of sodium, referred to in the above table, can be made to yield acids which differ in some points from ordinary tribasic phosphoric acid. Thus, the second member of the series yields pyrophosphoric acid, $H_4P_2O_7$, and the third yields metaphosphoric acid HPO_3 .

There is another oxygen acid of phosphorus, called hypophosphorus acid, which also forms a series of salts called hypophosphites; but their study does not come within the scope of these papers. Phosphorus also combines with other elements, in this respect somewhat resembling nitrogen, but none of these compounds have any practical importance.—*Brewers' Guardian*.

A DELICATE TEST FOR MERCURY.

A VERY delicate reaction for mercury is thus given by Biewend. The substance to be examined for mercury is intimately mixed with twice its bulk of finely divided metallic copper (obtained by precipitating a solution of sulphate of copper with metallic iron), the mixture introduced into a small test-tube, of about 15 mm. diameter, and a brightly polished disk of gold, *a*, fastened (see *b*) to a spirally bent watch-spring, introduced so that the disk is immediately over the mixture. The spiral twist of the spring causes the disk to be retained in its place. The test-tube is then heated cautiously in a slanting position, by applying the flame below until the bottom of the test-tube begins to

be red-hot, at the same time taking care that the gold disk does not become too hot. The amalgamated disk, after removal, is to be washed with alcohol, if the substance in which mercury was looked for was of a bituminous character. The mercurial mirror may be removed by heating the disk red-hot; but the latter will have a dull appearance on cooling, wherever it had been amalgamated. To restore the former brightness, the disk is laid on a flat surface, moistened with a few drops of water, and then rubbed over a few times with a thick steel knitting-needle held horizontally. This smoothes down and depresses the irregularities of the surface, and the disk becomes perfectly bright.

The above test will reveal the presence of as small a quantity as 0.08 milligramme.—*Dingler's Pol. Journ.*

ON A CURIOUS ACTINIC PHENOMENON.

By DR. T. L. PHIPSON, F.C.S., etc.

HAVING seen a paragraph in several English and foreign periodicals relating to a novel actinic phenomenon discovered by me some time ago, it will be, perhaps, expedient to publish all I know at present upon this singular occurrence. In the first place, it is necessary to state that the phenomenon in question was first noticed by my friend, Mr. Thos. Griffiths, F.C.S., who called my attention to it more than a year ago, and requested me to investigate the cause of it.

The first observation was that a gate post painted white by means of a new white pigment having a zinc basis appeared black all day and white all night, turning black again soon after sunrise, *et ainsi de suite*, for any number of days.

The white pigment was prepared by precipitating a solution of sulphate of zinc by another of sulphide of barium, and its analysis gave me the following results:

Loss by calcination.....	1.62
Sulphate of baryta.....	41.50
Sulphide of barium.....	1.02
Protoxide of iron.....	2.12
Oxide of zinc.....	16.30
Sulphide of zinc.....	37.44
Lead, arsenic, manganese, etc.....	traces

100.00

I found that when this white powder was spread upon a piece of paper and exposed to the direct rays of the sun, it became fawn colored, brown, and finally a dark slate color in the course of about twenty minutes. When in this state it was placed in darkness it became white again in $2\frac{1}{2}$ to 3 hours time.

The phenomenon was doubtless due to the use of sulphide of barium in the preparation of the pigment; for specimens made by another process in which no sulphide of barium is used did not show it at all.

The property possessed by sulphide of barium of becoming phosphorescent after insolation has been long known, but the explanation of this curious phenomenon is no further advanced now than when my little volume "Phosphorescence, etc.," appeared in 1862, unless the recent interesting electric experiments by Mr. Crookes, F.R.S., supply the key to the enigma.

In the present case, however, no phosphorescence is observed when the insolated pigment is carried into a dark place during the time it is undergoing coloration by the direct influence of the solar rays.

Another curious fact soon struck me, namely, that if a piece of glass were laid over the white pigment when exposed to the sun, it did not darken, however thin the glass might be; while the half of the specimen which remained uncovered took a very dark slate-color in about half an hour; that which was protected by the glass was nearly as white as at first, and it took from 4 to 8 hours' exposure to direct sunlight to give to this portion under the glass a very slight fawn-color.

Of course these phenomena could not be due to any compound of silver; nevertheless, the specimens were tested for silver, and with great care, but without the slightest result. In fact, no actinic substance has been met with that will darken in the sunshine, become white again in the dark, and will not darken under a sheet of ordinary window glass. It was hinted that I was dealing with a new element (to be called "actinium"); but the continuation of my experiments lead me to believe that the phenomena described above may probably be due to the presence of sulphide of barium and

protoxide of iron in the specimens, rather than to some unknown metal.

I observed that the dark slate colored product was immediately soluble in cold acetic acid (as sulphide of iron is); and if the dark color be due to the production of sulphide of iron, the return of the pigment to its original white tint when placed in darkness for some hours, may be owing to the gradual oxidation of this sulphide of iron and consequent disappearance of the dark color.

The baryta soluble in acid found in the analysis is calculated as sulphide, and the iron as protoxide (as it exists in the *proto* state), but the pigment may really contain some compound oxysulphide of zinc, iron, and barium, which has the property of turning black in the sunshine by the carrying of sulphur on to the iron during insolation; and the black sulphide disappearing by gradual oxidation when the stuff is placed in the dark would account for its reassuming its white tint.

I find also that a strong calcination, with free access of air, destroys, or considerably hinders, the production of the actinic phenomenon. I have also observed that although the pigment will retain this property of darkening in the sunlight for more than a year, some specimens have lost this property in a few months; and a gate post painted white, after darkening, in the manner above mentioned, for the space of several days, will at last remain white.

All this points to the probability of the above explanation, but the matter is still under investigation.—*Chemical News*.

THE CAT AND ITS RELATIONS.*

By FREDERIC A. LUCAS.

IN taking for our subject the cat and its relations, we will consider it as an animal entirely new to us, and that we wish to ascertain as near as may be the position it holds in regard to other animals, and set it in that place as we would a book in a library. In other words, we wish to classify it. Now this very interesting and very difficult problem of classification is one that has long occupied the attention of scientists, and is still far from being satisfactorily settled. System after system has been proposed, only to be overthrown or modified by subsequent investigation, and although the methods of research now at our disposal are far beyond those of any previous age, the chain connecting the highest and lowest members of any great division is far from complete. One important reason for this lies in the fact that many of the links have been lost by the extinction of entire races of animals, which are only imperfectly known to us by their fossil remains. At best but a small portion of the globe is available for paleontological research, and when we reflect upon the large number of new forms already discovered in that limited area, we gain an idea of the number that are still totally unknown.

METHODS OF CLASSIFICATION.

As it is, we have among extinct animals five orders of reptiles, one of birds, and two of mammals, that are without living representatives. I recently spoke of the chain connecting the members of a group; but this is really a bad simile, unless we consider it a very crooked chain, for no system of classification proceeds in a straight line. The highest animals in any given group are often above the lowest forms of the next, so that really it is like climbing a lofty mountain range, where, although our progress in the main is upward, yet we often find ourselves going down hill. There is one method of classifying the higher animals that would naturally suggest itself, and that is form and habits, and this was employed to some extent by the ancients. Animals, they said, walk, fly, creep, or swim, and we will divide them accordingly. This, at all events, was a beginning; but it gave rise to some grouping that seems to us very strange. For example, it brought together bats and birds, although this, after all, was not so bad a mistake as it might have been, for there are plenty of people now who have an idea that a bat is a kind of bird, and our German friends call it a flying mouse. Seals, whales, and fishes were also more or less thrown together, and some lizards were placed with the snakes. Even as late as 1680, an English naturalist took pains to form a definition which should include whales and fishes. But little by little, as animals became better known, external appearance became less and less trusted, and other methods were resorted to. Now, as in arranging a library, you would not be guided by the bindings or external appearance of the books but by the contents or internal structure, so in modern systems of classification; all the large groups are based on similarity of structure, and external characters are only used in defining the smaller divisions. In the solution of knotty questions, no point, however small, is neglected. For example, in determining the position of a bird, its anatomical relations are carefully considered, and next, the manner in which it is covered with feathers—for this varies greatly. The number of the wing and tail feathers is noted, together with the general texture of the plumage. The appearance of the new-born chick is an important point, and the structure of the nest and even the number and form of the eggs all help.

THE CAT DESCRIBED.

As we would first look at the title of a book, and then at its contents, we will glance briefly at the external appearance and internal anatomy of our cat. Externally it is a small fur-clad animal with a rounded head, moderately long ears and tail, and eyes with a vertical pupil. An investigation of its anatomy shows that the skull is rounded, and articulates with the first vertebra of the neck by two projections or condyles; that the canine teeth are long and powerful, and the grinders few in number, and mostly sharp-edged. After saying that the head was round, it may have seemed superfluous to say that the skull was also; but that one does not always conform to the other is shown by examination of the head of the porpoise.

We find seven neck vertebrae, thirteen dorsals or rib-bearing vertebrae, seven lumbar, three sacral, to which the hip bone is fastened, and eighteen caudals. The clavicle or collar bone is very small, and the bones of the limbs are quite round, and so jointed as to give great freedom of movement. The fore foot has five toes, the hind foot but four, all incased in sharp claws. We notice two peculiarities about the feet: first, that the sole of the foot is not applied to the ground, but that the animal walks on tip-toe; and secondly, that there is a peculiar but simple mechanism for drawing back the claws so that they do not touch the ground in walking. In comparing our cat with other animals, we will choose the more obvious characters, and by preference those peculiar to the skeleton, as those are the most important, and

* A paper read before the Rochester Society of Natural Sciences.

last after the soft tissues have decayed. It is only by means of skeletal peculiarities that we are enabled to form any idea of extinct vertebrates, and it may not be too presumptuous to compare astronomy to osteology, since by one we grasp the distant in space, and by the other the distant in time.

TWO GREAT GROUPS.

Taking structure as our base of operations, we find that there are two great groups or sub-kingdoms into which animals can readily be divided. Examining a worm, snail, butterfly, or lobster, we find that hard parts to which the muscles attach are on the outside of the body. A fish, frog, bird, or mammal has, on the contrary, an internal framework or skeleton, consisting of a chain of vertebrae, to which are appended ribs and limbs. The first is termed *Invertebrata*, and the second *Vertebrata*, and to this latter the cat evidently belongs, as it has a very complete skeleton. Hence our first step has been to decide that the cat is a vertebrate. There are five great modifications of the vertebrate plan, forming as many classes.

FISHES.

The lowest of these, *Pisces*, comprises all fishes, and is distinguished by the possession of median fins, supported by bony rays, and by limbs which cannot be divided into upper arm, forearm, and hand. Moreover, a breast-bone or sternum is almost invariably absent. Fishes, too, are never clothed with hair.

Referring to the cat, we recognize that it cannot be a fish, since it has no fine rays, and has limbs whose divisions are well marked.

AMPHIBIANS.

The second class, *Amphibia*, contains all frogs, toads, and salamanders, besides a few small snake-like animals termed *Cæcilians*. These *cæcilians*, by the way, are interesting from certain characters they have in common with the extinct labyrinthodonts. The *amphibia* have affinities both with reptiles and fishes, but are distinguished from the former by having a skull with two condyles, and no cartilages running from the ribs to the sternum, and from the latter by the absence of fin rays, and by having the limbs, when present, divisible into three parts. The *amphibia* are nearly all small animals, breathing by gills when young, and both by gills and lungs, or lungs alone, when adult. Each half of the lower jaw is composed of several pieces, and does not join the cranium directly, but by the interposition of another bone. Usually *amphibia* are covered with a smooth, moist skin. Although the cat has two occipital condyles, yet the lower jaw is formed of but two pieces, and joins the skull directly. Moreover, the ribs are joined to the sternum by cartilages, and evidently the cat is not an *amphibian*.

THEIR TRANSFORMATIONS.

Many of the *amphibia* undergo some wonderful transformations, which it may be worth while to notice. If Stanley had told us that he had discovered in Lake Tanganyika a fish which, after living for some time in the water, shed its gills and tail, and afterward passed the greater part of its life on land, we should be much inclined to disbelieve Mr. Stanley. However, as this animal dwells in every pool, and is simply called a pollywog, we see nothing remarkable in it. Living in Mexico is a little lizard-like animal known as the axolotl. As it has both lungs and gills, it is a very typical *amphibian*, and as it reproduces its species it would seem to be a perfect animal, reproduction being usually considered a good test of maturity. But under certain conditions, one of which seems to be lack of water, the axolotl loses its gills entirely. The skin is shed several times, and the tail becomes round instead of vertically flattened. The eyes also increase in size, and the skin changes color. The result of this metamorphosis is a terrestrial salamander of the genus *Amblystoma*.

REPTILES.

The third class, *Reptilia*, is composed of such widely different forms as crocodiles, lizards, snakes, and turtles. Varied as they are in external appearance, all agree in the following structural peculiarities: The skull, which has but one condyle, is joined to a short neck, of at the most nine vertebrae. The iliac bone of the pelvis projects much farther behind the socket for the thigh-bone than in front of it, while the pubes unite with one another. Each half—or ramus—of the jaw is formed of five pieces. The reptilia are usually covered with horny scales, and, as well as *amphibians* and fishes, have cold blood.

BIRDS.

The double condyle and lower jaw of but two pieces rule out the cat from the class reptilia, and we pass to that of *Aves*, or birds. Birds are, of all animals, those most readily distinguished by their outward appearance, and can be described in four words as *animals clothed with feathers*. No other animal possesses feathers, and no bird is without them. Even where the feathers are so loosely webbed as to appear slightly like hair, as in the apteryx, emu, or cassowary, the resemblance is entirely superficial, and no one would mistake a feather of either for anything else. The skeleton of a bird bears a certain resemblance to that of a reptile; but while reptiles have short necks and long bodies, birds have long necks and short bodies. Birds have never more than three fingers, reptiles never less than four, when they have any. The sternum of birds never has ribs attached to its hinder margin, as in reptiles, and by referring to the diagram we find a different arrangement of the bones of the pelvis. Besides, birds have a peculiar curved process, termed the uncinate process, on the hinder margin of the rib, which is very rarely found in reptiles. Birds and reptiles have been united in a so-called province, and although at first sight there seems no bond of union between a bird and a snake, yet by the aid of fossils we are enabled to bridge the gap between them. Here is the skeleton of a crow, in which we notice the keeled sternum, toothless beak, and short tail, and here a rough restoration of the *Archæopteryx*, which shows a vast departure from any modern bird. There are teeth in the front of the mandible, a total absence of a sternum, no hooked projection on the ribs, and an extremely long tail. Besides all this, the *Archæopteryx* was provided with feathers only on the thighs, wings, and tail. Intermediate between the *Archæopteryx* and modern birds are the toothed birds discovered by Prof. March, and which were provided with teeth in both jaws, except at the lips, just where they are found in *Archæopteryx*. Thence it is an easy step to those extinct flying lizards, the *Rhamphorhynchus* and *Pterodactyl*, which had three and four fingers of the hand at liberty, the wing being sustained by the enormous little finger. Remove the membrane and shorten the finger, we get an ordinary lizard, and we complete the change by means of the seps, a small lizard with elongated body and very small legs, and the pseudopus, which externally has no limbs at all.