extreme tenuity, others were dense and bright, hiding the stars over which they passed. The sky in the end was covered with a light haze, which condensed into a cloud canopy. No prismatic colours were visible, streamers, beams, and rays throughout being alike of a pure white light, though greatly luminous, so as to retain distinctive individuality in the face of brilliant moonlight. Thursday, early morn, sun shining through a hazy sky, wind light from the south; 9 a.m., overcast; 11 a.m., rainfall set in. Continuous all the day. Sharp fall of barometer. Thermometer mid-day, 65, wind inclined to back to the eastward. Considering that the vernal and autumnal equinoxes are the usual periods of auroral activity, and that there is yet a month to the 21st of September, an instance, now of auroral energy is somewhat out of the usual course of things. The equinoctial gales, yet earlier, set in with much rigour. Perhaps, as everything has a meaning, these phenomena presage the kind of weather which is to rule the autumn. Scarcely a summer bird remains save the swallow and martin. The swift left early. A solitary bird or a pair was observed, however, evening by evening up to the 28th to return to the nesting place of the tribe, as loth to leave the English home. To-day (Friday) continuous rain, which has prevailed all the night. Mid-day, thermometer 64; barometer 29·3; set of wind southerly. X.

Worcester, September 1

Habits of Spiders

YOUR correspondent, Mr. Frank Rowbotham, in his letter on the "Habits of Spiders" (vol. xxvi. p. 386), gives it as his opinion that a spider shakes the web from a desire "to effect concealment when it feels danger is near." I am inclined to think it does so from a feeling of anger. During a long residence in the tropics, I often amused myself irritating spiders and watching their conduct. I noticed that they generally seized the web and shook it up and down in the manner described by your correspondent, but some of the spiders were of so great a size as to render concealment by such a manœuvre quite hopeless, and I attributed their behaviour to other motives. They appeared to me more to resemble angry monkeys than anything else. I have not unfrequently seen the latter when annoyed jumping up and down on all fours with their tails erect in the air, or if confined in a cage seize the bars bp their hands and feet and shake them as the spiders did their webs. W. J. C.

Torquay, August 30

THE RESPIRATORY MOVEMENTS OF INSECTS

THE respiratory movements of some of the larger insects are quite apparent, and have been described by various observers. A German naturalist, Herr Rathke, published in 1861 a memoir in which he compared those movements, observed with the naked eye and a magnifying glass, in insects of all the principal types.

According to M. Plateau (who has lately studied the subject, and has made a preliminary communication of his results to the Belgian Academy), though Rathke's memoir is very remarkable, he overlooked many details, and fell into sundry errors, owing to the difficulty of the inquiry.

Haussmann (1803) suggested a method of indicating the movements of dilatation and contraction of an insect's abdomen, by oscillations of a liquid column; but he recognised that it would apply only to articulata of large size, and it seems incapable of yielding very exact results.

M. Girard (1873) proposed encasing the insect's abdomen with a thin envelope of caoutchouc having a style attached which would inscribe the movements.

It is a form of the graphic method that M. Plateau first adopted. He confined himself to perfect insects, and directed his attention to (1) the form of the inspiration and expiration; (2) the parts of the body participating in the respiratory movements; (3) the expiratory and inspiratory muscles; (4) the influence of certain parts of the nervous system on the movements of respiration. The technical processes concerning the muscles and nervous system are a matter of mere dissection, once the form of respiratory movement is ascertained, and the latter, therefore, chiefly claims notice in a simple *résumé*.

M. Plateau used two kinds of styles to inscribe the movements on a rotating blackened cylinder. One was a narrow light strip of Bristol paste-board, fastened to the part of the body whose movement was to be ascertained, with a little Canada balsam; the other a lever of the third order, turning freely about a horizontal axis placed at one end, and resting by its own weight, at a point near the axis, on the body of the insect (the insect, in either case, being supported fixedly in any desired position).

The graphic method is, however, unsatisfactory, and sometimes quite inapplicable, and M. Plateau used another along with it, viz. the method by projection, which gave excellent results.

The insect, fixed on a small support, so that the movements in breathing are not interfered with, is introduced into a large magic lantern lit with a good petroleum lamp. A reversed silhouette is obtained on the screen, and if a certain magnification be not exceeded (say 12 diameters), a very distinct image is produced, on which one may follow all the respiratory movements sufficiently amplified to indicate real displacements of a fraction of a millimetre. With a sheet of white paper over the image one draws the contours of the silhouette, corresponding to expiration and inspiration. Further, by changing the position of the insect, and by attaching short paper styles at parts whose movements are doubtful, a complete knowledge may be acquired of all details of the respiratory movements that characterise a given insect.

With a little practice, not only may the respiratory movements of small insects, such as flies, be easily studied thus, but a number of questions are unmistakably settled, which cannot be decided by direct observation.

The following is a brief *résumé* of the author's results:—

1. There is no close relation between the form of the respiratory movements of an insect, and the insect's place in zoological classifications. The respiratory movements are similar only when the structure of the abdominal rings and the arrangement of muscles moving them are nearly the same. Among curious facts here, the movements of Phryganeidæ are unlike those of nearly related Neuroptera (such as Sialis), and like those of sting-bearing Hymenoptera.

2. *In all insects* the diameter of the abdomen diminishes in expiration by approximation of the dorsal and sternal arches of the segments; in some cases the dorsal, in others the sternal, showing the greater mobility; and in others both having nearly the same mobility.

3. The modifications in the vertical diameter *may* be accompanied by changes in the transversal diameter (*e.g.* Libellulæ).

4. Contrary to a former view, the changes of length of the abdomen, in normal respiration, by protrusion and return of the rings, are rare in insects; they are observed in an entire group only in the case of the sting-bearing Hymenoptera. Some isolated cases occur in the other zoological subdivisions (*e.g.* the caddis flies among the Neuroptera).

5. In the majority of cases, the thoracic segments do not participate in the respiratory movements of insects at rest. But the respiratory displacements of the posterior rings are less rare than Rathke supposed.

6. It has been thought that the respiratory movements in many insects were progressive, and propagated like a wave either from the base of the abdomen towards the point, or from the middle towards the two ends. This wave is, however, an exceptional phenomenon, is absent in all Coleoptera, in Acridians, in Libellulæ, in sting-bearing Hymenoptera, in Muscides, and a part of Lepidoptera, and only appears in isolated forms in certain groups.

7. When there is a pause in the respiratory phrases it always occurs in inspiration.

8. In all insects vigorous enough to furnish suitable curves (such as the large Coleoptera) one finds that the inspiration is usually slower than the expiration, and that the latter is often sudden (confirming an observation by Sorg in 1805).

9. In most insects expiration is alone active, inspiration being passive, and due to elasticity of the teguments and the tracheal walls. (This confirms previous observations.)

10. Nearly all insects possess only expiratory muscles. M. Plateau has found muscles aiding inspiration not only in Hymenoptera and Acridians (Rathke, Graber), but in Phryganeidæ.

11. The superior and inferior diaphragms of Hymenoptera have not the *rôle* Wolff attributes to them (a confirmation of objections by Graber).

12. Many insects, perhaps all, perform, with their abdomen, general movements, sometimes small, sometimes very ample, which do not coincide with respiratory movements, properly so called, and must be distinguished from them.

13. The respiratory movements of insects are purely reflex, persisting in the decapitated animal, and even in the isolated abdomen in forms whose nervous system is not condensed. In the latter case these movements are excited or retarded by the same causes which excite or retard them in the intact insect (a confirmation of previous observations).

14. The metathoracic ganglions are not, as Faivre supposed, special respiratory centres (a confirmation of the views of Barlow and Baudelot on Libellulæ).

15. The abolition of respiratory movements by destruction of the metathoracic ganglions in Dytiscidæ and other Coleoptera, results from the condensed state of their nervous system, in which a certain number of abdominal ganglions are fused with those of the metathorax.

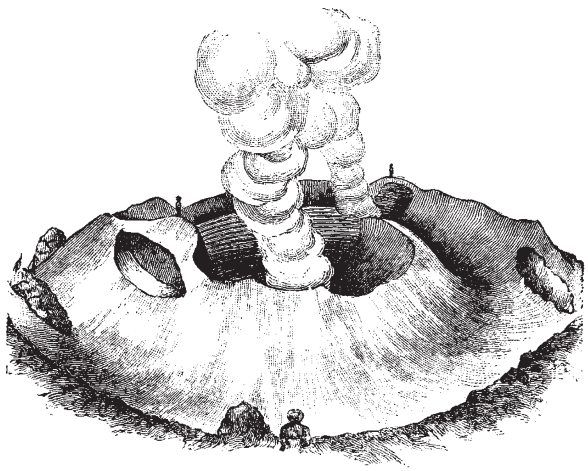
16. In insects with a condensed nervous system the excitation or partial destruction of a complex nervous mass resulting from the union of successive ganglionary centres always affects all the centres entering into the constitution of this mass.

DIARY OF VESUVIUS, JANUARY 1 *TO JULY* 16, 1882

IN the account given in NATURE, vol. xxv. p. 294, the eruption that has been going on in December was described up to the last day of 1881. As the height of the lava column had been diminished by the lateral outlets, the surface was consequently some considerable distance below the lip of the crater, its level on ordinary occasions being only a few metres below.

Under ordinary conditions the ejectamenta consist of masses of fluid lava blown out as the spray from an effervescing liquid. They form the so-called lava cakes, being flattened out by their fall, while still plastic. They are usually very spongy, or scoriaceous, and rapidly disintegrate. In the present instance, however, as the vapours quitted the lava at some considerable depth, these plastic masses could not reach the surface. This rapid escape of vapour through the narrow tube between the lava surface and the crater lip, was under analogous conditions to the powder gas in a fire-arm. If, for instance, we imagine a cannon, whose bore is composed of materials easily broken up, we have a rough illustration of what takes place. The lava-cakes were replaced by ejectamenta derived from the components of the sides of the chimney, such as compact lava fragments, lapilli, old scoria cakes, all more or less altered and decomposed by the hot acid vapours, to which they had been exposed for considerable periods.

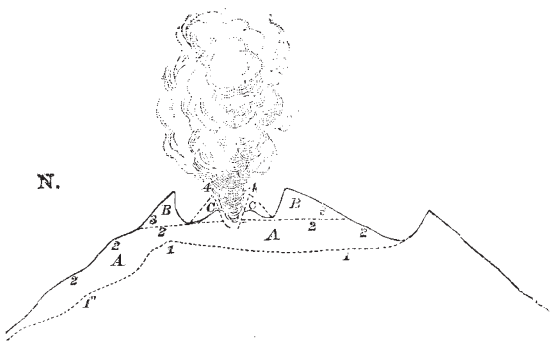
Such a condition of things naturally results in the straight-tube or chimney assuming the form of a funnel, or conical hollow whose apex will be at or near the lava level, that is to say, at the point where the gaseous products quit the fluid magma. We have, in fact, two conditions upon which the size and depth of a crater depend, namely, height of lava column, and amount and force of vapour escaping. Naturally the effect would be modified by local causes, and also the difference of com-



Sketch after Nature on July 16, 1882, 9.30 a.m. View from the north of the cones and craters of December, 1881, and January to July 16, 1882. The outer rim is broken away over the old fissure to the left or east. The smaller bocca is beneath the little figure, there is probably the remnants of another beneath the middle, or left figure.

ponent materials. The ejectamenta which in this manner were very different from that of ordinary occasions, were deposited simultaneously in a rim-like manner around the new crater.

Thus we see how a nearly perfect cone of eruption, such as existed in the beginning of December, composed as it was of alternate beds of lava and scoria cakes, with a chimney, but without a crater, may be converted into a low truncated cone, whose base is of an area considerably larger than that of the original, but whose height is much



1, Outline profile of apex of cone after eruption of 1872; 2, outline on December 31, 1881; 3, outline section on April 23, 1882 (*i.e.* the continuous line); 4, cone and crater formed between April 23 and July 16, 1882; A, materials, lava, and scoriæ since 1872; B, ditto, since December 31, 1881; C, ditto, since April 23, 1882.

less. The interior now occupied by a crater proportionally large. The whole of these changes occurring without the addition or abstraction of any materials, except an ash blown away by the wind.

On January 1, Vesuvius had become quiet, and the feeble ejections consequent thereon could no longer hoist the materials over the new crater edge, but were instead building up a new cone of eruption around the vent at the bottom of the craterial hollow.