Some Wonders of the Microscope.

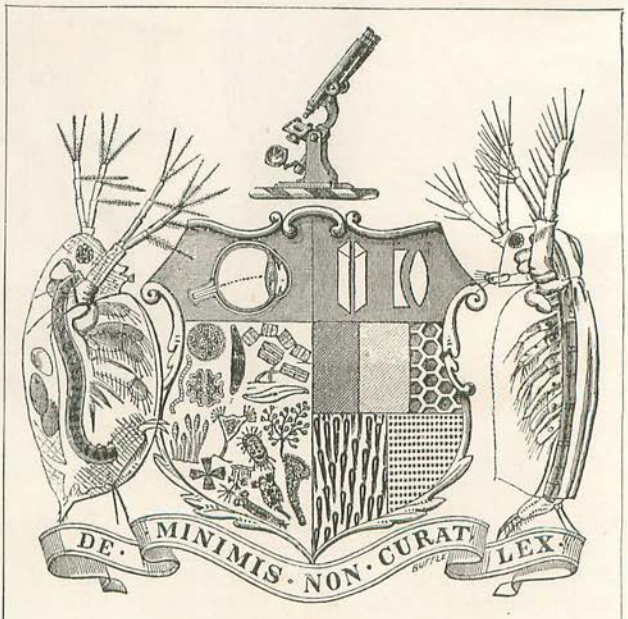
By William G. FitzGerald

A SMALL instrument and a big subject. The microscope, through which Nature has revealed some of her most stupendous secrets, is one of the necessaries of modern life. Where would the bacteriologist be without it? Or the analytical chemist? Or the Home Office expert in a criminal case? Or the young man who wears spectacles and talks of diatomaceæ? The young man who wears spectacles and talks of diatomaceæ is generally an amateur microscopist who can find Paradise in a Hampstead pond; he is also a nuisance, filling the house with nasty, horrid things, including human remains and vermin with big names. And yet it is a mistake to suppose that microscopists are devoid of humour. One glance at the crest and coat-of-arms here shown (No. 1) should dispel such an idea. Notice the "microscope rampant"; the structure of the human eye, the prisms, the Desmids, Fungi, Acineta, Stentor Rotifer, Brachionus, Lemna, and Diatoms—all in the quarterings. And the important-looking "supporters"—two common Entomostracans, with nice names; Daphnia on the left and Sida on the right. This was specially designed by a member of the Quekett Microscopical Club, for reproduction in one of the annual reports at a banquet of that interesting body.

I once attended a lecture on the microscope; everything was microscopic—even the audience. The lecturer was a temperance gentleman, and the lantern slides were a little startling—mainly enlarged photo-micrographs. Presently part of a drunkard's liver was thrown upon the screen, as an "awful example," but it was evident that little attention was being paid. One man said it was a map of South Africa; he knew South Africa well, his uncle having got five years for diamond stealing at Kimberley. Wonderful, indeed, are the lessons taught through the "golden tube!"

The accompanying microscopic photograph (No. 2) is of especial interest at this season. It depicts a section of the human skin, the various "layers" being plainly visible. But observe the seven little corkscrew spirals beneath the outer coating; these are the perspiration ducts, through whose agency we are compelled to mop our moist brows during the summer months. This particular specimen was obtained from the hand of a hospital patient.

The apparatus for taking these photographs is rather elaborate and very costly. It consists of a lamp, a microscope, and a camera, arranged horizontally. The object, usually indistinguishable to the naked eye, is first placed on the stage of the microscope, and receives the light through a condensing lens. Isochromatic plates are used, the exposure given lasting from one to two minutes. The principle seems



Ye Mikroskopiker's Arms.

Crest:—*A Microscope rampant.*

Supporters:—*Daphnia pulex and Sida crystallina.*

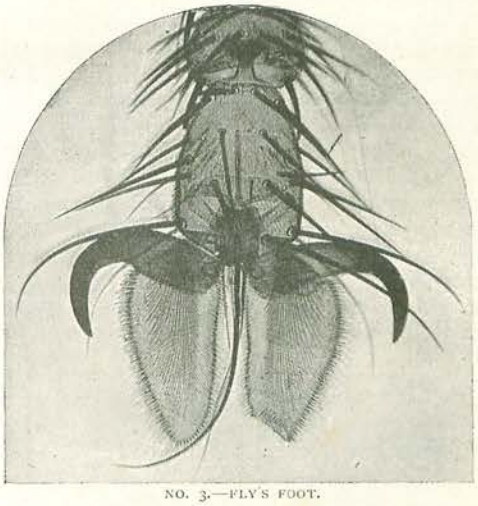
Motto:—*De minimis non curat lex.*

NO. 1.—COMIC CREST AND COAT-OF-ARMS DESIGNED FOR THE MENU OF AN ANNUAL DINNER OF THE QUEKETT MICROSCOPICAL CLUB.

NO. 2.—HUMAN SKIN, SHOWING PERSPIRATION DUCTS.

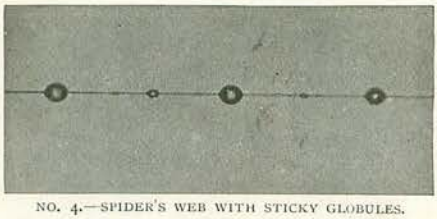
simple enough—the reception of the image by the microscope and photographic plate instead of by one's own eye. These photos are utilized in many ways, not the least interesting being their production in courts of law. Quite recently a photo-micrograph practically decided an incandescent light case, the dispute hinging on the material of certain "mantles" unknown to drapers.

Now fancy this awful-looking thing (No. 3) being laid lightly on your face at all hours of the day! It is the leg and foot of a fly—of



NO. 3.—FLY'S FOOT.

course, highly magnified and photographed. The common, or exasperating, house-fly cares as little for the laws of gravitation as it does for our personal comfort. Why is it able to walk nimbly up the window-panes, sleep on the ceiling, and select a bald-headed man out of a hundred? These be big questions, and I don't think they've been settled yet. Anyhow, they are problems that don't interest the ordinary man, who is chiefly concerned with the total abolition of *musca domestica.* Notice the pair of pads between the hooks. It was at one time thought that these acted as suckers, but some truculent scientist got an air-pump and a few flies and demolished this theory. The hooks assist the insect in releasing itself from any point to which it may be adhering. It may seem strange, but it is nevertheless a fact, that a complete house-fly (we know the complete house-fly) distributed over a dozen microscopic slides would cost you fifteen shillings. Like most of us, the fly gets into trouble—and the spider's web. The latter, as you may see for yourself, is provided with nice little sticky globules, which render impotent the releasing hooks on the fly's foot



NO. 4.—SPIDER'S WEB WITH STICKY GLOBULES.

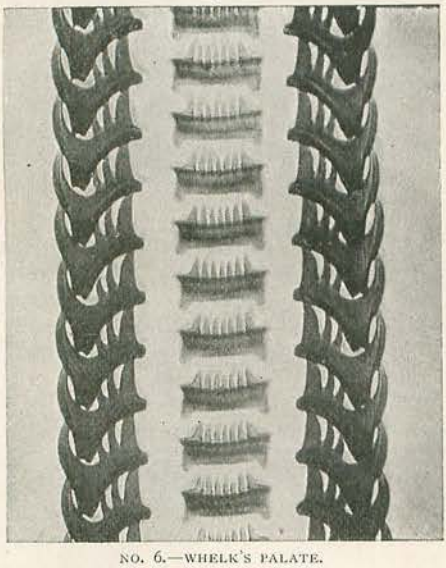
(No. 4). One eminent authority has computed that in an ordinary web there are 87,360 of these globules. This particular strand of a spider's web had to be drawn taut over a wooden cell before being photographed for this article.

Next is shown the foot of a spider (No. 5), with its web-combing claws, hardly an attractive spectacle for the fly, you would think. The mounting of these microscopic objects is a wonderful business. Fancy having to dissect a flea, and place its various organs on different slides! Of course, this work is done under the microscope; the tool, in some cases, being a hedgehog's bristle. The mounters frequently breed their own insects, and attend hospitals and inquests to procure human anatomical specimens. Many people like to have microscopes and microscopic "furniture" about them, even though they

NO. 5.—SPIDER'S FOOT, WITH COMBS FOR THE WEB.

don't know the stage from the eye-piece of the instrument. You see, these things give the room an imposing appearance as the abode of a scientist. The firm of Watson and Sons, of High Holborn, keep a stock of 40,000 microscopic specimens, and sell more than a thousand microscopes every year. You can buy an instrument for two or three pounds, or you can spend two or three hundred on one; the next thing is to get your set of objects. In these your tastes may be peculiar, inclining you to buy a chimney sweeper's lung for 1s. 9d., or the swine fever bacillus for 4s. Tadpoles' tails, ostrich blood, whales' eyelashes, house-crickets' gizzards, whelks' palates—all these will be found competing for your favour in the catalogue.

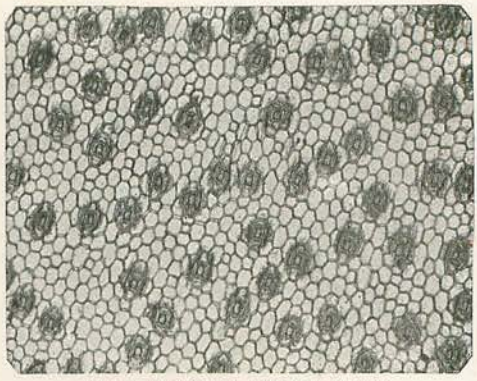
One of the last-named is next reproduced (No. 6); you will notice it resembles a patent



NO. 6.—WHELK'S PALATE.

fire-escape. Without doubt the mounter is called upon to supply queer things, beside which the constituents in the witches' caldron dwindle into mere ordinary "stock" material. There are spiders' eyes, seals' whiskers, and human eyelids, showing the "crying machine." Optic nerves, cats' lips, hornets' stings, rabbits' brains, elephants' corns, eruption dust from Vesuvius, parasites' eggs, the "wicious" eyes of the wasp, the blowfly's buzzing organ, and the breathing apparatus of a flea.

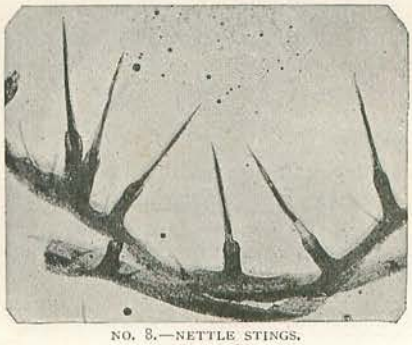
Here are two wonderful photo-micrographs from the vegetable world. The first (No. 7) shows the breathing pores on the surface of a leaf, and the second (No. 8), the stinging



NO. 7.—BREATHING PORES OF A LEAF.

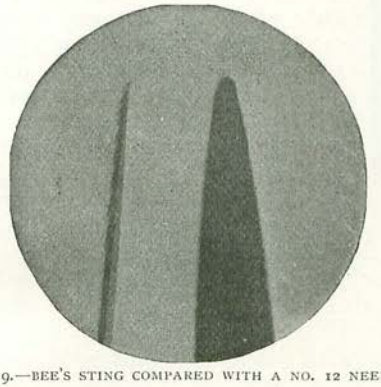
hairs on a nettle. By the way, the application of a solution of ammonia is the best remedy for nettle stings. As I have already said, the mounting of microscopic objects is trying work. Mounted specimens range in price up to £5 each; and Herr J. D. Möller, the great diatom man, once sold a slide for as much as £80. It consisted of 1,600 separate diatoms arranged on the glass, the whole scarcely visible to the naked eye. Here is a fact to be noted. The ability of a microscope lens to show fine detail is *not* dependent on its magnifying power, but rather on the number of light-rays it is capable of receiving from the objective. So it comes about that a modern lens, giving a total magnification of 2,500 diameters—or 6,250,000 "times"—will show fine detail in proportion of 136,000 lines to the inch. On the other hand, the famous microscope belonging to Ephraim Cutter, of New York, will only show 96,000 lines to the inch, although it magnifies 15,000 diameters, or 225,000,000 times, being the most powerful microscope in the world in this respect.

One can't really form an idea of the fineness of the sting of a bee without comparing it with some familiar object. Most of us know what a No. 12 needle is; some of us



NO. 8.—NETTLE STINGS.

may have sat on one. Well, here is the point of such a needle, side by side with the barbed tip of the bee's sting (No. 9); both are magnified equally. One wonders if Dr.

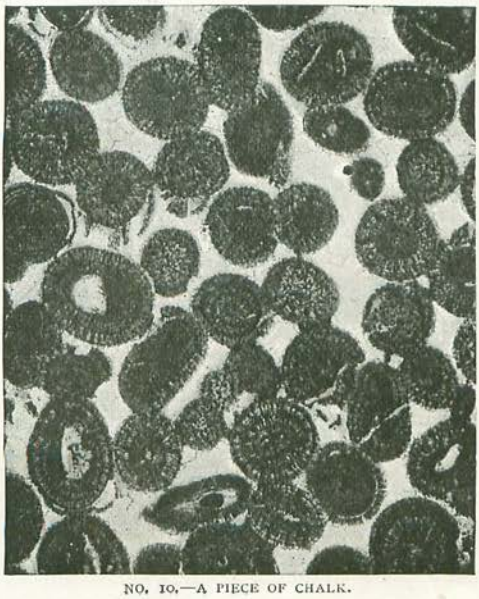


NO. 9.—BEE'S STING COMPARED WITH A NO. 12 NEEDLE.

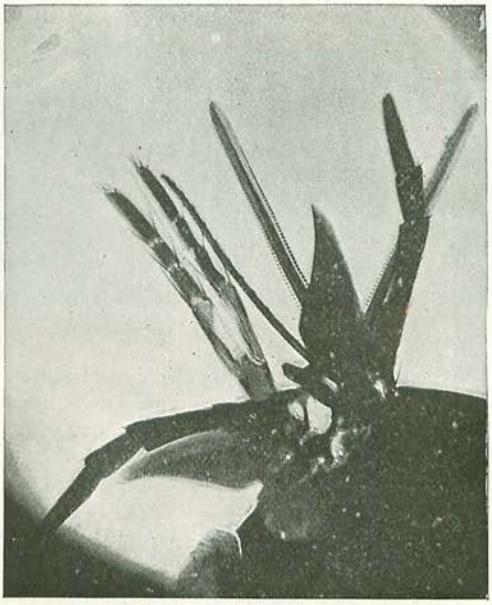
Watts was ever stung, or if he ever used the microscope on the "harpoon" of the "little busy bee." The man who *is* stung has no time to express amazement at the wonderful arrangement of the bee's anatomy; probably he is busy with other expressions.

But let us turn to the seaside. Here we see under the microscope a piece of chalk from the cliffs on the coast. It's made up, you will notice, of little shells whereof a million might easily be put in a lady's thimble (No. 10).

An ordinary flea is furnished with a pair of very sharp lancets, which are shown in the next picture (No. 11), and with which



NO. 10.—A PIECE OF CHALK.

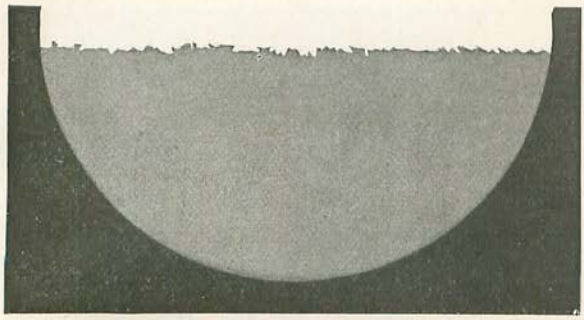


NO. 11.—LANCET OF A FLEA.

the flea makes incisions in the skin of its victim. In passing, one may notice the peculiar development of the flea's legs, whereby the insect is enabled to bound from place to place. If we were endowed with proportionately the same muscular power, it would be an easy matter for us to clear St. Paul's Cathedral in one jump. The lancets are the two serrated, sword-like spikes, and they are magnified ninety diameters in the photograph.

It is said that negroes regard the flea's attention with comparative indifference.

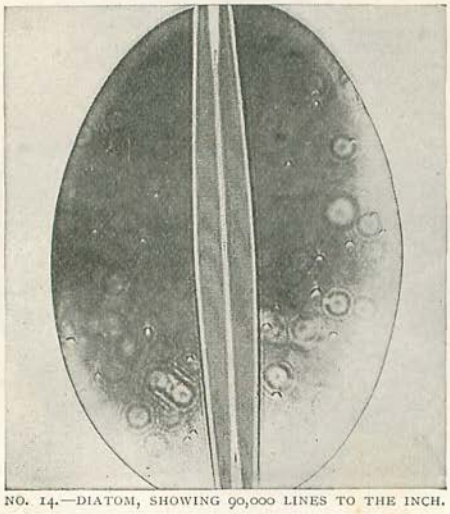
NO. 12.—SKIN OF NEGRO, SHOWING BLACK PIGMENT.



NO. 13.—EDGE OF A GOOD RAZOR.

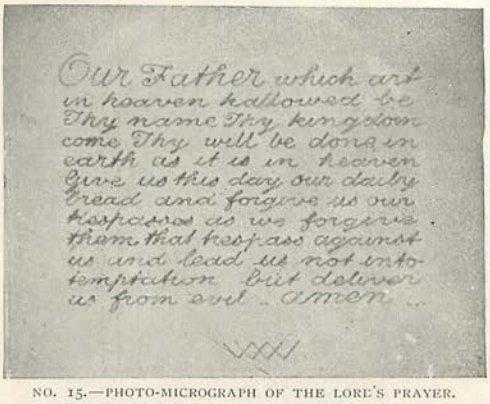
Howbeit, the accompanying photograph shows a section of the skin of a "cullud gen'l'man," pigment cells and all complete (No. 12). At the same time you would think our black friend would need all his callousness to withstand the touch of a razor with an edge like that one here shown (No. 13). And yet we selected for treatment a decent barber's razor; of course we didn't show him this, lest he should bring a libel action against us.

Diatoms are perpetually being examined by microscopists, amateurs and otherwise. They are aquatic in origin, and consist of two almost indestructible flinty shells, inclosing an organic vegetable substance. The shells are held together by connecting girdles. After a brief life, the organisms die, and the shells (known to the microscopist as "valves" or "frustules") fall to the bottom of the water. The city of Richmond, in Virginia, is built on a great stratum of diatoms, 18ft. thick, and the paving stones of our own Royal Exchange are largely composed of them. The little band of pure flint which binds together the twin valves of every circular diatom is a true ring, so absolutely flawless that a magnifying power which would extend a postage stamp to a square mile would fail to reveal even the most trivial deviation from a fidelity of curve, mathematically perfect. That's how Nature does her work.



NO. 14.—DIATOM, SHOWING 90,000 LINES TO THE INCH.

Diatoms vary in size from the 1-60th to the 1-250th of an inch at the widest part. One, called *Amphipleura pellucida*, shown in the accompanying photograph (No. 14), measures 1-250th of an inch in length, and ranks as a test object for microscopes; the fine lines in it are about the 1-90,000th of an inch apart. This photograph represents the *pons asinorum* of the microscopist—and, indeed, of the microscope also. This is because the very highest magnifying powers are required to render visible these amazingly fine lines. The best of apparatus and the most skilful manipulation are, of course, also indispensable. But it is when one comes to consider microscopic writing, or engraving, that one is impressed by the wonders of this instrument. Some years ago a man ruled on glass, with a diamond, lines that were the 1-120,000th of an inch apart. The prices of these engravings vary according to the minuteness of the writing. Look at the Lord's Prayer, whereof a photo-micrograph is here reproduced (No. 15). The original is so small (it occupies the



NO. 15.—PHOTO-MICROGRAPH OF THE LORD'S PRAYER.
(The original occupies only the 1-318,000th part of an inch.)

1-318,000th part of an inch) that, according to the same proportion, the whole of the English Bible and Testament could be written *twenty times in the space of one square inch.* Just consider what this means; the entire Bible contains 3,566,480 letters. A "ten-Bible" Lord's Prayer, written on glass, would now cost about a couple of pounds, the return for

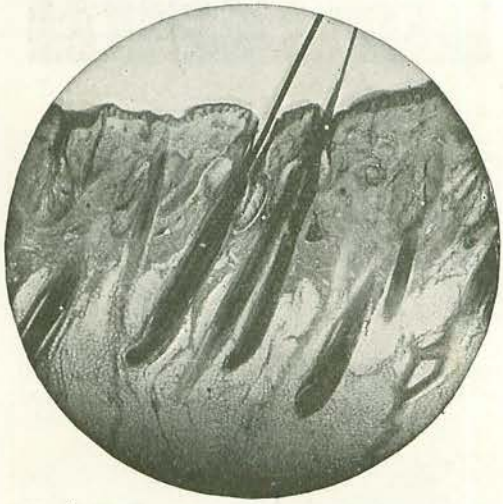
your money being an exceedingly minute speck.

After this, the next microscopic curiosities seem rather tame. Here is seen a vase of flowers built up with infinite skill and patience by the mounter, who only used in his "picture" the scales and hairs from the wings and bodies of various butterflies, moths, and other insects (No. 16). Altogether 1,252 particles

NO. 16.—VASE OF FLOWERS, CONSTRUCTED WITH THE HAIRS AND SCALES OF INSECTS.

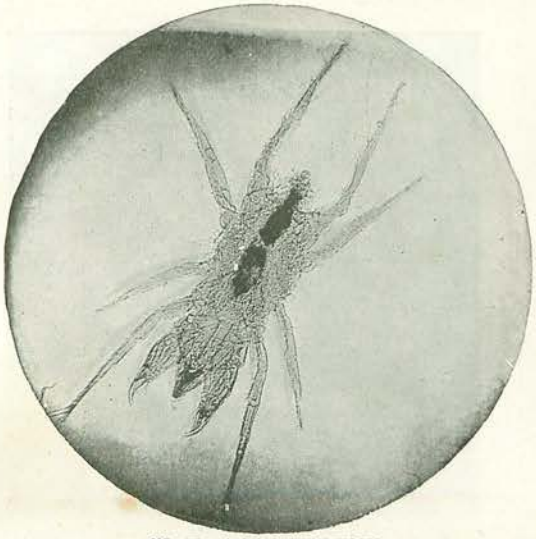
had to be placed in position separately, yet you can hardly see the whole without the aid of a microscope—under which, of course, the design was executed. The original of this is a microscopic treasure, and treasures are "skeers and dear," as Mark Twain's aunt remarked about the buckwheat cakes in a bad season.

Most microscopists are enthusiasts. Look at John Quekett, who, when only sixteen years old, gave a course of lectures on the microscope, his instrument being a home-made one, constructed from some pieces of brass bought at a rag-shop, a common roasting-jack, and an old-fashioned parasol! The ordinary amateur is for ever on the look-out for new subjects in general, or he may confine himself to one species; he may, for example, become a "diatomaniac." He is almost certain to upset people who like a piece of ripe Stilton, by producing microscopic photos of the ap-



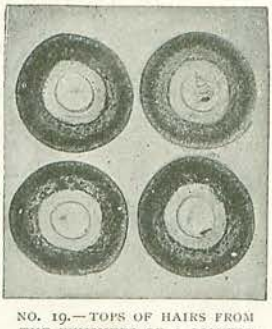
NO. 18.—PART OF THE HUMAN SCALP, SHOWING HOW THE HAIRS GROW.

parently gigantic insects that inhabit that cheese. By the way, even mites have their likes and dislikes. For instance, this mite (No. 17) is like the flawless hero—never found out of books. He seems to be a studious mite—a bookworm in fact (his full title is *Cheiletus Eruditus*), and his greatest enemy is the industrious librarian.



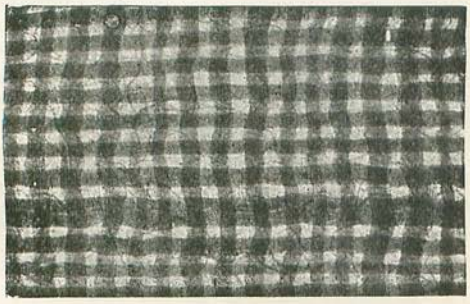
NO. 17.—A REAL BOOK-WORM.

Here is another interesting photograph. It shows part of the human scalp with the hairs growing; the roots of hairs that have not yet risen to the



NO. 19.—TOPS OF HAIRS FROM THE WHISKERS OF A LIONESS.

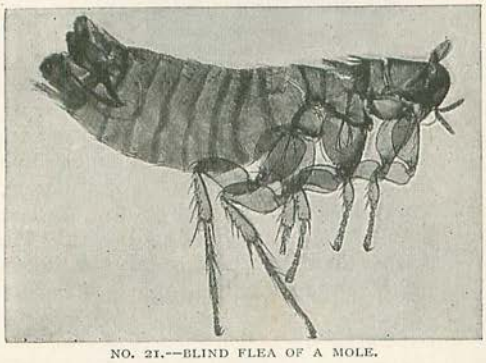
top are also visible (No. 18). Next come four hairs from the whiskers of a lioness. You are looking vertically down on to these latter, and the tops of the hairs were cut off to give a better result in the photograph (No. 19).



NO. 20.—THE FINEST FRENCH CAMBRIC.

Under a powerful microscope, even the most delicate specimen of human workmanship looks astonishingly coarse. Look at this photograph (No. 20). The fabric shown is not a rough Harris or Sutherland tweed, such as shooting suits are made of, but a piece of the most exquisitely fine French cambric, which cost twenty shillings a yard.

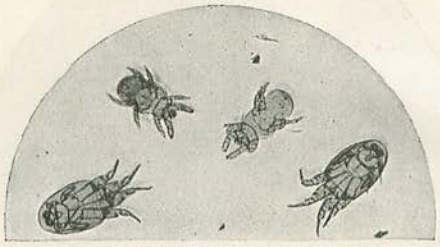
The various microscopical societies throughout the world are in no danger of a famine in subjects — or objects. Swift told us that "great fleas have little fleas upon their backs



NO. 21.—BLIND FLEA OF A MOLE.

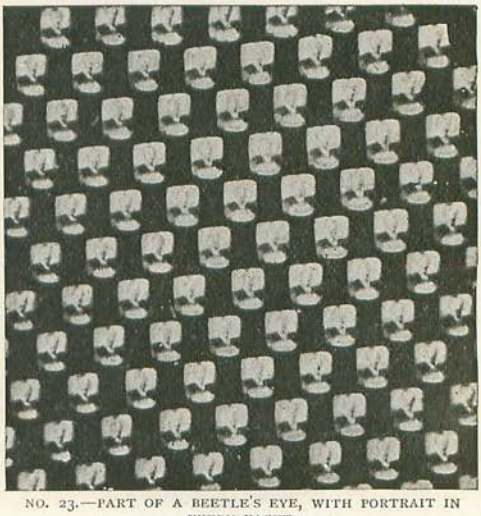
to bite 'em"; and then, again, "little fleas have lesser fleas, and so *ad infinitum*." Here is an extraordinary example of what I might call the physiological sympathy which the parasite has for its "host." The mole, as we all know, is not remarkable for keenness of vision, and it has a special kind of flea all to itself. Well, that flea is also blind, although you wouldn't think so on looking at the photograph (No. 21).

It may be some satisfaction to the victims of the ordinary house-fly to know that that provoking insect is in turn preyed upon by these little parasites (No. 22); whether these, too, "have lesser fleas" I can't say—probably they have. At any rate, the beetle has its parasite, with lancets 700 times finer than a human hair; and an exceedingly minute flea has been found upon the flea of a hedgehog. The eye of a water-beetle is made up of many facets; there are about 24,000 of them in the two eyes of a dragon-fly. Each of these facets acts as a lens to convey to the insect's brain some small portion of the object



NO. 22.—PARASITES OF THE HOUSE-FLY.

that is being looked at; at the same time, I want to illustrate a peculiar phenomenon in connection with these facets. If an image be placed between a luminant body and one of these sets of lenses, that image will be represented entirely in each individual facet. A really wonderful microscopic photograph has been specially taken to illustrate this (No. 23). It shows a portrait in every facet of the beetle's eye. The eye was first of all dissected and placed on the stage of the instrument. The portrait—on glass and, of course, exceedingly small—was then interposed and the photograph taken through the microscope.



NO. 23.—PART OF A BEETLE'S EYE, WITH PORTRAIT IN EVERY FACET.