crepancy is greater and greater. Thus, from curves given by Dines (p. 256) showing his own and Rayleigh's results, I find the normal resistance to a blade moved through air in a direction inclined 30° to its plane, to be 1·82 times that given by Rayleigh's formula. And by drawing a tangent to Dines' curve at the point in which it cuts the line of zero pressure, I find that, for very small values of i, it gives

$$3 \cdot 25 \times \sin i \times \text{PA}.$$

This is rather more than double the value of the force given by Rayleigh's formula for very small values of i, which is

$$\tfrac{1}{2} \pi \sin i . \text{PA}.$$

It is about three and a half per cent. greater than that given by my conjectural formula (NATURE, August 20, p. 426, and September 27, p. 525; and *Phil. Mag.*, October 1894) for very small values of i, which is

$$\pi \sin i \cos i. \text{ PA}.$$

My formula is, however, merely conjectural; and I was inclined to think that it may considerably under-estimate the force. That it does so to some degree is perhaps made probable by its somewhat close agreement with Dines; because the blade in his experiments was 3″ broad and $\frac{3}{8}$ of an inch thick in the middle with edges "feathered off." An infinitely thin blade would probably have shown greater resistances, at all angles, and especially at those of small inclination to the wind.

(To be continued.)

OBSERVATIONS ON YOUNG PHEASANTS.

THE pheasants which formed the subjects of the following observations were hatched out in an incubator from eggs kindly given me by Sir Cecil Miles. The eggs were taken from the hen and transferred to the incubator a few days before the young birds were due to emerge.

The accuracy of pecking and seizing was found to be about the same as that of newly-hatched chicks. For example: two pheasants were hatched out at about 3 p.m.; that evening, at about 6.30, finely chopped egg was placed before them, but they showed no signs of pecking at it; nor did they peck at grain or sand next morning at 11 a.m. At 4 p.m. they began to peck, but seized very little. One struck repeatedly at a crumb of egg on the other's back, but failed to seize it, though the other bird was quite still. On the following morning they pecked at sand and grain (chiefly canary seed) with fair aim. One seized, at the first stroke, a grain of boiled rice at the end of a long steel pin. Another pheasant was hatched out in the night. At about 12 noon, I offered him some egg-bread on the end of a tooth-pick. He struck at it and missed, struck a second time and seized, swallowing some. He could not be induced to strike again. Later he picked up some ants' "eggs," striking with fair accuracy, but did not swallow any. At 4 p.m. he pecked some egg-bread off the end of the tooth-pick, and swallowed. He also pecked at an ant's "egg," but failed to swallow it; then at a second, and swallowed it. Further details would be merely wearisome. One may say that the co-ordination for pecking and swallowing is inherited in a condition such as to ensure fair but not complete accuracy; and that some individual experience is necessary to bring it to perfection.

The young pheasants took no notice whatever of water placed before them in a shallow vessel. When I gave them water on the tip of my finger, they seemed to enjoy it, and one in particular drank eagerly from the end of a tooth-pick, so that an association was established between the sight of the tooth-pick and the satisfaction of drinking. But when I lifted this bird and others, and placed them in the shallow vessel, they made no attempt to drink from it. They learnt to drink from the vessel through pecking at grains of food lying on the bottom. They drank, however, less freely than chicks.

The little birds showed no sign of fear of me. They liked to nestle in my warm hand. My fox-terrier was keen to get at them, much keener than with chicks, probably through scent-suggestion. I placed two of the young pheasants, about a day old, on the floor, and let him smell them (under strict orders not to touch them). He was trembling in every limb from excitement. But they showed no signs of fear, though his nose was within an inch of them. When the pheasants were a week old, I procured a large blind-worm and placed it in front of the incubator drawer in which the birds slept at night. On opening the drawer they jumped out as usual, and ran over the blind-worm without taking any notice of it. Presently first one, then another, pecked vigorously at the forked tongue as it played in and out of the blind-worm's mouth. Subsequently they pecked at its eye and the end of its tail. This observation naturally leads one to surmise that the constant tongue-play in snakes may act as a lure for young and inexperienced birds; and that some cases of so-called fascination may be simply the fluttering of birds round this tempting object. I distinctly remember when a boy seeing a grass-snake with head slightly elevated and quite motionless, and round it three or four young birds fluttering nearer and nearer. It looked like fascination; it may have been that each hoped to be the first to catch that tempting but elusive worm! Presently they would no doubt be invited to step inside.

Another incidental observation is worth recording here. I gave the young birds some wood-lice. These were frequently caught when they were moving, and eaten. But if one had time to roll up, and was thus seized, it was shot out to a distance by the pressure of the bill, just as a fresh cherry-stone is shot from between the finger and thumb of a school-boy. The protective value of the round and slippery form was thus a matter of observation.

I have not observed in the young pheasants the crouching down, which is seen in young chicks when an unusual sound startles them. They appear under such circumstances to stand motionless. For example, when two of them were walking about, picking up all the indigestible odds and ends they could find on my carpet, a high chord was sharply struck on the violin. Both stopped dead. The gentle piping noise they were making ceased. One of them was just lifting his leg, and remained in this position quite still, with neck stretched out, exactly as if he had been suddenly fixed in the attitude in which he chanced to be when the sharp sound fell on his ears. Thus he remained for half a minute. Then he took a few steps and again stopped, remaining quite still for about the same period. (Age 13 days.)

The method of tackling a worm appears to be a matter of inherited co-ordination. So soon as the worm is seized, it is shaken and battered about. There seems to be, also, an inherited tendency to run away with it to some distance before eating it. At all events, of two little pheasants, one of which was weakly, the stronger always bolted off with his worm, though his weakly brother or sister seldom or never chased him. He sometimes tried to bolt with one of his companion's toes by mistake, when one or both of the birds would topple over.

Two notes or sounds, one loud and distressful, the other soft and contentful, appear from the first to be clearly differentiated. A third sound, more gentle than the soft note and double, was occasionally heard when one caressed the birds in one's warm hand. It closely resembles a similar note uttered under similar circumstances by the chick. The note expressive of danger, alarm, or anger, was occasionally heard after about the sixth day. For example, as the little pheasant was bolting with his worm, I seized it with a pair of forceps. This alarm or anger note was at once uttered, and the little fellow bridled up and seemed ready to show fight.

The birds when fresh run about with little short spurts or dashes, as do also chicks. They have a dislike to being confined. When they were surrounded with wire netting, although the space inside was ample for all their needs, they squeezed through the meshes, and did so very cleverly when four or five days old. At about this age or earlier they preen their down, and the incipient feathers of the wing, often tumbling over from imperfect co-ordination. They also peck persistently at their toes. They scratch the ground much less than chicks.

More difficulty was found in rearing the pheasants by hand than in the case of chicks. Several died apparently from constipation. None were reared beyond the fifteenth day. The coldness of the season was against them, and unfortunately, through an accident, the incubator drawer in which they slept was allowed to get cold, and this caused the death of the last two, one of which was quite healthy. I hope to repeat the observations, next year, on these and other young birds under more favourable conditions. Such as they are, however, they serve to confirm the conclusions based upon the study of newly-hatched chicks and ducklings, which I briefly set forth in *Natural Science* for March 1894, and which are considered at greater length in my "Introduction to Comparative Psychology," to be published this autumn in the Contemporary Science Series.

C. LLOYD MORGAN.

SCHOOLS OF METEOROLOGY.

IN your issue of September 13, p. 481, you correctly state that one reason for the small number of meteorologists is the want of a training school. This is a defect in our University curricula that I have frequently pointed out and sought to remedy. You will agree with me that meteorology is worthy of a generous and profound treatment. It should be recognised as a possible major course in all large Universities. Laboratories should be provided where all questions bearing on the atmosphere and its motions can be experimentally elucidated.

I append a sketch of the four years' course of study and work that I hope to carry out with my own students. The necessary laboratory conveniences have not yet been provided, but we are looking forward hopefully.

I shall be glad if your publication of this course contribute in any way to the proper study of meteorology by the young physicists of the British Empire.

CLEVELAND ABBE.

Washington, September 24.

COLUMBIAN UNIVERSITY.

Department of Meteorology.

The series of courses in the Department of Meteorology is designed to give a complete review of the present condition of that science, and is therefore necessarily extended through four years; but the series of lectures is so arranged that each of the four divisions is complete within itself; each course presents a view of a branch of the subject such as may be desired by a large number of students who need this information in connection with other branches of knowledge to which they are specially devoting themselves.

Students who intend to take the degree of Ph.D. in meteorology, and who therefore make this the major subject in connection with several other minor courses, must pursue the whole four years' course. Those who desire merely to enter the service of the United States Weather Bureau will probably find the first year's course sufficient to enable them to pass the necessary Civil Service examinations. Those who desire to do work in climatological study should also take the second year. The third year's course is designed for those who wish to perfect themselves in methods of making local weather forecasts. Finally, the fourth year's course will serve as an abundant introduction to the present state of our knowledge of the mechanics and physics of the atmosphere. In addition to the lectures, the instructor will give one hour a week to a quiz-class, in which, by question and answer, he will seek to remove any difficulties that remain.

(1) *Observational Meteorology.*—The methods of observation; the simpler instruments, their errors, corrections, and reductions; the use of self-registers; the forms of record and computation; personal diary of the weather.

Time.—About eighty lectures, or two hours a week, as also eighty other hours of personal investigation of instruments, especially self-registers.

Algebra and trigonometry are necessary preliminaries to this course. Elementary laboratory physics, as illustrated by Hall and Bergen's text-book, is desirable as a preliminary, but may be pursued as a concomitant study. The German language is earnestly recommended as a concomitant. The differential and integral calculus will be needed as preliminary to the Graduate Course in Meteorology.

(2) Climatology, both local and general; empirical meteorology, generalisations, averages, periodicities, irregularities. The relation of climate to geology, to vegetation, to animal life, and to anthropology.

Time.—About forty lectures and four hours weekly given to the investigation of special problems proposed in each lecture.

Students should be familiar with the use of logarithms; the method of least squares; the laws of chance; the details of physical geography, orography, geology, and ocean currents; the physiology of plants and animals; the distribution of species; physical astronomy, especially that of the sun, earth, and moon; terrestrial magnetism; the chemistry of the atmosphere; the biology of atmospheric dust. Physical laboratory work on radiation, conduction, and absorption of heat, and on condensation and evaporation of vapour, and on elementary electricity, is recommended, while German, the calculus and analytic mechanics should be continued as preliminary to the Graduate Course.

Graduate School of Meteorology.

The following scheme of studies in meteorology, subject to arrangement between the teacher and his pupils, is offered for the degree of Doctor of Philosophy:—

(1) Practical meteorology; the daily weather chart; the empirical laws of weather changes as depending on meteorological data, and the arrangement of continents, plateaus, mountains, oceans, &c.; weather types and typical weather charts; prediction of daily weather and seasonal climates; verification of predictions.

Time.—About forty lectures and at least five hours a week additional, in verifying old laws and studying new ones, in making and verifying predictions.

Concomitant Studies.—Methods of chart projection; experimental laboratory work in both steady and discontinuous motions of fluid and gases; mathematical and experimental electricity; the laws of refraction and interference of light; elementary hydrodynamics and thermodynamics; differential equations and definite integrals; the German language.

(2) Theoretical meteorology. Insolation. The absorption, conduction, and radiation of heat by the air and the earth. The thermodynamics of the atmosphere; the graphic methods of Hertz and Bezold. Convective equilibrium, as applied to the atmosphere of the sun by Lane, and to that of the earth by Sir William Thomson