comets, this band might be photographed in their spectrum.

Accordingly at the first attempt a photograph of the nucleus and part of the envelopes was obtained in seventeen minutes, on the night of June 24, through breaks in the clouds. On succeeding occasions, when an exposure of 162 minutes was given, the tail impressed itself to an extent of nearly ten degrees in length.

I next tried by interposing a direct-vision prism between the sensitive plate and the object-glass to secure a photograph which would show the continuous spectrum of the nucleus and the banded spectrum of the coma. After an exposure of eighty-three minutes a strong picture of the spectrum of the nucleus, coma, and part of the tail was obtained, but the banded spectrum was overpowered by the continuous spectrum.

I then applied the two-prism spectroscope used for stellar spectrum photography, anticipating that, although the diminution of light would be serious after passing through the slit, two prisms, and two object-glasses, yet the advantage of being able to have a juxtaposed comparison-spectrum would make the attempt desirable, and, moreover, the continuous spectrum being more weakened than the banded by the increased dispersion, the latter would become more distinct.

Three photographs of the comet's spectrum have been taken with this arrangement with exposures of 180 minutes, 196 minutes, and 228 minutes, and with a comparison spectrum on each. The continuous spectrum of the nucleus was plainly seen while the photography was in progress. It will take some time to reduce and discuss these photographs and prepare the auxiliary photographs which will be necessary for their interpretation. For the present it suffices to say that the most striking feature is a heavy band above H which is divisible into lines, and in addition two faint bands, one between G and *h*, and another between *h* and H. I was very careful to stop the exposures before dawn, fearing that the spectrum of daylight might become superposed on the cometary spectrum.

It would seem that these photographs strengthen the hypothesis of the presence of carbon in comets, but a series of comparisons will be necessary, and it is not improbable that a part of the spectrum may be due to other elements. HENRY DRAPER

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MY first view of the comet was on June 25, when it appeared through a momentary opening in the clouds, with a nucleus that, in size and brightness, seemed to equal Venus at her best. The tail, immediately at its commencement, was exceedingly bright also, but I could see no more of it then, nor at a second view, also momentary, when little more than the head was visible. Notwithstanding the immense development of tail shown by the great comet of 1861 it could not compare for an instant in brightness with the nucleus of the present one as I saw it on June 25.

On June 27 I again observed it wonderfully waned in light, with a tail plainly traceable for ten degrees, and pointing directly to the Pole. The tail was slightly curved to the right; that is, it was convex to the apparent east, or on the preceding side, and was brightest and best developed on that side. There was no time for observation with the telescope when the clouds shut up the skies for the remainder of the night.

On the next night, the 28th, I got a view with the telescope, and by an observation, which was much interfered with by clouds, I made out the position to be, in Right Ascension, 5h. 58m. 44s., and in Declination 63° 12′ 53″, at 12h. 15m. Greenwich mean time. The comet was progressively waning, but the tail seemed still about 10° long, and pointed to the Polar star. The nucleus, though growing smaller, was still exceedingly brilliant, and as large as a star of the first magnitude. The direction o the tail did not differ very much from the comet's apparent course, and seemed *concave* to it, contrary to what is usually observed with other comets. With a power of 126 on a 4½-inch achromatic I saw a curve of light extending like wings on each side of the head, and outside, with a dark space between them, appeared a large enveloping curve of inferior brightness. I fancied at times that I could discern a very faint third envelope outside all. These curves extended farther in the direction of the tail on the *following* side than on the other, though it was on the latter or preceding side that the tail showed the best definition.

On July 8 the comet seemed much diminished in light and magnitude, though the nucleus was still brightly stellar. I could now see only the inner light-curve extending on both sides of the comet's head, and through it on the following side I distinctly observed a small star shining, as it would appear, with undiminished brightness. The preceding side of the tail was still brighter and better defined than the following. I made the comet's position at 14h. G.M.T. = Right Ascension 7h. 49m. 38s, and Declination 79° 27′ 21″.

On July 11 it was still further diminished, and in the bright moonlight there was no longer any light-curve traceable in my telescope. The nucleus however continued remarkably bright and star-like, and there was an extensive nebulosity round it. The tail might be traced by the naked eye three or four degrees. I had on this night a very satisfactory micrometrical observation, but I have not as yet been able to perfectly identify the star of comparison. The calculated light of the comet was scarce more than a tenth of what it was on June 22. It is now fast receding out of naked-eye view, and of little interest except for marking its position. This on July 20, at 12h. 20m. G.M.T., I made to be 11h. 17m. 47s. in R.A., and 82° 9′ 2″ in Declination.

Schæberle's comet is now well in view, and would be visible to the naked eye only for the brightness of the sky where it is moving. The weakest binocular is sufficient to show it, and it is rapidly gaining in brightness. On the 27th inst. it appeared to me with a stellar nucleus and a tail visible for about half a degree. I made its position at 14h. 15m. G.M.T. = 6h. 14m. 41s. R. Ascension, and 43° 59′ 10″ in Declination. The observation was difficult owing to the brightness of the sky and to clouds.

Millbrook, Tuam, July 28 J. BIRMINGHAM

A POPULAR ACCOUNT OF CHAMÆLEONS[1]

THE animal to which I propose especially to direct your attention to-day is one which has been the subject of many observations, and has inspired great interest from the most ancient times.

Its name "chamæleon" is derived from two Greek words signifying "Ground-lion," a name singularly inappropriate, since it is one of those creatures which are specially fitted by their organisation to live on trees, and which are comparatively ill at ease when on the surface of the earth.

It is by no means surprising however that this creature should have attracted the attention it has attracted, such is the singularity of its appearance and the peculiarities of its habits and properties. Neither is it surprising that it should have occasioned many errors and superstitions when we consider the erroneous beliefs current amongst ourselves with respect to our own toads and slow-worms, efts, &c.

Aristotle was acquainted (as was to be expected of him) with the singular motions of its eyes, but even he fell into some curious mistakes respecting it, and he tells us that

[1] Lecture delivered at the Zoological Gardens on July 28, 1881, by St. George Mivart, F.R.S.

it has no spleen and no blood except in the vicinity of its head and eyes.[1]

Pliny is careful to restate these errors, and further tells us that it lives without eating or drinking, and though generally an inoffensive animal, becomes terrible in the dog-days. He also adds,[2] on the authority of Democritus,[3] that it has the power of attracting to the earth birds of prey, so that they become in turn the prey of other animals, and that its head and neck, when burnt on oak charcoal, will cause thunder and rain to occur simultaneously. On the other hand, he rejects as fabulous the Grecian belief that its right leg cooked with a certain herb has the power of making a person invisible; that the thigh of its left leg mixed with sow's milk will induce gout if the foot be rubbed with the compound, and that a man may be made to incur the hatred of all his fellow-citizens by having his gate-posts anointed with a mixture of chamæleon's intestine and the renal secretion of an ape.

Aldrovandus informs us[4] (on the authority of older writers) that if a viper passes beneath a tree in the branches of which a chamæleon is perched, the latter will let fall some of its saliva upon the viper, which is thereby killed; and he further tells that elephants sometimes unwittingly eat chamæleons amongst the leaves of the trees on which they feed, and that the meal is a fatal one unless the elephants have recourse to the wild olive as an antidote. Gesner in his History of Animals[5] has carefully collected all these fables.

But though more accurate knowledge has dissipated many errors and destroyed many superstitions with respect to the chamæleon, yet such knowledge, far from detracting from the interest of our subject, has made it more than ever an object of scientific wonder and intelligent admiration.

My duty to-day, as I understand it, is to enable you to give a rational answer to the question, "What is a chamæleon?" and therefore to give you an accurate general notion of what the creature is in itself, and in what relations it stands to the world about it. Let us first look at the animal itself. It has a wonderfully lean and hungry look, and is in fact a hungry animal, and keen in pursuit of its insect prey at the present warm season. Its trunk is often greatly flattened from side to side, though sometimes swollen and inflated. It is never flattened from above downwards (as in so many lizards), but deep and raised up from the ground by the animal's long legs. Its head is large, and, in shape, somewhat triangular when seen in profile, and its upper surface is bounded on each side by a prominent ridge extending from the muzzle to the hinder part of the head or occiput. There is hardly any neck externally distinguishable. The limbs (of which there are two pairs) are long, uniformly slender members, each terminated by a paw in the form of a pair of pincers. There is a very long tail, also slender and curled towards its extremity, so as to be able to grasp firmly any object about which it may be rolled. The skin is rather soft and distensible. It is similar all over the body—not scaly (as in most lizards), but beset with small horny tubercles which become more close-set and flattened along the mid-line of the back and of the belly (where the tubercles project in a serrated manner), and also on the head. The mouth of the animal is very wide, but its lips meet so exactly that when closed the situation of the mouth is not readily distinguishable. The nostrils are small and open, one on each side of the muzzle, a little behind its apex. The eyes are very large, but the prominent eyeballs are covered by skin like that of the body, except at a minute central point where there is a small opening like an external pupil. Thus, instead of two eyelids, as in ourselves, there is one, formed as it were by the almost complete junction of two such as ours.

[1] See his "History of Animals," book ii. chapter vii.
[2] See his book viii. Panckoncke's edition, Paris, 1830, vol. v. p. 318.
[3] See his book xxviii. chapter xxix.
[4] See his "De Quadrupedibus Digitatis viviparis," 1645, book ii. p. 668.
[5] See his "Historiæ Animalium," book ii. p. 2. The work was published in 1554.

What is however much more remarkable than the form of the eyes is the manner in which they can be used. When we look at any object our eyes always move simultaneously, and are directed as much as possible towards the same object. We can thus make them converge, and we can restore the axes of our eyes to a parallel position, but we cannot make them diverge or direct one eye upwards and the other downwards at the same time. This limited power of motion in our eyes is with us innate and natural. Indeed such is the tendency to simultaneous action in our own eyes, that the very eyelids of our two eyes naturally move together, and it is only by repeated efforts that we obtain the power of moving them separately. The art of winking, then, is not an original gift but an acquired accomplishment, and this is especially the case with that refined winking which consists of a scarcely perceptible motion of the upper eyelid only.

In the chamæleon the motion of the eyes is not thus limited. It can move them with complete independence, and can simultaneously direct one eye upwards and forwards while the other gazes downwards and backwards. As far as I am aware, the chamæleon is the only animal which possesses this power.

But the chamæleon's eye has a very noteworthy internal structure. In ourselves the special organ of sight is an exceedingly delicate membrane called the "*retina*," which is spread out over the back of the inside of the eyeball. This membrane is composed for a part of its thickness of certain most minute structures termed "*rods* and *cones*," which are placed side by side, one end of each being directed outwards, and its other end towards the interior of the eyeball. At that part of the human retina which is directly opposite the pupil of the eye, is what is called "the yellow spot," which is the seat of our most acute sense of vision. In this yellow spot of ours there are many cones but few rods,[1] and the centre of it is formed of cones only. The cones of the yellow spot, moreover, are longer than those found in any other part of the retina.

According to Heinrich Müller, who has most carefully investigated the structure of this animal's eye,[2] the retina of the chamæleon has cones only, but no rods (like the centre of our yellow spot), while its cones are longer even absolutely (and therefore greatly longer relatively) than are our own. Finally the yellow spot itself is larger in the chamæleon than it is in us. Thus in all these respects the perfection of the human eye is exceeded by that of this very singular reptile.

That the chamæleon is able to gaze simultaneously at two distinct objects placed wide apart is not wonderful, because there are so many animals with eyes placed so completely on opposite sides of the head that many objects within the range of one of their eyes cannot possibly be seen simultaneously by the other. But even we are able to direct our attention simultaneously to two objects which lie towards opposite margins of our field of vision, while we neglect the sense impressions produced by all the various intermediate objects.

There is no external sign whatever of an ear in the chamæleon. Not only is there no projection, but there is no external aperture on the surface of the head, or any indication of the drum of the ear—an indication very commonly found in animals nearly allied to it. Nevertheless the chamæleon has a pair of ears substantially like those within our own skull, and these ears each communicate with the exterior by an aperture at the back of the mouth, as do ours also. It is this communication between the internal ear and the mouth which causes a man to open his mouth when he is intently listening.

[1] In the rest of the human retina the rods are much more numerous than are the cones.
[2] See *Würzburg naturwiss. Zeitschr.*, iii. 1861, pp. 10-42.

The chamæleon's internal ear however is not an exceptionally perfect organ like its eye. On the contrary, an important part, resembling a snail's shell in form, called the cochlea, which is largely developed in us, and which exists in a rudimentary manner in lizards generally, is absolutely and entirely wanting in the chamæleon.[1]

The tongue of this animal is the most wonderful of all its organs, and the chamæleon's entire organisation may be said to have been formed with reference to this most remarkable tongue.

If the animal's mouth be opened, its tongue will be seen as a thick fleshy mass lying between the two sides of the lower jaw. At the front end of this tongue is a cup-like depression with a prominence specially developed above and below it like an upper and lower lip. But this thick portion of the tongue thus at first visible is but a part of the entire structure. At its hinder end it suddenly narrows into another very long and cylindrical part, which is arranged and bent in transverse folds behind and beneath the thick part first described. This narrow part or, as it is called, "worm," finally bends to the front end of the lower jaw, where it becomes continuous with a third firmer part, which is rigid, because it contains a solid body within. This third part reaches from the front of the lower jaw to the back of the floor of the mouth, where it enters a sort of funnel-like depression, to the bottom of which it is firmly attached by flesh and membrane. The cavity of the mouth is very deep, as is necessary for the reception within it of this very voluminous tongue. When the tongue is elongated it may be extended six or seven inches. The action of the tongue will be spoken of in connection with what I have to say as to the other actions of the chamæleon.

The structure of the chamæleon's feet is very noteworthy. Each foot is (as has been said) practically a pair of pincers, but each branch of each pincer is made up either of two or of three toes bound together by the skin down to the very roots of the claws.

There are five toes or (as they are technically termed in anatomy) "digits" to each foot, and these five digits correspond with our own thumb and four fingers and our own five toes respectively.

In the fore-paw or hand of the chamæleon the digits which answer to our thumb, index, and middle digits are bound together in one bundle, while the digits answering to our ring and little fingers form the other bundle.

In the hind-paw or foot of the chamæleon the arrangement is different. There the digits which answer to our great and second toes are bound together in one bundle, and are opposed to another bundle formed of the third, fourth, and fifth toes.

Moreover while the three united digits of the fore-limb are directed inwards, the three united digits of the hind-limb are directed outwards.

There is yet another noteworthy point as to the structure of the paws. In ourselves the small bones which form our "wrist" and our "ankle" respectively are (as they are in almost all beasts) distinct and separate from those long, more or less slender bones which are in the palm of the hand and the sole of the foot, and which are called "metacarpal bones" in the hand and "metatarsal bones" in the foot. In the chamæleon however each metacarpal and each metatarsal absolutely unites with the wrist or ankle bone which is adjacent to it, so that they together form but one bone.

As to the internal organs of the chamæleon, I will only speak of the lungs. These organs are practically a pair of bags—air-bags—but each bag is furnished with seven or eight tubular prolongations, which seem each to end in a point. These ends however really open into certain sacs within the cavity of the body, which sacs can thus be inflated and the whole body much blown out.

[1] See Prof. Parker's paper in the *Transactions* of the Zool. Soc., vol. xi. p. 102.

The last structure I shall notice is the skin, so remarkable for the very conspicuous changes of colour it undergoes. The chamæleon's skin, like the skin of other animals, is furnished with very minute bags containing pigment. It is the presence of very many such bags containing a dark pigment which makes the negro's skin black. These pigment-bags are called "chromatophores," and the chromatophores of the chamæleon, unlike those of the negro, are contractile, and it is by the alternate contraction and expansion of chromatophores containing different coloured pigments that the changes of colour which take place in the chamæleon's skin appear to be effected.

The chamæleon does not make at all a bad pet. It is not only perfectly inoffensive, but most gentle and not at all wild, while it forms an object very interesting to contemplate. It needs to be kept warm and supplied with flies, mealworms, or other insects, and also with water, and with some branching shrub on which it may perch and climb. It is better to inclose the shrub in a glass case or cage, to prevent such accidents as happened to one of mine, which, being left alone and free, wandered to the fire-place, where it got beneath the grate, and so scorched its paws that it could no longer climb, and soon died.

Wonderful is the slowness with which the chamæleon ordinarily moves. When at rest it clings to the branches by its four paws and prehensile tail. When it wishes to advance it only moves one limb at a time. Let us say it begins by moving the right fore-limb. It first, of course, unhooks that paw, and then, bending the elbow, slowly raises it and holds it suspended a certain time, moving it right and left, forwards and backwards, till it finds a suitable foothold. Then its pincer-like fingers slowly and firmly grasp the new point of support, after which the left hind-limb performs a similar series of movements; then follows the left fore-limb, afterwards the right hind-limb, and finally the tail is unrolled, and then readjusted round some new sustaining object.

This is its ordinary mode of progress, but it can sustain itself by its tail only, and when thus hanging may seek for fresh foothold by stretching in various directions all its four limbs.

The chamæleon is probably the most thoroughly arboreal animal which exists. Many creatures of different kinds which live in trees are furnished with a prehensile tail. This is the case, for example, with the most arboreal monkeys, such as the spider- and howling-monkeys. It is also the case with that most arboreal member of the raccoon family, the kinkajou, and with the most arboreal members of the porcupine family and of the opossum order.

Arboreal animals may have their feet especially organised for climbing, as is the case with monkeys and opossums, but they are not such perfectly and exclusively climbing organs as are the chamæleon's feet. The sloths are animals the whole organisation of which is planned for tree-life, and their paws are modified to serve almost exclusively for climbing, and their digits are also bound together by skin to the roots of the claws. Moreover, in the sloths the wrist and ankle bones may more or less coalesce with the metacarpals and metatarsals, as in the chamæleon; nevertheless the sloth's digits are not pincers, but hooks only, all the digits of each foot being bound together in a single bundle. Moreover, admirable as is generally the arboreal organisation of the sloth, that animal is nevertheless devoid of a prehensile tail.

In birds the ankle-bones coalesce with the metatarsals, and there is a certain resemblance between the feet of the climbing arboreal parrots and those of the chamæleon, for though the parrot's toes are not bound together to the claws, they yet form a pair of pincers, two of them being turned in one direction and opposed to the other two Yet the mode in which they are grouped is different. for

in the parrot it is the first and fourth toes which are opposed to the second and third, instead of the first and second to the others.

In remarkable contrast with the slowness of its limb-movements is the quickness with which it can move its eyes, and above all its tongue. The chamæleon lives largely upon flies, and at first sight it would seem impossible that so apparently torpid and sluggish an animal should be able to reach and seize creatures not only active in their movements, but possessing the power of flight. At this season, when the chamæleon's appetite is keen, it may often be observed when a fly has been introduced into its cage to move about with comparative celerity, attentively watching the fly's movements, now with one and now with the other eye. It sooner or later happens that the fly settles for a few seconds somewhere within half a foot's distance of the chamæleon's head. Then the chamæleon's mouth may be observed to open and the apex of the tongue to protrude. In an instant it has shut again and the fly has disappeared. In fact the chamæleon has spit out, as it were, its enormously extensible tongue upon the insect, secured it by the viscid secretion with which the tongue is coated, and again withdrawn that organ together with the prey, but the whole has been effected with such amazing rapidity that the observer's eye cannot follow the movements of the reptile's tongue. It is projected and withdrawn without the slightest noise, but in the twinkling of an eye.

As I have said, it is this tongue which is as it were the centre of the chamæleon's organisation, and this tongue-movement is the very essence of its existence, and is its whole *raison d'être*. Without it the animal's life would be impossible, while the very slowness and deliberation of its other movements are a gain, since they enable the chamæleon to advance upon its prey within shooting distance without alarming it.

(*To be continued.*)

THE UNEXPLORED PARTS OF EUROPE AND ASIA

UNDER this title M. Venoukoff has just published an interesting paper on those parts of Europe and Asia which remain yet unexplored. It is not to be wondered at that the name of Europe should be among incompletely explored parts of the world, as there are even in Europe considerable spaces, especially in the Balkan peninsula and in North-Eastern Russia, which await scientific exploration. The war of 1877-78 certainly afforded occasion for surveying and mapping wide spaces in Bulgaria and Eastern Roumelia, but the geography of Macedonia, Epirus, and even of Thessaly is far from being exact. In Russia all the northern provinces, from the Norwegian frontier to the Ural Mountains are only known superficially; we know here only the coast and the three principal rivers—the Onega, the Dwina, and the Petchora. The great Samoyede *tundra* remains quite unexplored. Notwithstanding several journeys in the Northern Ural, this country is little known, and the interior of the great double island of Novaya Zemlya remains quite unknown, both affording, however, a very great interest, especially for geologists. As to the hydrographical exploration of the Kara Sea and of the Arctic Ocean north of Siberia, M. Venoukoff does not give them much of importance, notwithstanding what he terms the pompous newspaper writing about the trade with Northern Siberia, and he thinks that there are on the Asiatic continent several places far more interesting for explorers. For instance, Chekanovsky's and Nordenskjöld's explorations have quite changed our ideas on the geography of that land, twice as wide as France, which belongs to the basins of the Khatanga and of the Anabara. It would be a rich field of exploration for a bold traveller. The lands east from the Lena remain quite unknown, and the northern slopes of the Stanovoï Mountains are still a *tabula rasa;* the sources of the Indighirka, Kolyma, Omolon, Aniouy, and Ghijiga rivers were never visited by Europeans, and Wrangel mapped them only from hearsay. The land of the Chukchis is better known, thanks to the work of the explorers of the last century, to the recent Russian expeditions, and to Nordenskjöld's information; but all our knowledge of this country is far from being exact, and Europeans have never penetrated to the interior of the peninsula which separates the Arctic Ocean from the Pacific, and which promises to have a future as a meeting-point for the whalers, as well as for the trade in mammoth bones. The land of the Koriaks is less attractive, except for a naturalist. As to Kamchatka, certainly it is passably well known, but what a mass of work remains to be done in mapping the west coast, preparing a map of the interior, studying the most interesting geology, botany, and ethnography of the peninsula! Further south we see that the northern part of Sakhalin remains quite unexplored; the Sikhota-alin Mountains are all but unknown; and the regions between the Ussuri and Sungari Rivers, the sources of the Nonni and Argoun Rivers promise very much to the naturalist and to the geographer who would study them. The interesting peninsula of Corea will certainly be explored as soon as access to it is not forbidden to Europeans. In the Chinese Empire there are spaces as wide as England which remain unexplored. As to Eastern and Northern Thibet we are not yet sure as to what is the true source of the Brahmaputra and of the Irawaddi, and what is the importance in the orography of this land of the Kuen-Lun range. The inaccessible deserts of Eastern Turkestan are as deserving of exploration as Thibet, and the reaching of the sources of the Hoang-ho is one of the *desiderata* of geographical science. The great desert of Gobi is passably well explored, but still there remains an important problem: Does there exist, under the 42° and 43° N. lat., a chain of mountains which crosses the desert and unites the eastern Thian-Shan with the In-Shan Mountains? In northern Mongolia there still remain unknown the highlands at the upper parts of the Selenga River. In China proper there is certainly no room for geographical discoveries, but there remains very much to do as to astronomical determinations, and the substitution of a true picture of nature for the hypothetical chains of mountains which cover our maps. Useless to speak of what might be done with regard to the ethnography of Western and South-Western China. A most attractive exploration would be certainly that of Indo-China in all directions, but it is to be feared that such an exploration will remain for a long time a simple dream, because of the political institutions of this terrestrial paradise. But the exploration of Siam and Annam is one of the most necessary geographical *desiderata*. Without speaking of the Asiatic islands, where so much remains to do, M. Venoukoff points out that British India is certainly one of the best explored countries in the world, and that several parts of Europe are far behind India as to our geographical knowledge of them; but it is not the case as to those countries which are situated to the north-west of India. Afghanistan and Beluchistan await explorers, especially for certain, perhaps the most important, parts of them, as well as Southern Turkestan and the land of the Turkomans, where so much remains to do. Khorassan and Western Persia are quite well known, but Iran remains unknown; of course the exploration of these deserts, as well as of those of the interior of Arabia, would afford very great difficulties and give comparatively few scientific results. But a thorough geographical exploration of Armenia and of Asia Minor is most desirable; and, to finish with Turkey, M. Venoukoff asks if the Straits of the Hellespont and Bosphorus will