, Wilts.

In the department of Australia the case containing 132 specimens of

merino wool, contributed by Lieut.-Col. E. Macarthur, exhibited very favourable examples of the condition of the fleeces of that valuable variety of the sheep in New South Wales. The Jury regretted that the quantities transmitted were too small to afford the requisite means of judging of the average qualities of the flocks; but, taking into consideration the important services rendered by Lieut.-Col. Macarthur to the colony of Australia by his persevering and successful endeavours to develope a source of wealth from the merino breed of sheep, they awarded to him the prize medal.

The first importation of wool from New South Wales into England, in 1807, was 245 lbs. In the year 1848 the quantity from New South Wales alone amounted to 23,000,000 lbs., valued at more than 1,200,000*l.* sterling.*

In Russia, good examples of fine unwashed Cashmere goats' hair were exhibited by J. Abramoff, of Ekaterinoslaff, and L. K. Narishkin, of Saratoff, district of Balasheffsk.

In India, specimens of the wool of the sheep, the lamb, and the camel, were exhibited from Cutch, Sindh, and Assam. Goats' hair, or down, of Thibetian, Persian, and Hindostanee breeds, was also transmitted, together with a fine silky kind of down from the "Tsos" antelope.

The specimens of wool, or down, the production of the Cashmere goats kept by his Royal Highness Prince Albert at Windsor, and exhibited by his Royal Highness, were interesting examples of an additional staple new to England, and gave encouragement by their quality to the repetition of similar efforts to multiply and preserve that remarkable variety of the genus *Capra*. This staple includes, besides the closer and finer hairs answering to the wool of sheep and the fur of other quadrupeds, a coarser or stronger kind of white hairs. Both kinds are of value in manufactures —the stronger hairs, which require to be picked out prior to attempting to manufacture the finer portions, being afterwards used in the fabrication of coarse woollen cloths. This example of European Cashmere wool would have received a medal from Jury IV. had not one already been awarded to it by the Jury of Class XII.

Hair and Bristles.

Of the specimens of hair and bristles, a brief notice will suffice. The best developed and most valuable examples of these productions were exhibited in the Russian department, in which the Jury selected those shown under No. 340, by Kondriaozof and Jadenofsky, for the award of the prize medal, merited by the superior qualities of the horse-hair exhibited by them under that number. In the sample of white hair from the tail, the hairs were forty inches in length, and of the first quality for evenness, elasticity, and shining surface. In the sample of black tails, the hairs were forty-two inches in length. Fine specimens of white hair from the mane, of from twenty-eight to thirty inches in length, both transparent and opaque, and good samples of horse-hair for furniture, both twisted and untwisted, black, grey, and white, were also shown by the above firm.

* "Official Catalogue," vol. ii. p. 989.

Of the sample of bristles exhibited in the Russian department, the Jury selected No. 135, sent by MM. Semenoff and Faleyeff, as deserving, from the superiority of the combined qualities of strength, elasticity, and fineness of surface, the prize medal. These qualities were particularly shown in the packets of the sorted variety called "okàtka."

Camels' hair cloth, bristles from the wild boar and the elephant, and quills of the porcupine, were exhibited in the Indian department; and I must not omit to mention that in the department of Spain, Don D. Delgado, of Saragossa, exhibited some interesting examples of the hair of the rabbit and hare, shaved off the skin by a mechanical process. The vast numbers of those prolific rodents in Spain afford a large supply of this kind of hair, which is put to the same uses as down.

Baleen.

I have next to speak of a substance which, though commonly called "whalebone," has nothing of the nature of bone in it, but is an albuminous tissue, nearly allied to hair and bristles, both in its chemical and vital properties and its mode of developement.

Of all the creatures which man has subdued for his advantage and use, that which surpasses every other animal in bulk, and which lives in an element unfitted for man's existence, might be supposed to be the last that he would have the audacity to attack or the power to overcome. The great whales that "tempest the ocean" are able, as many instances—and a very recent one—have shown, to stave in the bottom of a ship by a blow of their muzzle, and crack a boat by a nip of their jaws, as easily as we would a nut. "Si sua robora norint!"—if they did but know their strength, and how to use it, pursuit would be in vain, and whales would become the most dreaded instead of the most coveted of the denizens of the deep.

The cetaceans, which afford the whalebone, or, more properly, baleen-plates, are of a more timid nature than the great sperm-whales, which commonly cause the catastrophes alluded to; they have no teeth, but, in their place they have substitutes in the form of horny plates, ending in a fringe of bristles—a peculiarity first pointed out by Aristotle.* Of these plates, properly called "baleen," the largest, which are of an inequilateral triangular form, are arranged in a single longitudinal series on each side of the upper jaw, situated pretty close to each other, depending vertically from the jaw, with their flat surfaces looking backwards and forwards, and their unattached margins outwards and inwards, the direction of their interspaces being nearly transverse to the axis of the skull. The smaller subsidiary plates are arranged in oblique series, internal to the marginal ones. The base of each plate is hollow, and is fixed upon a pulp developed from a vascular gum, which is attached to a broad and shallow depression occupying the whole of the palatal surface of the maxillary, and of the anterior part of the palatine, bones. The base of each mar-

* The passage occurs in the 12th chapter of the 3d book of the "Historia Animalium," and has given rise to much speculation and controversy:—"Mysticetus etiam pilos in ore intus habet vice dentium, suillis setis similes." To a person looking into the mouth of a stranded whale, the concavity of the palate would appear to be beset with coarse hair. The species of *Balænoptera*, which frequents the Mediterranean, might have afforded to the Father of Zoology the subject of his comparison.

ginal plate is the smallest of the three sides of the triangle; it is unequall imbedded in a compact subelastic substance, which is so much deeper o the outer than on the inner side, as in the new-born whale to includ more than one-half of the outer margin of the baleen-plate. The form c the baleen-clad roof of the mouth is that of a transverse arch or vault against which the convex *dorsum* of the thick and large tongue is applie when the mouth is closed. Each plate sends off from its inner and obliqu margin the fringe of moderately stiff but flexible hairs which projects int the mouth. The bases of the baleen-plates do not stand far apart fron one another, but the anterior and posterior walls of the pulp-fissure ar respectively confluent with the contiguous divisions of the bases of th adjoining plates at their thin and extreme margins, which by this conflu ence close the basal end of the interspace of the baleen-plates, which inter space is occupied more than half way down the plate by the cementing substance, or gum. Thin layers of horn in like manner connect the con tiguous plates, and may be traced extending in parallel curves with th basal connecting layer across the cementing substance.

The baleen-pulp is situated in a cavity at the base of the plate, like the pulp of a tooth; whilst the external cementing material maintains both with respect to this pulp and to the portion of the baleen-plate whicl it developes, the same relations as the dental capsule bears to the tooth According to these analogies, it must follow that only the central fibrous or tubular portion of the baleen-plate is formed, like the dentine, by the basal pulp, and that the base of the plate is not only fixed in its place by the cementing substance or capsule, but must also receive an accession of horny material from it.

The baleen-plates are smallest at the two extremities of the series; in the Southern whale (*Balæna Australis*) they rapidly increase in length to the thirtieth, then very gradually increase in length to about the one hundred and fortieth; from this they as gradually diminish to the one hundred and sixtieth plate, and thence rapidly slope away to the same small size as that with which the series commenced. Besides the external, and, as they may be termed, the normal, plates, which have just been described, there are developed from the inner part of the palatal gum, in the *Balæna Australis*, a series of smaller fringed processes, progressively decreasing in size as they recede from the large external plates: the small plates clothe the middle region of the palate with a finer kind of hair, against which the surface of the tongue more immediately rests; they are also arranged in longitudinal series, which, however, are not parallel with the external one, but pass from the inner margin of that series in oblique lines inwards and backwards.

In the great Northern whale (*Balæna mysticetus*) the baleen-plates which succeed the large ones of the outer row, are more numerous, and are relatively longer and larger, than in the *Balæna Australis*. Mr. Scoresby, who, in his account of the *Balæna mysticetus*, notices only the marginal plates, states that they are about two hundred in number on each side; the largest are from ten to fourteen feet, very rarely fifteen feet in length, and about a foot in breadth at their base. These plates are overlapped, and concealed by the under lip when the mouth is shut. In the *Balænopteræ*, or fin-backed whales, the baleen-processes internal to the marginal plates,

are fewer and smaller than in the true whales (*Balænæ*). The marginal plates are more numerous, exceeding three hundred on each side; they are broader in proportion to their length, and much smaller in proportion to the entire animal; they are also more bent in the direction transverse to their long axis.

Each plate of the baleen consists of a central, coarse, fibrous substance, and an exterior compact fibrous layer; but this reaches to a certain extent only, beyond which the central part projects in the form of the fringe of bristles. The chemical basis of baleen, according to the experienced Professor Brande, is albumen hardened by a small proportion of phosphate of lime.*

The final purpose of this singular armature of the upper jaw of the great whales is to secure the capture and retention of the small floating mollusks and crustaceans, which serve principally as their food. When the capacious mouth is opened, the water rushes in, and is strained through the fringed surface of the roof and sides, whilst the small animals are retained, bruised against the stiff bristled margins of the plates, and swallowed.

Baleen, or whalebone, from its tenacity, flexibility, elasticity, compactness, and lightness, is applied to a great variety of useful purposes. These were well exemplified in the collection exhibited under No. 103, by Mr. Henry Horan, which showed well-selected examples of whalebone plates from the Arctic whale (*Balæna mysticetus*), which yields the largest and best kind; from the Antarctic whale (*Balæna Australis*), which affords the second best kind; and from the great finner whale (*Balænoptera boops*), which affords the shortest and coarsest plates. With these examples of the raw material, Mr. Horan exhibited specimens of the raw material in various states of preparation, and numerous and ingenious applications of the prepared baleen, dyed of different colours, as, *e.g.*, for covering whip-handles, walking-sticks, and telescopes, and in the form of shavings for platting, like straws, in the construction of light hats and bonnets. An excellent and instructive series of preparations of baleen was also exhibited by Messrs. Westall, in which was more especially deserving of notice the great variety of filamentary modifications of the whalebone material for numerous useful applications. Fine blades of whalebone from the *Balæna mysticetus* were exhibited in the United States department, under No. 531, by Mr. L. Goddard; and characteristic specimens of baleen-plates from the *Balæna Australis* had been transmitted by Mr. S. Moses from Van Diemen's Land.

Silk.

From a product of the most gigantic of animals I next proceed to notice one derived from a seemingly insignificant insect; yet it is the most costly of all raw materials for textile purposes,—I allude to silk. The most valuable kind of silk, and that which is the subject of the most extensive and pains-taking culture, is a secretion of the larva of a species of moth, indigenous to China, called, *par excellence*, the "silk-moth," and

* For the microscopical characters and other particulars of the baleen-plates, I must refer to my "Odontography," vol. i. p. 311.

by entomologists *Bombyx mori*, from its native and favourite food, the leaves of the mulberry-tree.

Raw silk was imported into Europe long before the insect which produces it; but the antiquity of this raw material for the richest of our textile fabrics, by no means goes so far back as that of wool.

There is no certain reference to silk in any part of the Old Testament; the Hebrew word so rendered by King James's translators (Ezekiel, xvi. 10, 13) may signify "fine flax;" and the learned Braunius concludes that silk was unknown to the Hebrews.*

The first definite mention of silk, with a notice of the creature producing it, is in the fifth book of the "Historia Animalium" of Aristotle. He indicates the island of Cos as the place where silk was woven into cloth; and he mentions (cap. xix. p. 850, Duval) four states of the insect which produces silk, under the terms σκώληξ, κάμπη, βομβύλιος, and νεκύδαλος; and these terms were understood by ancient writers after Aristotle, and no doubt correctly, to signify the states which modern entomologists would call the "young larva," the mature or "spinning larva," the "pupa" with its cocoon, and the "imago," or perfect insect.

In the New Testament, the use of silk is mentioned once unmistakeably (Revelations, xviii. 12).

The beautiful illustration of the Christian doctrine of the resurrection which Basil, in the year of our Lord 370, drew from insect-metamorphoses, shows plainly that he had obtained his facts by a perusal of the famous zoological treatise of Aristotle:—"What have you to say, who disbelieve the assertion of the Apostle Paul concerning the change at the resurrection, when you see many of the inhabitants of the air changing their forms? Consider, for example, the account of the horned worm of India, which, having first changed into a caterpillar (*eruca* or *veruca*), then in process of time becomes a cocoon (*bombylius* or *bombulio*), and does not continue even in this form, but assumes light and expanding wings. Ye women, who sit winding upon bobbins the produce of these animals—namely, the threads which these Seres send to you for the manufacture of fine garments—bear in mind the change of form in this creature; derive from it a clear conception of the resurrection, and discredit not that transformation which Paul announces to us all."†

Galen judiciously recommends silk threads for tying blood-vessels in surgical operations. The Roman poets and satirists made frequent mention of the luxurious silken clothes and attire, which were introduced at enormous expense during the period of the Empire. The silk so obtained was exported from Persia and India; but whether the *Bombyx mori* had been introduced into those countries at that period, or whether the raw material was obtained from China, is uncertain.

That silk was most abundant in China we learn from the oldest records of the singular people inhabiting that country, where, from an early period, not only the mandarins, but all persons in easy circumstances, as well male as female, have worn silk, satin, or damask clothes. Even the uni-

* De Vestitu Heb. Sacerdotum. My knowledge of the history of silk, as of wool, is chiefly derived from the "Textrinum Antiquorum" of Mr. Yates.

† "Textrinum Antiquorum," p. 215.

forms of the soldiers were made then, as now, of this elsewhere considered so valuable material.

Of the wild original of the *Bombyx mori* there is the same incertitude as with regard to most domesticated animals. The description which is given by M. Bertin in his work entitled "China, its Costumes, Arts, and Manufactures," seems to refer, as M. Latreille remarks, to the large *Phalæna atlas*. The wild silkworm is there said to curve a leaf into a kind of cup, and then to form a cocoon as large and nearly as hard as a hen's egg. These wild cocoons are so strong and so compact, that the insects have great difficulty in extricating themselves, and therefore remain enclosed from the end of the summer to the spring of the following year. These moths fly well. The domestic silk-moth, on the contrary, soon extricates itself, and has very feeble powers of flight. The wild silk-moth feeds indifferently on the ash, oak, and nagara; the *Bombyx mori*, as its name implies, feeds by choice, if not exclusively, on the leaves of the mulberry-tree.

I have now to speak of the introduction of the silkworm into Europe. According to Procopius, the *Bombyx mori* was first introduced into Europe in the reign of the Emperor Justinian, by two Nestorian monks who had travelled in Serinda—which, whether it be India or China is uncertain—and who succeeded in bringing a quantity of eggs—secured (according to Photius) in a hollow cane—to Constantinople, where they were hatched, and the larvæ fed and reared on the leaves of the black mulberry. The breeding of silkworms in Europe was confined for six centuries to the Greeks of the Lower Empire. In the twelfth century, the rearing of silkworms and the manufacture of silk were introduced by Roger, king of Sicily, into Palermo, whence this important branch of industry was rapidly and successfully established in Italy, Spain, France, England, and subsequently in most of our colonies possessing a suitable climate.

Silk is a secretion of a pair of long glandular tubes, called "sericteria," which terminate in a prominent pore or spinnaret on the under lip. Before their termination they receive the secretion of a smaller gland, which serves to glue together the two fine filaments from the two "sericteria:" the apparently single thread being, in reality, double, and its quality being affected by the equality, or otherwise, of the secreting power of the "sericteria." The silkworm commences spinning when it is full grown, in some convenient spot affording points of attachment for the first-formed thread, which is drawn from one part to the other until the body of the larva becomes loosely enclosed by the thread. The work is then continued from one thread to another, the silkworm moving its head and spinning in a zig-zag way, in all directions within reach, and shifting the body only to cover the part which was beneath it. The silken case so formed is called the "cocoon." During the period of spinning the cocoon, which usually takes five days for its completion, the silkworm decreases in size and length considerably; then casts its skin, becomes torpid, and assumes the form of the chrysalis.

The main object of the silkworm-breeder is to obtain cocoons of a large size, composed of a long, strong, very fine, even, and lustrous thread. These properties of the silk were found realized in the highest degree in the specimens transmitted from France, in which country the develope-

ment of the silkworm has for a long period exercised the care and pains o many able silkworm-breeders, and of late years has been the object o systematic advancement by the Central Society of Sericiculture of France

Much skill is exercised—I wish I could add without cruelty—in the ar of killing the pupa and extracting it from the cocoon, and in preparing th latter for unwinding the delicate thread; heat being the agent of destruc tion in most of the processes, as it seems to have been in the remotes historic times in China. The method there employed, according to the ol French missionaries in China, is as follows:—"The extremities of the cocoo are first cut off with a pair of scissors; they are then put in a canvass ba and immersed for an hour or more in a kettle of boiling lye, which dissolve the gum. When this is effected, they are taken from the kettle, are presse to expel the lye, and are left till the next morning to dry. Whilst they ar still moist the chrysalis is extracted from each cocoon, which is then turne inside out to make a sort of cowl. They are then easily wound int thread."

An accomplished author, who has celebrated the Great Exhibitio in a work full of apt and striking allusions, beautifully apostrophizes th "wondrous worm, self-shrouded in thy silken tomb! Anon to emerge i brighter form, on higher life intent; but that stern man thy mysti transformation intercepts, with fatal fires, consuming tenant for th sepulchre."*

The results of all the most approved modes of rearing the silkworm and preparing the cocoons were exhibited, and might be studied with advantage, in the Crystal Palace.

The *Bombyx mori*, having been bred and reared under the special car and management of man during a long succession of ages, may be regarded as a domesticated species of insect; and it has become the subject, as in the higher domesticated races, of varieties, of which those called "Sina," "Syrie," and "Novi," in France, are examples.

The "Sina" variety of the silkworm is known and esteemed for the pure whiteness of its silk, the thread of which is fine, but weak, and not very lustrous. The "Syrie" variety is of large size, produces a cocoon abundant in silk, but the thread is rather coarse, and inclines to a greenish tint. The "Novi" race is small, but the cocoons are firm and well made, and the silk has a yellowish tint.

The specimens of cocoons and raw silk exhibited in the French department were numerous, and the degrees of excellence hardly to be discriminated in the finest examples selected for the award of the prize medal. With regard to the superior quality of these raw silks and cocoons, the Jury, by their recommendation of the award of the Council medal to the "Central Society of Sericiculture of France," desired to testify their admiration of the specimens exhibited by many members of that Society, and their appreciation of the important influence which it has exercised in the improvement of this beautiful and valuable product of the animal kingdom.

The Jury, however, justly gave the honour of their first notice to the specimens shown under No. 782, by Major Count de Bronno Bronski, exhibitor of unbleached silk and silk cocoons from the Château de

* "The Lily and the Bee," by Samuel Warren, F.R.S., p. 92.

St. Selves, near Bordeaux, Department de la Gironde. The cocoons were remarkable for their large size and regularity of form, and the silk for the unusual length of the thread, its natural pure white colour, its fineness and lustre. The circumstances under which this superior quality of silk was obtained are certified in a report by a Committee of the Agricultural Society of the Gironde, dated 28th April, 1847, to be as follows: — "In 1836 Major Bronski reared separately the eggs of the three varieties, 'Sina,' 'Syrie,' and 'Novi.' In 1837 he set apart the cocoons of the varieties 'Syrie' and 'Novi;' and on the exclusion of the imago, or perfect insect, he associated the males of the 'Novi' with the females of the 'Syrie;' and the hybrid ova were hatched at the ordinary period in 1838, the operations being repeated in 1839 and 1840. With regard to the race 'Sina,' M. Bronski, in 1837, separated the white from the black worms as soon as they were hatched. He then selected the largest and best-shaped cocoons, and made a special collection of the eggs from the moths excluded from those cocoons. This procedure was repeated in 1838 and 1839; but in 1840 he associated the males excluded from the large cocoons of the black worms with the females excluded from those of the white worms. In 1841 he associated the males of the 'Sina' race with the hybrid females obtained from the above-described crossings of 'Novi' and 'Syrie' breeds." By these and similar experiments M. Bronski at length appears to have succeeded in obtaining a race of silkworms not subject to disease, producing large and equal-sized cocoons of a pure white colour, the silk of which was equal in all its length, strong and lustrous, and presenting an average length of thread of 1057 mètres.

Very beautiful examples of raw silk were also transmitted from different parts of Italy; and amongst the Italian silks the first mention was due to those exhibited in Tuscany, which showed well all the desirable qualities of the cocoons and thread. From these the Jury selected for the award of the prize medal No. 51, exhibited by Professor Savi, of Pisa, for the specimens of raw silk from silkworms fed upon leaves of the Philippine mulberry. In the department of Sardinia the Jury selected as deserving, for their excellent qualities, the prize medal, the silks exhibited by Messrs. H. Jacquet and Co., Messrs. Casissa and Sons, and Messrs. Rignon and Co.

Many of the silks exhibited in the department of Turkey were of a very fine character, exhibiting a good length of thread, with the qualities of fineness, strength, elasticity, and lustre. The Jury had great pleasure in awarding the prize medal to the School of Sericiculture at Broussa, as well as to some private exhibitors from Turkey.

Very fine examples of silk were shown in the Indian department, from which the Jury selected, as meriting the prize medal, the following: —D. Jardine, of Calcutta; Watson, of Surdah, Bengal; Mackenzie Brothers, of Bengal; Jennings, of Commercolly; W. M'Nair, of Surdah, Bengal. Besides the silk from the ordinary silkworm (*Bombyx mori*), called in India *pat*, specimens of stronger and coarser kinds of silk were shown, from the *tussur*-moth (*Saturnia mylitta*), which feeds on the leaves of the *terminalia catappa* and *zizyphus jujuba*. The cloth woven from this silk is called "tussur-cloth," and is made at Midnapore. The moonga-silk is from the *Bombyx saturnia*, which feeds upon the same

trees as the tussur. A piece of moonga-silk cloth, made in Assam, was exhibited. The *Phalæna cynthia* produces the *eri* silk. This species feeds upon the *ricinus communis*. The eri cloth is also woven at Assam. It is observed in India, that the *pat*, or true silk, from larvæ of the *Bombyx mori* fed on mulberry-trees grown in a strong clay soil, is generally better, the cocoons being larger and of better colour.

In the Chinese department the quality of the silk developed in the native country of the silkworm was worthily illustrated by the specimens exhibited by Yun-kee, of Shang-hae; to whom the Jury, therefore, adjudged the prize medal.

I must not quit the subject of silk without, finally, offering a tribute of praise to specimens of silk, from silkworms, reared on leaves of the white mulberry, at Godalming, Surrey, and exhibited by Mrs. Catherine Dodge, which, considering the unfavourable conditions of climate, showed qualities that deservedly elicited the award of Honourable Mention from our Jury.

Feathers and Down.

The most beautiful, the most complex, and the most highly-elaborated of all the coverings of animals, due to developements of the epidermal system, is the plumage of birds. Well might the eloquent Paley say, "Every feather is a mechanical wonder; their disposition, all inclined backward, the down about the stem, the overlapping of their tips, their different configuration in different parts, not to mention the variety of their colours, constitute a vestment for the body, so beautiful, and so appropriate to the life which the animal has to lead, as that, I think, we should have had no conception of anything equally perfect, if we had never seen it, or can now imagine anything more so."

A feather consists of the "quill," the "shaft," and the "vane:" the vane consists of "barbs" and "barbules."

The *quill* is pierced by a lower and an upper orifice, and contains a series of light, dry, conical capsules, fitted one upon another, and united together by a central pedicle.

The *shaft* is slightly bent; the concave side is divided into two surfaces by a middle longitudinal line continued from the upper orifice of the quill, the convex side is smooth. Both sides are covered with a horny material, similar to that of the quill; and they inclose a peculiar white, soft, elastic substance, called the "pith."

The *barbs* are attached to the sides of the shaft, and consist of plates, arranged with their flat sides towards each other, and their margins in the direction of the convex and concave sides of the feather; consequently they present considerable resistance to being bent out of their plane, although readily yielding to any force acting upon them in the direction of the line of the stem.

The *barbules* are given off from either side of the barbs, and are sometimes similarly barbed themselves, as may be seen in the barbules of the long feathers of the peacock's tail.

The barbules are commonly short and close-set, and curved in contrary directions, so that two adjoining series of barbules interlock together, and form the mechanism by which the barbs are compacted into the close

and resisting vane of the quill, or "feather," properly so called. When the barbules are long and loose, they characterize that form of the feather which is properly called a "plume:" and such are the most valuable products of the plumage of birds in a commercial point of view; as, *e. g.* the plumes of the ostrich.

The lower barbs in every kind of feather are usually loose, forming the down, which is increased, in most birds, by what is called the "accessory plume." This is usually a small downy tuft, but varies in different species, and even in the feathers of different parts of the body of the same bird. The value of feathers, for bed-stuffing, depends upon the proportion of loose soft down that enters into their composition; and, as the "accessory plume" in the body-feathers of the swans, geese, and ducks, is almost as long as the feather from which it springs, hence arises the commercial value of the feathers of these aquatic birds.

In the developement of plumage, the first covering of the bird is a temporary one, consisting of bundles of long, loosely-barbed filaments, which diverge from a small quill, and on their first appearance are enveloped in a thin sheath, which soon crumbles away after being exposed to the atmosphere.* These down-feathers are succeeded by the true feathers; to which they bear the same relation as wool does to hair, or the temporary to the permanent teeth. In most birds a certain proportion of the down-feathers is retained with the true feathers, and this proportion is usually greatest in the aquatic birds. It is most remarkable in the eider-duck (*Anas mollissima*); which may be compared with the sheep in regard to the quantity and quality of the softer and warmer kind of the epidermal covering. The down of the eider combines with its peculiar softness, fineness, and lightness, so great a degree of elasticity, that the quantity of this beautiful material which might be compressed and concealed between the two hands of a man will serve to stuff the coverlet of a bed.

All the varieties and modifications of the plumage of birds, serviceable in manufactures, or valued as ornaments, might be compared and studied with advantage in the Great Exhibition.

An instructive and comprehensive collection of feathers and down, in different states of preparation for bed-stuffing, including English goose feathers, Irish goose and mixed feathers, Dantzig feathers, Russian goose feathers and mixed duck feathers, Hudson's Bay goose and duck feathers, Russian down and Greenland eider-down, were exhibited by Messrs. Heal and Son. Messrs. W. and C. Nightingale likewise exhibited an illustrative collection of feathers and down, showing the effects of their mode of purifying feathers by steam, without the use of sulphurous gas.

In the Russian department good specimens of white Bejetsk bed-feathers, grey feathers, and goose-down, were exhibited by J. Lapshin (No. 145), of Petersburg. Madame Ladighin, of Tamboff, transmitted a fine quality of down from the breast of the goose; together with articles made of goose-down.

In the Indian department were shown white and black ostrich plumes;

* A good account of the mode of formation of feathers is given in a paper by M. F. Cuvier, entitled "Sur le développement des Plumes," in the "Mémoires du Muséum," tom. x. 10; or the article "Aves," in the "Cyclopedia of Anatomy," may be consulted.

but these had been imported from Aden. If the ostrich ever steps into Asia, it is only a little way into the Arabian side of the Isthmus of Suez: the *Struthio camelus* belongs to a peculiarly African genus of the great wingless birds. Tippets, victorines, and boas, made from the down of the young adjutant-crane (*Ciconia argala*) were exhibited from Commercolly; and also beautiful white feathers, of a smaller species of crane, from Arrahan. With regard to the application of quill-feathers as instruments for writing, I have nothing to say: the specimens illustrating that application having been placed, with other articles of stationery, under the inspection of another jury.

Horns and Antlers.

I next proceed to notice a class of raw materials from the animal kingdom extensively and variously exemplified in the Great Exhibition, most commonly used in the manufacture of implements, and known by the general name of "horns." In common parlance any hard body projecting from the head, terminating in a free, unopposed point, and serviceable as a weapon, is called a "horn:" such as the canine tusks which curve upwards and backwards through the skin of the head of the babyroussa, the larger incisive tusks of the elephant, and the long, straight, spirally-twisted tusk of the narwhal, which figures as the horn of the heraldic unicorn.

Even the weapons to which the term "horn" is properly or technically applied consist of very different substances, and belong to two organic systems as distinct from each other, as both are from the teeth. Thus the horns of deer consist of bone, and are processes of the frontal bone; those of the giraffe are independent bones, or "epiphyses," covered by hairy skin; those of oxen, sheep, and antelopes, are "apophyses" of the frontal bone, covered by the corium, and by a sheath of true horny material; those of the *Dicranoceros* (or prong-horned antelope) consist, at their base, of bony processes covered by hairy skin, and are covered by horny sheaths in the rest of their extent; they thus combine the characters of those of the giraffe and ordinary antelope, together with the expanded and branched form of the antlers of deer. Only the horns of the rhinoceros are composed wholly of horny matter, and this is disposed in longitudinal fibres, so that the horn seems rather to consist of coarse bristles compactly matted together in the form of a more or less elongated, subcompressed cone.

The Indian and the Javanese rhinoceroses have a single horn; the Sumatran and African rhinoceroses have two horns; these, however, do not form a symmetrical pair, but are placed one behind the other. The anterior is supported upon a rough tract of the anchylosed nasal bones; it is always the longest, and this difference is considerable in the *Rh. simus*, in which it is straight and inclines forwards. The posterior horn, which is always the smallest in the two-horned rhinoceroses, is the one which is absent in the one-horned species. The horn in these is placed nearer the end of the nose in the old than in the young animal, and this change of position is effected by an order of growth analogous to that of the adductor muscle of the oyster, viz., by the addition of new fibres to the fore part of the horn in greater proportion than to the hind part, where they may be observed to be always in a state of decay.

The horns of the ruminants are always symmetrically disposed, and usually in a single pair; very rarely, as in the four-horned antelope (*Antilope quadricornis*), and in the great extinct Sivathere and Bramathere, in two pairs. In the ox, sheep, goat, and antelope tribes the horns are always supported by processes of the frontal bones, into which (save in some *Antilopidæ*, *e. g. Cervicapra*, *Dorcas*,) the frontal sinuses are continued. A thin vascular layer of the corium is co-extended with the periosteum of the bone-process, or "core," and secretes the true horn, or "sheath." Horns of this type are never shed, and the *Ruminantia* that possess them are termed "cavicornia," or "hollow-horned."

Such horns are usually simple and conical, though they may be straight, curved, bent, hooked, or spirally twisted; only one existing species (*Antilope* (*dicranoceros*) *furcifer*) has them flattened, expanded, and bifurcate, like the great posterior horns of the extinct Sivatherium. Such compound horns are developed in both sexes in the *Bovidæ*, the *Ovidæ*, in all goats, and many antelopes, as, *e. g.* the caama (*bubalis*), the goral (*kemas*), the mar (*capricornis*), the chamois (*rupicapra*), the gazelle, and the oryx; but they are mostly larger in the males; they are not developed in the females of the *Saiga* and other species of *Antilope* proper, in the prong-horned antelope, the chiara (*tetraceros*), the madoqua (*Ant. montana*), the duyker-bok (*sylvicapra*), the bosch-bok (*tragelaphus*), and the strepsiceros (*calliope*).

Sometimes the horns are smooth and polished, sometimes longitudinally grooved; more commonly they are transversely ridged or "annulate." It is commonly believed that the horns of the ox acquire an additional ring every year after the third; but the addition of annuli is far from being annual in other species: many rings are gained in one year's growth of the ram's horns, and in those of the ring-horned antelope (*Ant. cervicapra*). The first formed horny sheath of the *Cavicornia* is commonly obtuse, thicker, and of a coarser texture than that which is formed later; but it is equally extravascular, and is merely displaced and shed piecemeal by the formation of new horn-fibres beneath it, like other layers of epidermal substance. The more compact horny matter developed at the period of maturity, and the use to which the horns are then more habitually and forcibly put, gives their points a sharpness and compactness very different from the first formed substance. In the young oryx it is bent backwards before it is cast off, but the bony core does not partake of this form.

The horns of deer, which consist wholly of bone, are properly called "antlers." They are covered by periosteum, and this by a soft vascular tegument technically termed the "velvet," during the progress of their growth. This once completed, the vessels shrink, the supply of blood is stopped, the integument of the antler dries and becomes detached, leaving the dense bony part as an insensible weapon. As this part loses its vitality, the absorbents proceed to sap its base, and at a certain season of the year the antlers are shed, after which the growth of another pair soon begins.

Thus the antlers of the deer tribe are shed and renewed annually, like the hair; and the antlers increase in size and in the number of the branches, until the animal has attained its full maturity and strength.

The red deer, at this period, will develope, in the course of about ten weeks, a pair of antlers weighing about twenty-four pounds. But the great extinct Irish deer (*Megaceros Hibernicus*) must have thrown out of its circulating system in the course of a few months between seventy and eighty pounds weight of osseous substance.

The antlers of all the deer tribe have the same chemical and physical qualities as true bone; and the same chemical products, *e. g.* phosphorus and ammonia, may be obtained from them. The common term "harts-horn" indicates the former exclusive use of the antlers as the source from which ammonia was obtained. The density of the texture of the antler gives it value and utility for the purposes of cutlery, and for weapons and ornaments of various kinds.

Numerous fine and illustrative specimens of horns and antlers were transmitted to the Great Exhibition, amongst which the collection in the Indian department merits the first notice for the number and variety of the examples. There were shown the dense antlers of the *Cervus Aristotelis;* of the bara sinha (*Cervus Duvaucellii*); of the sámber (*Cervus hippelaphus*); of the kaher, or barking deer (*Cervus vaginalis*, Boddaert); of the axis (*Cervus maculatus*); of the mar (*Capricornis bubalina*); and of the hog-deer (*Cervus porcinus*); there also might be seen noble specimens of the horns of the gour (*Bos cavifrons*), and of the great Arné buffalo (*Bos* (*bubalus*) *Arna*).

In Canada were shown fine examples of the palmated antlers of the great moose or elk (*Alces Americana*); and both Egypt and the Cape contributed specimens of the horns of the rhinoceros, the buffalo, and of various antelopes.

It did not appear that any of the specimens of horns exhibited improvements of size or texture, as the consequence of modifications in the food or habits of the species, superinduced to that end by the art of man. The functions of the Jury, therefore, in judging between degrees of excellence as the consequence of human ingenuity and skill, found no exercise in regard to the present class of raw materials.

Ivory.

The same considerations necessarily limited the functions of our Jury in regard to the tusks of animals presenting the modification of dental substance to which the term "ivory" is applied. Fine ivory, distinguished by the decussating curved lines on the surfaces of transverse fractures or sections of the tusk, is peculiar to the African and Asiatic elephants, amongst existing quadrupeds, and the best is obtained from the wild individuals; domestication of the elephant, in India at least, having been attended usually by deterioration of the length and quality of the tusks.

The finest specimens of elephant's tusks sent to the Great Exhibition were a pair weighing 325 pounds, from the *Elephas Africanus*, obtained from an animal killed near the newly discovered Lake Ngami, in South Africa; each tusk measured eight feet six inches in length, and twenty-two inches in basal circumference. A single tusk, weighing 110 pounds, from the same locality, was associated with them. These specimens were exhibited by Mr. Joseph Cawood.

Messrs. Fauntleroy and Sons exhibited an instructive collection of

elephants' tusks in No. 135. The largest of these was also from the African elephant, and weighed 139 pounds. Varieties of tusks were exhibited from the Gold Coast, the Gaboon River, Zanzibar, the Cape of Good Hope, Angola, Alexandria, Ceylon, and the East Indies. Of the tusks which possess a dense texture, but have not the engine-turn markings of true ivory, Messrs. Fauntleroy exhibited those of the narwhal, the walrus, and the hippopotamus; and the Jury regarded this instructive collection as deserving Honourable Mention.

Fine tusks of the Ceylon variety of elephant were shown in the collection from that island; and several examples of the continental Asiatic kinds were exhibited in the Indian departments; amongst the tusks of the Siamese elephants was one which weighed 100 pounds, and showed a fine white compact kind of ivory.

Tortoise-shell.

Of the modifications of epidermal productions, commonly called tortoise-shell, almost every variety might be studied in the wonderful collection of the works of nature and of art which has made the present year ever memorable.

The substance called tortoise-shell consists of certain large horn-like epidermoid plates, which cover in an imbricated or overlapping manner the carapace, or back shell of the marine tortoises or turtles (*Chelone*). The species which afford the most valuable of these plates are the Karet tortoises or imbricated turtles (*Chelone imbricata*, *Chelone Caretta*), from which are obtained five large plates from the middle of the carapace, and four large ones from each side; these plates, thirteen in number, are technically called "blades;" twenty-five smaller plates are obtained from the margin of the carapace, which are called the "feet" or "noses," in commerce. The other plates collectively are called the "head" of the turtle.

Pearl, Nacre, Shell.

A still more beautiful and precious animal product is that which, in all ages, has been classed as an ornament amongst the jewels or precious stones,—I allude to Pearls.

These valuable substances are the result of an excretion in superimposed concentric laminæ of a peculiarly fine and dense nacreous substance, which consists of membrane and carbonate of lime. The finest quality of pearl is produced by the bivalve of the Indian Seas, called, *par excellence*, the "pearl oyster" (*Meleagrina margaritifera*), fine specimens of which were exhibited in the Indian and Ceylon collections. The finest pearls are found at Ceylon.

Pearls of an inferior description, formed in a fresh-water bivalve (*Unio margaritifera*), were exhibited under No. 15, Class I. by Mr. John Nelis, of Omagh, county Tyrone, from specimens obtained from the deepest parts of the river Strule, near Omagh. Similar pearls, also found in the *Unio margaritifera*, from the river Ythan, Aberdeenshire, were shown under No. 16, Class I., by Messrs. Corvie and Rae, of Ellon, Scotland. It is probable that the pearls from this source, collected by the ancient Britons, may have given rise to the statement by Tacitus, in his "Life of Agricola," of pearls "not very orient, but pale and wan," being among the indigenous

products of Great Britain. Pearls, similar to those from the *Unio margaritifera*, were exhibited under No. 41, Sweden and Norway, by M. Torstrup, from Christiana.

The smaller kind of pearl, called "seed-pearl," is obtained at Kurrachee on the Bombay coast. They are of little value, except to those who esteem them as medicine, viz., the Persians and some of the Hakeems of India. The oysters producing "seed-pearl" are washed up by the surf-wave to high-water mark, and are left there as the tide falls. They are gathered by Coolies, employed for the occasion, put into boats, and landed at Keeamaree Point. There the shells are broken, and the pearls extracted under the superintendence of the contractors, who now pay the Julpor Government 40,000 rupees per annum for the pearl-contract. Even the gleaners who come after them pay for the right of sifting the broken shells in search of any pearls that may remain.

Mother-of-Pearl, or Nacre.

In the Indian collection were shown most of the shells which yield the manufacturer the finest kind of nacre: these are the *Meleagrina margaritifera*, *Haliotis gigas*, *Haliotis iris*, and a large species of *Turbo;* which shells are known in commerce as flat-shells, ear-shells, green snail-shells, buffalo-shells, Bombay shells. The mother-of-pearl is the internal or nacreous layer of such shells. Dr. Carpenter has detected indications of a minute cellular structure in the nacreous laminæ of the *Haliotis*, which he has not observed in the nacre of bivalves. Fine specimens of some of these shells from Sincapore and Manilla, especially the great *Meleagrina* and *Haliotis*, were exhibited by Messrs. Fauntleroy, under No. 135; and by Mr. Banks, under No. 287, Class XXII., in connexion with the manufacture of mother-of-pearl buttons.

Cameo-Shells, Corals.

Specimens of cameo-shells (*Cassis rufa*), species of *Cypræa*, and other shells used as ornaments by certain natives of India, with the rude but efficient instruments for cutting them, were shown in the Indian collection.

Shells adapted for cameo-cutting are dense, thick, and consist of three layers of differently-coloured shell-material. In the *Cassis rufa* each layer is composed of many very thin plates — in other words, is "laminated" — the laminæ being perpendicular to the plane of the main layer: each lamina consists of a series of elongated prismatic cells, adherent by their long sides. The laminæ of the outer and inner layers are parallel to the lines of growth, while those of the middle layer are at right angles to them. In the cowreys (*Cypræa*) there is an additional layer, which is a duplicature of the nacreous layer formed when the animal has attained its full growth.

Descending now to the lowest forms of animal life, and those that link the animal with the vegetable, I ought to speak of the nature and development of those raw materials called "corals" and "sponges," which serve for various purposes of ornament and use. But the limits of an evening's discourse compel me to refer to the works on Zoology, in which their nature will be found fully elucidated. The Great Exhibition was rich in the various calcareous bases or skeletons of the ramified and rooted marine zoophytes, which are sought after for different economic applications.

One of the finest examples of the red coral (*Corallium rubrum*) was exhibited by Messrs. Paravagna and Casella, under No. 84, Class XXXIII., in connexion with cameo-work and carving in coral. Specimens of red coral were also exhibited in the collection from Algiers. A fine collection of both corals and madrepores, including the black flexible coral (*Gorgonia*), was shown in the department of Bermuda.

Gelatines.

Such productions as coral, shell, and pearl, are naturally attractive by their intrinsic beauty or rarity. But the most refuse and uninviting, and seemingly most worthless parts of animal bodies, are turned to uses of the most unexpected kind by the inventive skill and science of man.

The raw materials chiefly used in manufactures derived from the gelatinous textures of animal bodies, may be divided, as regards their commercial value and application, into two kinds :—

1st. The gelatines and glues, properly so called, derived from the dissolution of certain animal tissues, and especially from the waste residue of parts of animals which have served for food, or for the operations of tanning, or for the fabrication, as from bones, of articles in imitation of ivory, or from the waste particles in the carving of ivory itself.

2d. The cleansed and dried membranes of different species of fish, more especially of the sturgeon family (*Acipenseridæ*), preserving a peculiar texture, on which their value in the refining of fermenting liquors more especially depends; such membranes are called "isinglass."

The most remarkable progress in the economical extraction and preparation of pure gelatines and glues from the waste remnants of the skins, bones, tendons, ligaments, and other gelatinous tissues of animals, has been made in France, where the well-organized and admirably arranged establishments for the slaughter of cattle, sheep, and horses in large towns, give great and valuable facilities for the economical applications of all the waste parts of animal bodies. Among the beautiful productions of this industry, the specimens exhibited by its chief originator, M. L. F. Grenet, under No. 247, merited peculiar approbation. They included different kinds of gelatine in thin layers, adapted for the dressing of stuffs, and for gelatinous baths, in the clarification of wines which contain a sufficient quantity of tannin to precipitate the gelatine; pure and white gelatines cut into threads for the use of the confectioner: very thin white and transparent sheets called "papier glacé" or ice paper, for copying drawings; and, finally, a quantity of objects of luxury or ornaments formed of dyed, silvered, or gilt gelatines, adapted to a variety of purposes, and to the fabrication of artificial or fancy flowers. M. Grenet, who was the first to fabricate on a large scale, out of various residues of animal bodies of little value, these beautiful and diversified products, many of which previously had been derived from the more costly substance—isinglass, was deemed by the Jury to merit the award of the Council medal.

Many manufacturers in France have risen to great eminence in this line by following the processes of M. Grenet. H. Castelle, of Paris, exhibited (No. 107) a still more varied assortment of the modifications of gelatine, amongst which were particularly deserving of notice the very

large sheets of transparent gelatine, colourless, white, of various well-defined colours, and embossed or stamped with elegant patterns.

Isinglass.

This raw material owes the greater part of its commercial value to its special organization, which permits its separation into extremely delicate fibres, capable of operating mechanically in the clarification of white wines and malt liquors. In order to obtain the best isinglass, care must be taken to choose the most suitable membranes of the proper species of fish, and to avoid altering their peculiar tissue in the process of drying and preparing them.

Under these two relations the raw products exhibited in the department of Russia held the first rank. MM. Marimanoff and Armakoona (No. 81) displayed specimens of the best quality of isinglass, consisting of the tissues of the air-bladders of the species of sturgeon called *Acipenser huso*, well cleaned, and removed and dried without the texture being affected. No. 116, transmitted by an anonymous Russian exhibitor, presented a variety of isinglass obtained from the intestinal membranes of the sturgeon, in the form of elongated stripes, made into bundles. This substance, like the gelatines from the tendons, bones, and hides of cattle, serves well for different culinary purposes, and for the same uses in manufactures as fine gelatine from other sources.

Messrs. Simpson, Humphries, and Vickers, exhibited a rich variety of specimens of isinglass in the different raw states in which it is imported, and in all the states of its preparation for the applications for which it is sold.

The greater part of the gelatinous products exhibited by the English manufacturers were prepared from isinglass, and chiefly applied to articles of food. The commercial qualities of isinglass are instructively shown in the collection exhibited under Nos. 117, 118, and 141. Some exhibitors, however, showed excellent glues and gelatines obtained from various residues of animal bodies, and destined for manufacturing purposes. M. Muller (No. 125A) transmitted a fine assortment of glues and gelatines, analogous to the products of M. Grenet. M. Dufaville (122) exhibited a beautiful sample of amber-coloured, transparent gelatine, in shreds, called "crystalline," from its glittering surface; and also good filaments of isinglass for culinary purposes.

Amongst the specimens from India there were different kinds of isinglass in the raw state from species of fishes distinct from those of Europe which commonly afford this substance. The principal of these were from a siluroid fish, the *Polynemus plebeius*, the dried air-bladders of which possess the fine fibrous tunic which imparts the clarifying qualities that render isinglass so valuable in the manufacture of white wines and beers; and they also are well adapted for the fabrication of fine gelatines used in manufactures and confectionary.

Such, Sir, are some of the numerous and diversified kinds of products from the Animal Kingdom which I have selected for the remarks I have had the honour to submit to you this evening. To have attempted, in

the briefest way, to treat of all of that class which were transmitted to the Great Exhibition, would have led me far beyond the bounds of a single discourse.

Whatever the animal kingdom can afford for our food or clothing, for our tools, weapons, or ornaments—whatever the lower creation can contribute to our wants, our comforts, our passions, or our pride, that we sternly exact and take at all cost to the producers. No creature is too bulky or formidable for man's destructive energies; none too minute and insignificant for his keen detection and skill of capture. It was ordained from the beginning that we should be the masters and subduers of all inferior animals. Let us remember, however, that we ourselves, like the creatures we slay, subjugate, and modify, are the results of the same Almighty creative will; temporary sojourners here and co-tenants with the worm and the whale of one small planet. In the exercise, therefore, of those superior powers that have been intrusted to us, let us ever bear in mind that our responsibilities are heightened in proportion.