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BUSTARDS AT THE ZOOLOGICAL GARDENS.

THE Zoological Society of London has recently added to its collection in the Regent's Park several fine specimens of the largest species of bustard, which in South Africa is of grand size, but rarely seen except in places remote from human habitations. The Otis Kori, found on the banks of the Gariap or Orange River, is four feet high, or even bigger, and has long wings, but seldom cares to fly, running with great swiftness, and using its wings to assist its course in running; it will, however, occasionally rise and skim along just above the ground. Its body is very bulky and heavy, abounding in fat, and the flesh of this bird is much esteemed as meat, its flavor being like that of a turkey. The natives of Africa are accustomed to catch the bus-

upon the earth. Loki, the God of Envy, attended her disguised as a crow (crows at that time were white), and settled on a little blue flower, hoping to cover it up so that she might overlook it. The flower, however, cried out "Forget-me-not, forget-me-not" (and has ever since been known under that name). Loki then flew up into an oak and sat on a mistletoe. Here he was more successful. Nanna carried off the oath of the oak, but overlooked the mistletoe. She thought, however, and the divinities thought, that she had successfully accomplished her mission, and that Balder had received the gift of immortality.

One day, thinking Balder proof, they amused themselves by shooting at him, posting him against a holly. Loki tipped an arrow with a piece of mistletoe, against which Balder was not proof. This unfortunately pierced

the form and size and texture some reference to the structure and organization, the habits and requirements, of the whole plant?

The leaf, although so thin, is no mere membrane, but is built up of many layers of cells, and the interior communicates with the external air by millions of little mouths, called stomata, which are generally situated on the under side of the leaf. The structure of leaves varies as much as their forms.

It is, of course, principally in hot and dry countries that leaves require protection from too much evaporation.

The surface is in some cases protected by a covering of varnish, in others by saline or calcareous excretions. In others, again, the same object is attained by increased viscosity of the sap; in some, the leaves assume a

GREAT BUSTARDS RECENTLY ADDED TO THE ZOOLOGICAL SOCIETY'S GARDENS, LONDON.

tard in snares. They say that a single bustard is usually to be seen accompanying a herd of gazelles.—*Illustrated London News*.

THE SHAPES OF LEAVES AND COTYLEDONS.*

By Sir JOHN LUBBOCK.

ATTEMPTS to explain the forms, colors, and other characteristics of animals and plants, though not new, were until recent years far from successful. Our Teutonic forefathers had a pretty story which explained certain characteristics of several common plants.

Balder, the God of Mirth and Merriment, was, characteristically enough, regarded as deficient in the possession of immortality. The other divinities, fearing to lose him, petitioned Thor to make him immortal, and the prayer was granted on condition that every animal and plant would swear not to injure him. To secure this object, Nanna, Balder's wife, descended

him to the heart, and he fell dead. Some drops of his blood dropped on the holly, which accounts for the redness of the berries; the mistletoe was so grieved that she has ever since borne fruit like tears, and the crow, whose form Loki had taken, and which till then had been white, was turned black.

This pretty myth accounts for several things, but is open to fatal objections. You will judge whether I am more fortunate. In the first place, I need hardly observe that the forms of leaves are almost infinitely varied. To quote Ruskin's vivid words, they "take all kinds of strange shapes, as if to invite us to examine them. Star-shaped, heart-shaped, spear-shaped, arrow-shaped, fretted, fringed, cleft, furrowed, serrated, sinuated, in whorls, in tufts, in spires, in wreaths, endlessly expressive, deceptive, fantastic, never the same from footstalk to blossom, they seem perpetually to tempt our watchfulness, and take delight in outstripping our wonder."

Now, why is this marvelous variety, this inexhaustible treasury of beautiful forms? Does it result from some innate tendency of each species? Is it intentionally designed to delight the eye of man? Or has

vertical position, thus presenting a smaller surface to the rays of the sun. In other cases the leaves become fleshy. Woolly hairs are also a common and effective mode of protection.

The plants of deserts are very frequently covered with a thick felt of hair. Some species, again, which are smooth in the north tend to become woolly in the south. Species of the cool spring again tend to be glabrous. The uses of hairs to plants are indeed very various. They serve, as just mentioned, to check too rapid evaporation. They form a protection for the stomata or breathing holes, and consequently, as these are mainly on the under side of leaves, we find that when one side of the leaf is covered with white felted hairs, as the white poplar, this is always the under side.

In other cases the use of hair is to throw off water. In some Alpine and marsh plants this is important. If the breathing holes become clogged with moisture—with fog, for instance, or dew—they would be unable to fulfill their functions. The covering of hair, however, throws off the moisture, and thus keeps them dry. Thus these hairs form a protection both against too much drought and too much moisture.

* Lecture delivered at the Royal Institution on April 25, 1890, by Sir John Lubbock, Bart., M.P., D.C.L., F.R.S., etc.—*Nature*.

Another function of hairs which cannot be omitted is to serve as shades against too brilliant light and too much heat. Again, hairs serve as a protection against insects, and even against larger animals. The stinging hairs of the common nettle are a familiar example, and coarse woolly hairs are often distasteful to herbivorous quadrupeds.

Deciduous leaves especially characterize the comparatively cool and moist atmosphere of temperate regions. For different reasons evergreen leaves become more numerous in the Alps and in the tropics.

In the Alps it is necessary for plants to make the most of the short summer. Hence, perennial and evergreen species are more numerous in proportion than with us. Everybody must have noticed how our trees are broken if we have snow early in the season and when they are still in leaf.

The comparatively tough and leathery leaves, such as those of the evergreen oak and olive, are protected against animals by their texture, and often, as in the holly, by spines; they are better able to resist the heat and dryness of the south than the comparatively tender leaves of our deciduous trees, which would part too rapidly with their moisture. It is perhaps an advantage to evergreen leaves to be glossy, because it enables them better to throw off snow. Moreover, their stomata are often placed in pits, and protected with hair, which prevents too rapid evaporation. The texture and structure of leaves is indeed a wide and very interesting subject, but to-night I must confine myself to the shape.

CORDATE AND LOBED LEAVES.

Among broad leaves we may observe two distinct types, according as they are oval or palmate. Monocotyledonous plants, such as grasses, sedges, lilies, hyacinths, very generally have upright and narrow leaves. When they are wider, as, for instance, in the black bryony, this is mainly at the base, where, consequently, the veins are further apart, coming together again toward the apex. This we are tempted therefore to regard as the primitive type of a broad leaf.

There is, however, a totally different one, where the leaf is palmate, like a hand, widening toward the free end. Here the veins pursue a straight, diverging course; and as they not only serve to strengthen the leaf, but also to carry the nourishment, this is doubtless an advantage. Another reason perhaps for this arrangement is found in the fact that these leaves are generally folded up, like a fan, while they are in the bud.

I have elsewhere dwelt on the case of the beech, and perhaps I may briefly refer to it again. The weight of leaves which a branch can carry will of course depend on its position and strength. The mode of growth of the beech and the hornbeam are very similar, but the twigs of the latter are slenderer, and the leaves smaller. If we cut off a beech branch below the sixth leaf, we shall find that the superficial leaf area which it carries is about 18 square inches. But in our climate most leaves are glad of as much sunshine as they can secure, and are arranged with reference to it. The width of the beech leaves, about $1\frac{3}{4}$ inch, is regulated by the average distance between the buds. If the leaves were wider, they would overlap. If they were narrower, there would be a waste of space. The area on the one hand, and the width on the other, being thus determined, the length is fixed, because to secure an area of 18 inches, the width being about $1\frac{3}{4}$ inch, the length must be about two inches. This, then, explains the form of the beech leaf.

Let us apply these considerations in other cases. I will take, for instance, the Spanish chestnut and the black poplar. In the Spanish chestnut the stem is much stronger than that of the beech. Consequently it can carry a greater leaf surface. But the distance between the buds being about the same, the leaves cannot be much wider; hence they are much longer in proportion, and this gives them their peculiar sword-blade-like shape.

Now, if we look at the end of a branch of black poplar and compare it with one of white poplar, we are struck with two things: in the first place the branch cannot be laid out on a sheet of paper so that the leaves shall not overlap; the leaves are too numerous and large. Secondly, in the white poplar the upper and undersurfaces of the leaf are very different, the lower one being covered with a thick felt of hair, which gives it its white color; in the black poplar, on the other hand, the two surfaces are nearly similar.

These two characteristics are correlated, for while in the white poplar the leaves are horizontal, in the black poplar, on the contrary, they hang vertically. Hence the two surfaces are under very similar conditions, and consequently present a similar structure; while for the same reason they hang free from one another.

Let us again look for a moment at the great group of conifers. Why, for instance, do some have long leaves and some short ones? This, I believe, depends on the strength of the twigs and the number of years which the leaves last; long leaves dropping after one, two, or three years, while species with shorter ones retained them many years—the spruce fir, for instance, 8 or 10, *Abies Pinsapo* even as many as 18.

[Here Sir John dwelt on and explained the forms of several familiar leaves.]

SEEDLINGS.

I now come to the second part of my lecture—the forms of cotyledons. Any one who has ever looked at a seedling plant must have been struck by the fact that the first leaves differ entirely from those which follow, not merely from the final form, but even from those which immediately follow. These first leaves are called cotyledons. The forms of many cotyledons have been carefully described, but no reason had been given for the forms assumed, nor any explanation offered why they should differ so much from the subsequent leaves. Klebs, indeed, in his interesting memoir on "Germination," characterizes it as quite an enigma.

Mustard and cress were the delight and wonder of our childhood, but it never then occurred to me at least to ask why they were formed as they are. So they grew, and beyond that it did not occur to me, nor I think to most, that it was possible to inquire. I have, however, I think, suggested plausible reasons in many cases, some of which I will now submit for your consideration. Cotyledons differ greatly in form.

Some are narrow, in illustration of which I may mention the fennel and ferula, in the stalk or ferule of

which Prometheus is fabled to have brought down fire from heaven.

Some are broad, as in the beech and mustard. Moreover, some species have narrow cotyledons and broad leaves, while others have broad cotyledons and narrow leaves.

Some are emarginate, as in the mustard; lobed, as in the lime; bifid, as in *Eschscholtzia*; trifid, as in the cress; or with four long lobes, as in *Pterocarya*.

Some are unequal, as in the mustard, or unsymmetrical, as in the geranium.

Some are sessile, and some are stalked, some are large, some small.

Generally they are green, leaf-like, and aerial, but sometimes they are thick and fleshy, as in the oak, nut, walnut, peas, beans, and many others, in which they never quit the seed at all.

Let us see, then, whether we can throw any light on these differences, and why they should be so unlike the true leaves.

If we cut open a seed, we find within it the future plant; sometimes, as in the larkspur, a very small oval body; sometimes, as in the ash, or the castor oil, a lovely little miniature plant, with a short stout root and two well formed leaves, inclosing between them the rudiment of the future stem; the whole lying embedded in food material or perisperm; while sometimes the embryo occupies the whole interior of the seed, the food material being stored up, not round, but in the seed leaves or cotyledons themselves. Peas and beans, almonds, nuts, and walnuts are familiar cases. In split peas, for instance—Who split the peas? If you look at them, you will see that it is too regularly and beautifully done for human hands. In fact, the two halves are the two fleshy cotyledons; strictly speaking, they are not split, for they never were united.

NARROW COTYLEDONS.

Let us now begin with such species as have narrow cotyledons, and see if we can throw any light on this characteristic. The problem is simple enough in such cases as the plane, where they have, on the one hand, narrow cotyledons, and, on the other hand, a long, narrow seed fully occupied by a straight embryo. Again, in the ash, the cotyledons lie parallel to the longer axis of the seed, which is narrow and elongated. Such cases are, however, comparatively few; and there are a large number of species in which the seeds are broad and even orbicular, while yet the cotyledons are narrow.

In these it will generally be found that the cotyledons lie transversely to the seed.

The sycamore has also narrow cotyledons, but the arrangement is very different. The fruit is winged, the seed is somewhat obovoid and aperispermic—that is to say, the embryo, instead of lying embedded in food material, occupies the whole cavity of the seed. Now, if we wished to pack a leaf into a cavity of this form, it would be found convenient to choose one of a long strap-like shape, and roll it up into a sort of ball. This is, I believe, the reason why this form of cotyledon is most suitable in the case of the sycamore.

BROAD COTYLEDONS.

I now pass to species with broad cotyledons. In the castor oil plant, *Euonymus*, or the apple, for instance, the young plant lies the broad way of the seed, and the cotyledons conform to it. In the genus *Coreopsis*, *Coreopsis auriculata* has broad cotyledons, and *Coreopsis filifolia* has narrow ones—the first having broad, the second narrow seeds.

In a great many species the cotyledons are emarginate—that is to say, they are more or less deeply notched at the end. This is due to a variety of causes. One of the simplest cases is that of the oak, where the two fleshy cotyledons fill the seed; and as the walls of the seed are somewhat thickened at the end, and project slightly into the hollow of the seed, this causes a corresponding depression in the cotyledons.

In such cases as the mustard, cabbage, and radish, the emargination is due to a very different cause. The seed is oblong, thick, and slightly narrower at one end than the other. There is no perisperm, so that embryo occupies the whole seed, and as this is somewhat deep, the cotyledons, in order to occupy the whole space, are folded and arranged one over the other like two sheets of note paper, the radicle being folded along the edge. To this folding the emargination is due. If a piece of paper be taken, folded on itself, cut in the form of the seed, and then unfolded, the reason for the form of the cotyledon becomes clear at once.

But it may be said that in the wall flower the seed has a similar outline, and yet the cotyledons are not emarginate. The reason of this is that in the wall flower, *Cheiranthus*, the seed is more compressed than in the mustard and radish, and consequently the cotyledons are not folded; so that the whole, not the half, of each cotyledon corresponds to the form of the seed.

LOBED COTYLEDONS.

The great majority of cotyledons are entire, but some are more or less lobed. For instance, those of the mallow are broadly ovate, minutely emarginate, cordate at the base, and three-lobed or angled toward the apex, with three veins, each running into one of the lobes.

The embryo is green, curved, and occupies a great part of the seed. The cotyledons are applied face to face; then, as growth continues, the tip becomes curved and depressed into a median longitudinal furrow, the fold of the one lying in that of the other.

[Sir John then showed clearly by diagrams and paper how the emargination arises, but it cannot be made clear without illustrations.]

The cotyledons of the line are very peculiar. They are deeply five-lobed, the central lobe being the longest; so that they are roughly shaped like a hand. The seed is an oblate spheroid, resembling an orange in form, and the embryo is embedded in semi-transparent albumen.

The embryo is at first straight; the radicle is stout and obtuse; the cotyledons ovate-obtuse, plano-convex, fleshy, pale green, and applied face to face. They grow, however, considerably, and when they meet the wall of the seed, they bend back on themselves, and then curve round, following the general outline of the seed. If any one will take a

common tea cup and try to place in it a sheet of paper, the paper will, of course, be thrown into ridges. If these ridges be removed and so much left as will lie smoothly inside the cup, it will be found that the paper has been cut into lobes more or less resembling those of the cotyledons of *Tilia*. Or if, conversely, a piece of paper be cut into lobes resembling those of the cotyledons, it will be found that the paper will fit the concavity of the cup. The case is almost like that of our own hand, which can be opened and closed conveniently, owing to the division of the five fingers.

UNEQUAL COTYLEDONS.

In most cases the two cotyledons are equal, but there are several cases in which one of them is larger than the other. They had not escaped the attention of Darwin, who attributed the difference to the fact "of a store of nutriment being laid up in some other part, as in the hypocotyl, or one of the cotyledons." I confess that I do not quite see how this affords any explanation of the fact. The suggestion I have thrown out is that the difference is due to the relative position of two cotyledons in the seed, which in some cases favors one of them at the expense of the other. Thus in the mustard they are unequal, and as we have already seen, they are folded up, one inside the other. The outer one, therefore, has more space, and becomes larger. In many other Crucifers, though the cotyledons are not folded, they are what is called "incumbent"—that is to say, they are folded on the radicle, and the outer one has therefore more room than the other.

UNSYMMETRICAL COTYLEDONS.

In other cases, as in the geraniums, laburnum, lupines, etc., there is inequality, not between the two cotyledons, but between the two halves of each cotyledon. In the geraniums this is due to the manner in which the cotyledons are folded. In cabbage and mustard we have seen that one cotyledon is folded inside the other; in the geranium they are convolute, one-half of each being folded inside one-half of the other, the two inner halves being the smaller, the two outer the larger ones.

In the laburnum, where the arrangement is very similar, the inequality in the two sides of the cotyledon is due to the inequality between the two sides of the seed.

SUBTERRANEAN COTYLEDONS.

I have already observed that in some cases the cotyledons occupy the whole of the seed, which, in more or less spherical seeds, is effected either by a process of folding and packing, or by the cotyledons becoming themselves more or less thickened, as in peas and beans, nuts and chestnuts. This is the reason why such seeds fall more or less readily into two halves, the radicle or plumule being so small in comparison as generally to escape notice, though, if a horse chestnut is peeled, the radicle appears as a sort of tail.

In some beans the cotyledons sometimes emerge from the seed, sometimes remain underground. In others, as also in the oak and horse chestnut, they never leave the seed, or come above ground; they have lost the function of leaves and become mere receptacles of nourishment.

Did it ever occur to you to think, when you have been eating walnuts, why their structure is so complex, and why the edible part is thrown into those complicated lobes and folds? The history is very interesting.

In the walnut, the cotyledons now never leave the seed, but in an allied genus, *Pterocarya*, they come above ground as usual, and are very peculiar in form, being deeply four-lobed. The reason of this is very curious. The fruit is originally much larger than the seed, but, as it approaches maturity, the hard woody tissue disintegrates at four places, leaving thus four hollow spaces. Into these spaces the seed sends four projections, and into these four projections each cotyledon sends a lobe. Hence the four lobes.

Now in the walnut a very similar process takes place, only the hollow spaces are much larger, so that, instead of a solid wall, with hollow spaces occupied by the seed, it gives the impression as if the seed was thrown into folds occupied by the wall of the fruit. To occupy these spaces fully, the cotyledons themselves were thrown into folds as we now see them. The fruit of *Pterocarya* is much smaller than that of the horse chestnut, which doubtless was itself formerly not so large as it now is. As it increased, the cotyledons became fleshier and fleshier, and found it more and more difficult to make their exit from the seed, until at last they have given up any attempt to do so. Hence these curious folds, with which we are so familiar, are the efforts made by the originally leafy cotyledons to occupy the interior of the nut. If you separate them, you will easily find the little rootlet, and the plumule with from five to seven pairs of minute leaves.

But perhaps you will ask me why I have assumed that in these cases the cotyledons have conformed to the seeds? May it not be that the seed is determined, on the contrary, with reference to the cotyledons? The size, form, etc., of the seeds, however, evidently have relation to the habits, conditions, etc., of the parent plant.

Let me, in illustration, take one case. The cotyledons of the sycamore are long, narrow, and strap-like; those of the beech are short, very broad, and fan-like. Both species are aperispermic, the embryo occupying the whole interior of the seed.

Now, in the sycamore, the seed is more or less an oblate spheroid, and the long ribbon-like cotyledons, being rolled up into a ball, fit it closely, the inner cotyledon being often somewhat shorter than the other. On the other hand, the nuts of the beech are more or less triangular: an arrangement like that of the sycamore would therefore be utterly unsuitable, as it would necessarily leave great gaps. The cotyledons, however, are folded up like a fan, but with more complication, and in such a manner that they fit beautifully into the triangular nut.

Can we, however, carry the argument one stage further? Why should the seed of the sycamore be globular, and that of the beech triangular? Is it clear that the cotyledons are constituted so as to suit the seed? May it not be that it is the seed which is adapted to the cotyledons? In answer to this we must examine the fruit, and we shall find that in both cases the cavity of the fruit is approximately spherical. That of the sycamore, however, is comparatively small, say

1 inch in diameter, and contains one seed, which exactly conforms to the cavity in which it lies. In the beech, on the contrary, the fruit is at least twice the size, and contains from two to four fruits, which consequently, in order to occupy the space, are compelled (to give a familiar illustration, like the segments of an orange) to take a more or less triangular form.

Thus, then, in these cases, starting with the form of the fruit, we see that it governs that of the seed, and that of the seed, again, determines that of the cotyledons. But though the cotyledons often follow the form of the seed, this is not invariably the case: other factors must also be taken into consideration; but when this is done, we can, I venture to think, throw much light on the varied forms which seedlings assume.

I have thus attempted to indicate some of the principles on which, as it seems to me, the shapes of leaves and seedlings depend, and to apply them in certain cases, but the study is only in its infancy: the number and variety of leaves is almost infinite, and the whole question offers, I venture to think, a very interesting field for observation and research—one, indeed, of the most fascinating in the whole of natural history.

HONEYSUCKLES.

THE common honeysuckle of the hedgerow and wood creates many pretty pictures in English gardens. It covers the tree stump, arch, and pillar with its twining growth, smothering the humble doorway of the cottage, or scrambles in at the latticed window, filling the air with the sweetest of scents. There are other honeysuckles than the common one, and other ways of growing them than nailed to walls, or stiffly trained with shreds and ties. Few more beautiful pictures could be made than by planting one or other of the honeysuckles at the foot of an arch, and permitting the plant to grow unmolested over the wood or wire-work, which it quickly hides. Just train out the growth to prevent it becoming entangled, but allow the shoots to spread about in their own charming and graceful way. A pillar of honeysuckles is of rich beauty and may be made by putting in strong stakes, each from eight feet to twelve feet high, but they must be strong to support the dense growth. Honeysuckles might also be planted on dead tree stems, as we frequently see roses, which clamber over them, making a cloud of color in the garden in the summer. It is in such happy ways that we obtain the beauty of the Loniceras, and not when simply trained to walls. The illustration that accompanies this note shows the delightful picture that may be made by planting honeysuckles over an arch; the luxuriant growth, dangling shoots, and profuse display of the small yellowish flowers are brought out in their fullness. There is no stiffness in growing the honeysuckle, as portrayed in the engraving. We have, besides the wild kind, the pretty Dutch and late Dutch varieties, flexuosa, characterized by purplish stems and hairy leaves, and L. japonica, also known as halleana, which is of elegant growth and very free blooming, the white flowers appearing in July and August. Then we have L. flava and the vigorous growing trumpet honeysuckles, L. sempervirens and the variety minor. These are two beautiful kinds for a cold house, and the freest to bloom is minor, which with the type will succeed well out of doors in a light soil and warm situation. They are not so hardy as caprifolium and the other forms.

A class of honeysuckles is that known as the bush, of which standishi and fragrantissima are well known varieties. They are not climbers strictly, but we frequently see them planted against walls, as in the royal gardens, Kew, where they flower in midwinter, scenting the air around with a sweet fragrance. L. flexuosa aureo reticulata is conspicuous for its richly colored foliage, netted with gold, but we do not care for such plants in the garden while there are so many finer types. A rare kind, but very elegant in growth, is L. acuminata, which comes from the Himalayas, and bears purple flowers in July.—*The Garden.*

[NATURE.]

ASTRONOMY.

OBJECTS FOR THE SPECTROSCOPE.

SIDEREAL time at Greenwich at 10 P. M. on May 22 = 14 h. 1 m. 54 s.

Name.	Mag.	Color.	R. A. 1890.	Decl. 1890.
(1) G. C. 3770....		White.	h. m. s.	° ' "
(2) 69 Virginis..	5.5	Yellowish-white.	13 21 35	+52 54
(3) B. A. C. 4699..	5	Yellowish-red.	14 3 32	+44 23
(4) 20 Bootis....	5	Yellow.	14 14 36	+16 49
(5) 7 Bootis....	3	Yellowish-white.	13 49 30	+18 57
(6) U Cygni....	var.	Very red.	20 16 11	+47 33

REMARKS.

(1) This very large nebula (101 M Bootis) has not yet been spectroscopically examined. According to the Parsonstown observations, it is at least 14' across, and exhibits a spiral structure with arms and knots. It is everywhere faint except in the middle. In the "General Catalogue" it is described as "Pretty bright, irregularly round, at first gradually, then very suddenly much brighter in the middle to a small bright nucleus." The spectrum of such a diffused mass is likely to possess great interest, and the nebula is so large that it will probably not be difficult to differentiate the spectra of different regions.

(2) In his catalogue of stellar spectra, published in 1887, Konkoly records an observation of this star, in which bright lines were strongly suspected. Notwithstanding the recent additions to this group by Prof. Pickering and Mr. Espin, the number is still very small, and it is important that suspected cases should be fully investigated. The lines suspected by Konkoly in 69 Virginis were C, D₃, and F—the three commonly observed in δ Lyræ and γ Cassiopeiæ. It is quite possible that the appearance of the lines is periodic, and observations should, therefore, be continued for some time. If the lines are of any considerable brightness,

the observations ought not to be difficult, as the bright lines in the 8th magnitude stars in Cygnus are easily seen and measured with 10 in. aperture. Any irregularities in the continuous spectrum, especially in the green and blue, should be noted; and, if possible, comparisons should be made with the carbon flutings. Prof. Lockyer has pointed out that a line near λ 447 is associated with D₃ in the Orion nebula, and also in the solar chromosphere, and it is important to observe whether this also applies to the bright-line stars. He has demonstrated by photographs that the line in the nebula (447) is coincident with one of the bright lines photographed by Prof. Pickering in P Cygni.

(3) Duner describes the spectrum of this star as a magnificent one of group II., particularly in the red end. The bands 1-9 are all strongly marked. The star is thus probably a little more advanced in condensation than the mean species of the group, and it will be interesting to know what line absorptions appear at this stage, and also what is the extent of carbon radiation.

(4 and 5) These are given in Vogel's catalogue as stars of the solar type and of group IV. respectively. The usual observations are required in each case.

(6) This is one of the very few variables with spectra of group VI. So far we have no records of any changes in spectra which may accompany the variations in magnitude, and the cause of the variability is, consequently, very imperfectly understood. Duner says that the spectrum consists of three zones rather feebly developed, band 6 (near λ 564) being weak, but he does not state the magnitude of the star at the time of his observation. The next maximum will occur about May 28. The star ranges from about magnitude 7.5 to < 11 in a period of 461 days. Changes of color should also be noted.

A. FOWLER.

Spica.—At the Berlin Academy of Sciences on April 24, Prof. Vogel announced that Spica consists of two close stars revolving round their common center of gravity. The star's spectrum is that of class IV., and twice in April, 1889, the F line appeared to be shifted toward the violet end of the spectrum as compared with the H δ line given by a vacuum tube, while once

AN ARCH COVERED WITH HONEYSUCKLE.

in the following month the shift appeared to be toward the red end. These observations and others made this year of the star's motion in line of sight are given in the following table, approach to the sun being indicated by (—) and recession from the sun by (+), both being expressed in German miles per second:

Potsdam Mean Time.	Observed Motion.	Relative to the Sun.	*—
1889, April 21, 9 15	— 11.6	— 0.7	— 12.3
" 29, 11 10	— 12.0	— 1.2	— 13.2
May 1, 10 58	+ 7.5	— 1.3	+ 6.2
1890, April 4, 11 30	— 3.4	+ 0.5	— 2.9
" 9, 10 30	— 14.2	+ 0.2	— 14.0
" 10, 11 30	— 0.3	+ 0.1	— 0.2
" 11, 10 50	+ 7.6	0.0	+ 7.6
" 13, 10 50	— 14.7	— 0.1	— 14.8
" 15, 10 00	+ 11.3	— 0.3	+ 11.0

The observations have been reduced to the epoch 1890, April 2, 10 h., Potsdam mean time, and the period of revolution of the system determined as 4 days 0.3 hour. The greatest motion in line of sight due to the orbital velocity is about 12 miles a second, and the system as a whole is moving toward the earth with a velocity of about 3 miles a second.

From this it is found that the distance between the components of the system is 660,000 miles, and their total mass = 1.2 that of the sun.

It will be remembered that Algol is a spectroscopic double of the same character as the above described.

The Meteoric Theory of Comets.—In the *Sidereal Messenger* for May, Mr. W. H. S. Monck discusses the evidence that has been brought forward in support of this theory, and in connection with the meteoritic origin of the universe. Only four comets are definitely known to be connected with meteor showers; and conversely only four meteor showers have been connected with comets; these comets are all periodic, the longest periodic being 415 years. From this fact it is argued that there is not sufficient evidence to allow the assertion that all comets are reconnected with meteor swarms, and that the ejection theory advocated by the late Mr. Proctor is supported. It is asserted that, since an ejection from a rapidly cooling body may be partly solid, partly liquid, and partly gaseous, the gaseous matter might form the comet and the solid (or solidified) matter form the attendant meteors; but for this origin to be true the assumption must be made that two planets exist beyond Neptune. Mr. Monck argues that because Arcturus was seen through 90,000 miles of Donati's comet, whereas Saturn's rings (except, per-

haps, the inner crape ring) are not transparent, the rings must be more than one thousand times as dense as the comet at the point where it crossed between us and Arcturus, hence meteoritic collisions should be more frequent and the effect of the increased temperature should be made clearly manifest in the spectrum. The meteoritic hypothesis is not, however, objected to as a working hypothesis, but is said to be on an equality with the older nebular hypothesis; and the writer does not think the spectroscopic will ever afford a crucial test between the two, for the reason that it cannot distinguish between a large solid surrounded by a gaseous envelope and a number of small bodies with interspaces filled with gas.

Mass of Shooting Stars.—Mr. C. C. Huchins, in the *American Journal of Science* for May, gives the result of an investigation undertaken with the object of finding data for determining the mass of shooting stars. Having determined the radiant energy of the standard candle, it was found that on the supposition that the rays of a meteor have the same ratio of visible to total energy as those of the candle, the mass of a meteor at a distance of fifty miles, having a magnitude equal to Vega and a velocity of twenty-five miles per second, would be 0.2936 gramme if it continued two seconds. If the meteor in burning produce, for a given expenditure of energy, more light than the candle, then a less mass would serve to produce the light given by it. A lump of the Emmett Co. (Iowa) iron meteorite was placed upon the lower carbon of an arc lamp and vaporized by the passage of the current, and it was found that for a given expenditure of energy the arc of meteoritic vapor gave ten times the light of the candle, hence the mass of a meteor giving the light of a first magnitude star moving with parabolic velocity, and lasting for two seconds, is 0.029 gramme.

Photographs of the Moon.—Admiral Mouchez, at the meeting of the Paris Academy of Sciences of May 12, presented a note on some new photographs of the moon obtained by the Brothers Henry at Paris Observatory. The instrument used was the equatorial 0.32 meter aperture, destined for the map of the heavens. The photographs are said to be far superior to those obtained in England and the United States with larger apertures, the superiority of the results being ascribed not only to the perfection of MM. Henry's objectives, but also to the method of direct enlargement adopted.

VELOCITY OF THE WIND ON THE EIFFEL TOWER AND AT THE FORTH BRIDGE.

FOR some months measurements of the velocity of the wind were made at the top of the Eiffel tower last year, and of some of these we have given the results. Since then M. Angot has published the results of numerous observations. The measurements were taken on two Richard anemometers, one on the top of the tower at an elevation of about 994 ft., the other at the office of the meteorological service, at an elevation of 69 ft. above the level of the ground. The horizontal distance between the two stations is about 1,640 ft. Up to the 1st of October 101 days' observations were made; 12 in June, 28 in July, 31 in August, and 30 in September. The daily variations in the velocity of the wind follow the same laws in each month, but it is not the same for the higher station and for the lower one. While at the latter the daily increase and diminution in the velocity follows the increase and diminution of the temperature, the opposite of this holds true upon the top of the tower.

The average of all the observations is 23.12 ft. a second at the top of the tower and 7.35 ft. at the station of the meteorological service, which shows that the velocity at the higher point is about 3.1 times as great as the other. The velocity at the 994 ft. station is much greater than usually believed. During 101 days it exceeded 23 ft. a second. During 2,516 hours of observation the velocity was more than 26.2 ft. for 39 per cent. of the time, over 32.8 ft. for 21 per cent. of the time.

In designing the Eiffel tower, such an increase in the velocity of the wind with increase in elevation was not assumed. The calculations were made upon two assumptions; the first that the pressure of the wind was 61.444 lb. per sq. ft. on all parts of the structure, the other assumption was that the pressure increased from 40.96 lb. at the base to 81.92 lb. at the top. In the second assumption the pressure is twice as great above as below, therefore the velocity above is not quite one and one-half times that below. Moreover, it is improbable that during very heavy storms the velocity above is three times that below, the pressure, therefore nine times as great. A glance at the table below shows that the difference between the velocities diminishes as

MEAN VELOCITY OF THE WIND IN FEET PER SECOND AT THE EIFFEL TOWER.

Hour.	Tower.	Office.	Ratio.
5 a. m.	24.6	4.9	5.0
4 "	25.3	5.25	4.8
3 "	26.6	5.3	5.0
2 "	26.2	5.3	4.9
1 "	23.2	5.4	4.3
0 midnight.	27.6	5.6	4.9
7 a. m.	27.7	6.0	4.6
6 a. m.	21.46.1	6.1	3.5
11 p. m.	28.7	6.3	4.5
9 "	26.6	6.5	4.1
8 "	25.3	6.6	3.8
10 "	28.2	6.8	4.2
8 a. m.	18.4	6.85	2.7
7 p. m.	22.9	6.9	3.3
9 a. m.	17.9	7.8	2.3
6 p. m.	22.0	8.0	2.7
10 a. m.	17.5	8.7	2.0
5 p. m.	21.9	9.0	2.4
3 "	20.7	9.2	2.2
4 "	21.1	9.25	2.3
11 a. m.	19.5	9.7	2.0
12 noon.	19.7	10.0	2.0
2 p. m.	21.1	10.0	2.1
1 "	20.7	10.4	2.0

they increase. For the lowest velocities below, those above are from 4.3 to 5 times as great. For the great-