THE LIFE-HISTORY OF A WATER-BEETLE.[1]

THE life-history of a water-beetle can be outlined in a very few words. An egg is laid by the mother-beetle: an aquatic larva hatches out which feeds and grows, and, during the process of growth, moults several times. When full grown it leaves the water and burrows into the earth, forming a "cell," in which it changes to a pupa. After a time the pupal skin is cast off, and the perfect insect makes its way out of the cell and resumes its life in the water.

There are, however, all sorts of interesting details in the life-history, and these details often differ considerably in different types. There are differences in the egg-laying habits; differences in the method of development of the embryo; differences in the way the larva gets out of the egg; differences in the way it feeds and in the nature of its food, and so on; and it is these differences which are of importance to each species in enabling it to fit in among other species in the life of the community.

Although there are a number of widely separated species of beetles which inhabit the water, there are two groups which are usually referred to as "water-beetles," and these may be broadly distinguished as the swimming carnivorous group—the Hydradephaga—and the creeping herbivorous group—the Palpicornia, or Hydrophilidæ. The description of this second group is not strictly accurate, as the larvæ are, apparently without exception, carnivorous, and the perfect insects, although capable of subsisting upon a vegetable diet, in at least many cases enjoy animal food; and although they are somewhat differently constructed from the swimming water-beetles, some of them are very fair swimmers.

I propose to outline the life-history of a type of the Hydradephaga, and then to compare with it a type of the Palpicornia; and as a type of the former group I will describe a species of Dytiscus, *D. lapponicus*, the life-history of which I worked out during last summer.

The male and female differ in general appearance, the former having smooth wing-cases, the latter having these grooved or fluted. The male has also a pad on each of the front legs, while the female has quite simple front legs. The slide also shows a full-grown larva, and thus gives an idea of the relative sizes of these two stages of the species.

This species is extremely local in the British Islands, only having been found in a few localities in Scotland, and in one in north-west Ireland. It inhabits lochs, usually mere lochans, at altitudes of from 800 ft. upward, and there are certain characteristics about its habitat which make it possible generally to tell at a glance whether a particular lochan is or is not likely to hold the species.

As a rule the habitat is a bare stony lochan, with very little vegetation; it has no stream flowing into or out of it, and trout and *lapponicus* are mutually exclusive. There are usually newts and fresh-water shrimps (*gammarus*), but otherwise there is always a marked scarcity of animal life. Very few other water-beetles are associated with *lapponicus*, which usually is abundant where it occurs.

The only place I have found the species in great abundance is in a lochan 950 ft. above sea-level on the island of Eigg. Along its eastern side this lochan is strewn with large stones, and under these the beetle is to be found, often as many as four or five under one stone. It occurs in other lochans on Eigg, and has been found also in Rhum, Skye, Mull, and Arran, but otherwise it is only known from Inverness-shire.

One place in Mull where it used to occur abundantly is a peculiar loch, situated in the top of a hill, about 800 ft. behind Tobermory. The place looks like the crater of a volcano, but I believe is not so described by geologists. The species has apparently quite disappeared from this loch; it is probably slowly disappearing from our islands, being a remnant of the fauna which abounded when our climate was much colder than it is at present.

All my specimens came from the one lochan on Eigg, and they were placed in large tubs in my garden in the north of Ireland. The tubs are filled with water, but the bottom is covered by a thick layer of soil, and in the soil a few species of water plants thrive, chiefly the common water-grass, *Glyceria aquatica*. The tubs are covered with wire-gauze to prevent the beetles escaping.

Now the Dytiscus possesses a small apparatus capable of piercing the tissues of the water-plants, and each time this borer makes a hole in the water-plant one egg is deposited. In my tubs the *lapponicus* chose the water-grass as the receptacle for its eggs. In its native home this grass does not grow, the only water-plants being a common rush, a species of *juncus*, and the club rush *eleocharis*, both possessing round stems. Now, the grass possesses a round stem surrounded by leaves, each leaf consisting of a long sheathing base and a free lamina or blade. The sheath is keeled, and in every case the mother-beetle pierced the leaf-sheath, and always in the line of the keel, depositing the egg in the tissues of the sheath, and this shows the peculiar instinct possessed by the mother in the deposition of her eggs and the extreme sensitiveness of the borer or ovipositor. Although I examined very carefully the plants in the tubs, only twice did I find that the ovipositor had passed right through the sheath and dropped the egg between that and the stem.

Lapponicus, unlike our other species of Dytiscus has a very definite egg-laying period, commencing in March and ending in June. From two of the British species I have had eggs in October, December, and February, as well as in the summer months.

I collected a number of the eggs, dissecting them out of the leaf-sheaths, and placed them on wet cotton wool in tumblers and watched their development.

I do not intend to weary you with the details of the development of the embryo, but I wish to point out that the embryo first appears on a part of one side of the mass of yolk—it does not at first occupy the whole length of the egg—and it then extends first backwards and then forwards, and the sides grow up around the yolk until the embryo ultimately encloses it. The nerve-chord does not increase in length with the embryo, and consequently appears to shorten as the embryo extends in the egg.

The development of the embryo occupies about three weeks in June, but temperature affects the length of this embryonic period. In the case of another species, an egg laid in April matured in three weeks, while one laid in winter took six weeks to hatch.

Towards the end of the embryonic period the pressure of the embryo in the shell is very great. I accidentally punctured an egg with a needle when turning it over, and immediately a portion of the embryo bulged through, just as the inner tube of a pneumatic tyre tends to bulge through a tear in the outer cover. The pressure is also indicated by the changed shape of the egg during the final stages.

During the latter part of the egg-period, there are various slight movements of the embryo, but during the last few hours certain very definite movements

[1] Discourse delivered at the Royal Institution on Friday, May 9, by F. Balfour Browne.

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become noticeable. In the first place, inside the head a spasmodic pulsation is visible, at first at long intervals, but later more or less continuously. I have observed this pulsation in eggs of other water-beetles, and also in those of the dragon-fly, and although I am not sure that the interpretation is the same in dragon-fly and water-beetle, I am satisfied in the latter case the pulsation is really a swallowing process.

The larvæ of all the water-beetles I have examined possess a special sucking apparatus known as a "pharyngeal pump," the use of which I shall describe directly, and in the embryo this pump apparently comes into use to absorb the fluid which surrounds the embryo in the shell; the embryo merely drinks this up.

After this sucking-pump begins to work, various other movements of the internal organs can be observed, including peristalsis, and also at infrequent intervals the whole body moves slightly in the shell, the tendency being to push the head into the end. One other movement is to be noted, and that is an up-and-down motion of the head, at first very slight, but later becoming very marked.

On either side of the head is a small papilla, at the apex of which is a minute, slightly curved spine. When the embryo is at rest, this papilla lies in a slight depression, but when the sucking-pump is at work the papilla bulges outward, so that the spine touches the shell. Thus when the head moves up and down and the sucking-pump works at the same time, the two spines scrape along the inside of the shell and ultimately burst it open. They are, therefore, "hatching spines," and similar instruments differently situated have been observed in a few insect embryos of other orders.

You see, therefore, that the shell bursts open at the head end; immediately it bursts the compressed larva bulges out, and by slight writhing movements works its way clear of the shell, the whole operation taking less than two minutes. As soon as the larva is clear of the shell the tail straightens out, and the legs and mouth parts assume their natural position. In the embryo there is a peculiar fold in the upper part of each jaw, but within two or three minutes of the larva's escape this fold has completely disappeared.

From the moment the larva escapes it begins to grow in length and breadth. The long air-tubes in the body are flat, but have a bright silvery appearance, suggesting that some gas has been secreted in them; but the larva is heavier than the water, and therefore sinks to the bottom. For a time, half an hour or more, it rests quietly and shows no desire to get to the surface, but sooner or later it gets restless and swims to the surface, using its feathered legs as oars, and raises its tail to the surface film and remains suspended for a few minutes. After this the newly hatched larva is buoyant, and cannot remain away from the surface without holding on to the submerged vegetation. The buoyancy is, however, only temporary, as older larvæ frequently require to swim to the surface to renew their air-supply.

In the insect, breathing and blood-circulation are normally not intimately associated as in other animals. In a human being or a fish, or even in a snail, air is taken into special organs—lungs or gills—where the blood takes up the oxygen and carries it through the whole body. In the insect the blood has usually nothing to do with the aëration of the different organs, the whole body being permeated by innumerable air-tubes.

In all the water-beetle larvæ which come to the surface to obtain their air, these innumerable air-tubes communicate with two large air-tubes which run the length of the body, one on each side, and these open on the last segment. Hence, when a larva requires to renew its air-supply it comes up tail first, bringing the openings of the two lateral tracheæ into communication with the air, and by contracting and expanding the body it exhales the used-up air and inhales fresh air.

For a day or so after hatching the larva is soft and is not hungry, but once its skin and jaws have hardened it begins to look about for food. I found that tadpoles and pieces of chopped worm were suitable food, but under natural conditions small newts, water-shrimps, and insect larvæ—including brothers and sisters—constitute the normal diet. It is impossible to keep two larvæ together in one small vessel, as one invariably attacks and kills the other within a few hours. Even when I gave a tub to four pecimens only one survived after a few weeks, so that in a small loch, where at least some thousands of these larvæ hatch out, the death-rate must be enormous.

The method of feeding of the larva is peculiar. The two long sharply pointed jaws are each pierced with a fine tube, of which one end opens on the inner side just below the apex, and the other end opens on the upper side just near the base. When the jaws are closed the inner ends of these tubes communicate with the corners of the mouth, but when the jaws are open the inner ends of these tubes do not communicate with the mouth at all. The mouth itself is also peculiar. In a front view of the head it is visible as a long narrow slit between the bases of the jaws, but if this slit is examined it is found that across the lower side of it is a raised ridge which fits into a groove running across the upper side of it. When the jaws are wide apart the ridge and groove are separated, and the mouth is open, but as soon as the jaws come together the ridge fits into the groove, and the mouth is closed. As soon, therefore, as the larva seizes its prey its mouth is closed, and the only communication into it is through the tubes in the jaws, the basal ends of which now open into the corners of the mouth.

Immediately behind the mouth is the powerful sucking-pump, the pharynx, which I mentioned in connection with the embryo. By expansion and contraction of its muscles it sucks in the juices of the prey through the tubes in the jaws. But if this were the whole process of feeding there would be a considerable waste, as a worm or a tadpole consists of a large amount of solid material; and yet, if one watches one of these larvæ feeding, one will find that almost nothing is left of the prey except the skin. This is due to the fact that at short intervals the sucking-pump stops working and saliva is poured into the prey. This saliva digests and dissolves away the solid parts of the food, which are then sucked in by the larva. The process of digestion, which in most animals takes place internally, is carried on in these larvæ outside the body.

With regard to the *duration of the larval period*, in my examples this varied from six to nine weeks. This period is divided into three stages, there being two moults prior to the final one which produces the pupa. Each of the first two stages only lasts about ten days, so that the last stage is a very long one, as it is in all other insects.

This last stage is also divisible into two parts, the first occupying four or five weeks, during which the larva feeds and grows as in the previous stages, the second occupying two to four weeks, being spent out of the water making a cell in the earth, and resting preparatory to becoming a pupa.

In the few cases which I had the opportunity of observing, the full-grown larva always left the water in the morning between eight and ten o'clock; but whether this is the rule with this species, or whether

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it was connected with the artificial conditions in which my larvæ were reared, I do not know.

Once the larva leaves the water it crawls about very actively, seeking a suitable place to enter the earth. If left to itself it usually selected a stone and burrowed underneath it, but I found that if I made an artificial burrow—with a pencil, for instance—the larva could be made to crawl into this, and as a rule would make its "cell" in it. By making such a burrow against the glass side of a box filled with earth, I was able to watch the process of the formation of the pupal cell.

Once the larva has entered and adopted the burrow, it straightway begins to prepare its cell, and this is done by enlarging part of the burrow. The jaws are now used for transporting pellets of soil from one position to another, and for breaking up the pellets into their separate particles. Very little earth is actually pushed into the unused part of the burrow, the cell being formed almost entirely by breaking up the pellets of soil and battering the fine particles against the sides. The vertex of the head is the main battering-ram, but the larva, which during the whole process of making the cell lies with its tail bent over its head, also flattens out the earth with its body.

The actual making of the cell occupies about twelve hours, and during that time the larva does not rest for a moment. At the end of that time it is apparently tired out, and rests in any position, often stretched across the cell, its head pressed against one side and its curved body against the other. It thus rests for about twenty-four hours, after which it bends its tail underneath it and usually adopts a sitting-up position—reminding one of Tenniel's illustration in "Alice in Wonderland" of the caterpillar sitting on the mushroom. It is, however, very restless, and frequently changes its position, tossing from side to side.

The pupa appears, after the larva has been thus resting for a fortnight or more, by the larval skin splitting along the back and being cast off at the tail end. On its back are to be seen a number of short projecting spines, and Lyonnet suggested in the case of another pupa, similarly though better equipped, that these are for the purpose of raising it off the damp soil of the cell. This may be true, but in my experience the pupa most usually lies, so to speak, on its face rather than on its back.

The pupal stage lasts about three weeks, and the only change noticeable during that time is a slight pigmentation of what is at first a perfectly white pupa. At the end of the pupal stage the skin ruptures along the back, and the perfect insect comes forth at first white and soft, but in the course of two or three days it assumes its normal coloration, and after a longer period its normal hardness. After a week or so it makes its way out of the pupal cell by biting and scraping, and at once goes to the water.

In its native haunts it spends most of its time amongst the stones and mud at the bottom, occasionally coming up to renew its air-supply, and in my tubs also it was seldom to be seen.

With regard to its winter habits, it apparently buries itself at the bottom of the loch as soon as the cold weather begins, and sleeps until the following spring. In my tubs it disappeared completely in October or November, burrowing deep into the soft oozy mud at the bottom, and there it remained until the following March. During all this time the metabolic processes must be practically at a standstill, as otherwise the insect would require to renew its air-supply at frequent intervals.

Having now outlined the life-history of this type of the swimming carnivorous water-beetles, I will take an example of the other group, and the one I have chosen goes by the name of *Hydrocharis caraböides.* There is only one species of Hydrocharis in the British Islands, and it is practically confined to the south-east of England, only very occasionally having been found anywhere else in the country. It inhabits stagnant ponds and drains, and is not uncommon in a few places in Surrey, Essex, and Middlesex.

I began to experiment with it five years ago in the north-east of Ireland, having obtained my specimens from Surrey. Each year I obtained eggs, reared the larvæ, and renewed and increased my stock, so that it is obviously not the climate of north-eastern Ireland which prevents this species from being a native there.

The conditions in my tubs were just such as are to be found in any pond or drain in the country, and apparently the only reason why this species is confined to the south-east of England is that competing species prevent it from extending its range.

Whereas Dytiscus lays its eggs singly in holes pierced by it in the living vegetation, Hydrocharis builds an elaborate silken cocoon which floats in the water, and in which about fifty eggs are deposited.

The spinning of the cocoon is a wonderful process. The beetle carries on its underside a film of air, which is part of its supply for breathing. The cocoon is actually spun on a part of this film of air, which is then detached from the rest of the film as a bubble enclosed in silk. The egg-laying commences soon after the cocoon is begun, and the eggs are arranged side by side in the cocoon standing upon one end, being fastened in position by silken threads. A space above the eggs is filled with very loosely woven silk.

In closing up the cocoon a peculiar plate-like structure is formed of very closely woven silk, and this ends in an upward projection known as the "mast." The purpose of this "mast" is not known. It is not a tubular structure, but merely a band of silk. It has been stated that if it is cut off the eggs die, but in the case of another species I have hatched eggs removed from the cocoon and submerged, so that the suggestion that the mast is necessary for keeping up the air-supply is without foundation.

I shall not weary you with details of the development of the embryo beyond mentioning that, unlike Dytiscus, the embryo from the first occupies the whole length of the egg, and that the nerve chord, again unlike Dytiscus, grows with the embryo as it develops. The only other point I need mention is that in the cocoon all the embryos develop head downwards.

The egg-laying period of Hydrocharis extends from about the middle of May until about the middle of July in my tubs, but it may perhaps be rather longer in the south-eastern parts of England. The incubation of the egg occupies nine or ten days, and, as in the case of Dytiscus, towards the end the embryo is very tightly packed within the shell. There is, however, no special hatching apparatus that I have been able to find. The pulsating organ or sucking-pump in the head is visible, and there are also movements of the embryo, but at the end the skin splits along the back and the larva treads it off, giving a peculiar backward wriggle.

Now, under normal conditions the newly hatched larva does not at once leave the cocoon; in fact, it does not appear for one or even two days after hatching. As soon as it bursts the egg-shell it wriggles backwards out of the egg into the space above all the eggs, and it is interesting to note that the hairs on the body of the newly hatched larva all point forwards. As the larvæ hatch, the empty shell and the silk bindings become broken down—I think they are chewed by the larvæ—and the whole cocoon ultimately becomes filled with the larvæ.

In those cases where I dissected the eggs out of

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the cocoon and allowed them to develop on the wet cotton wool, the newly hatched larvæ congregated into a mass and remained so for a day or two, after which they became active in search of food.

You will notice that the larva possesses on each body segment a pair of lateral processes, and on the last segment a pair of ventrally placed processes of a different kind. These latter, which are possessed by all water-beetle larvæ which come to the surface for their air, have probably some connection with raising the tail to the surface for breathing, but the hairy lateral processes have been called gills. Many larvæ of the Palpicornia have lateral processes, usually smaller than those of Hydrocharis, but in no case are they really gills, and the larvæ quickly drown if prevented from bringing their tails to the surface to renew their air-supply.

The larvæ of Hydrocharis, like those of Dytiscus, will eat almost any kind of animal matter, and hence they are easily supplied. I fed them mostly upon chopped worms, but their method of feeding is very different from that of Dytiscus. They seize their food with the jaws, antennæ, and the other mouth parts, and they then come to the surface, and raising their heads and part of the body out of the water, they proceed to chew up the food by opening and closing the jaws, turning it from time to time with the other mouth parts. The jaws are not perforated, nor is there any mouth-lock as in Dytiscus, and they suck in the juices of the prey by the mouth, spitting up saliva at intervals, which actually froths over the food and digests it, the dissolved material then being sucked down. The external digestion is so complete that in the case of a thick piece of worm all that is ultimately rejected is the thin transparent outer pellicle.

In the mouth parts of the larva I want to direct your attention to a curious want of bilateral symmetry, noticeable not only in the jaws—one of which, the left, has a small extra tooth near its base—but also in the upper lip. In many species there is an absence of bilateral symmetry where a pair of organs are complementary. Thus in the jaws of the beetle itself, the base of the left one is hollowed out to receive the base of the right one, which is convex, the two being related as pestle and mortar for grinding up the food. The larva of another species of the same group also shows asymmetry of the jaws, but here again it is definitely associated with the method of feeding. This species feeds upon pond snails, and the left jaw holds the shell while the right jaw with its large double tooth cuts through it.

The asymmetry of the upper lip, however, is at present inexplicable, and, curiously enough, it occurs in several other species.

The larva of Hydrocharis, like that of Dytiscus, passes through three stages, the first two of which occupy from five to eight days, and the third stage, up to the time the larva is full grown, occupies about four weeks. It then leaves the water and burrows into the earth, forming a cell, just as the Dytiscus larva did. I had many specimens of these larvæ, and so made many experiments with them, and one curious fact about them is that the instinct which leads them to burrow into the ground and make a pupal cell only lasts for one or, at most, two days. In no case, where I removed a larva even immediately after the completion of its cell, did it make any attempt to form another one, and if left on the surface of the soil it moved about listlessly and ultimately died, apparently of drought, since if placed in a damp position, for instance, in an artificial cell, it survived and pupated. If a cell was damaged before completion the larva often completely destroyed it, apparently in the attempt to repair the damage, and would be found sitting amongst the ruins.

Once the cell is completed the larva rests for about three weeks, at the end of which time the skin is cast off and a greenish-white pupa appears. This is more spinose than that of Dytiscus; but it also prefers to lie upon its face, resting upon the two small tail projections and upon the "collar" of the prothorax.

The perfect insect appears after about ten days, so that the whole life-cycle occupies about nine or ten weeks from the laying of the egg to the appearance of the perfect insect. This time, however, may be greatly prolonged under less favourable conditions. Thus, the later egg-cocoons produce larvæ which take twelve or fourteen weeks to grow up, and the cocoons built in July produce beetles which do not leave the pupal cell for six or seven months. The larvæ leave the water in September and even in October, and after three or four weeks turn into pupæ. These pupæ turn into beetles in late October or November, but the beetles remain, apparently torpid, until the following March or April, when they make their way out and to the water.

I have mentioned that the larvæ of both Dytiscus and Hydrocharis breathe in the same manner by raising the tail to the surface. The perfect insects, however, assume very different positions when taking in their air-supply.

Dytiscus floats up to the surface tail first, taking in air between the body and the great wing-cases which cover it, and it is in this cavity under the wing-cases that the whole reserve of air is carried.

On either side of the body under the wing-cases is a row of pits, spiracles; the last pair of these are much larger than the others. When the insect rises tail first to the surface, the tubes connected with this last pair contract and expand, just as in the larva, renewing the air-supply in the whole tube system, while at the same time the body contracts and expands, renewing the reserve supply under the wing-cases.

Hydrocharis, on the other hand, comes to the surface head first, turns its head on one side, and pushes its short, club-like antenna through the surface-film. Now a large part of the under side of this beetle is covered with fine velvety hair, which retains a thin film of air upon it, just as a piece of velvet does when gently pushed under water. When the beetle raises its antenna above the water it brings this film of air into communication with the air above the water. It also has a reserve supply under its wing-cases, and this communicates at the sides with the ventral film, and by expansion and contraction of the body the used-up air is expelled above the water and fresh air is taken in. In Hydrocharis the most important spiracles are situated well forward, and thus the used air from the air-tubes is expelled and fresh air taken in at the front end of the body instead of the tail end.

Anyone who examines Hydrocharis and compares it with Dytiscus will at once see great structural differences. In a ventral view of the two types, comparing the heads, the most noticeable difference is in the antennæ, which are filamentous in the former and clubbed in the latter, and the maxillary palpi, which are short in the former and long in the latter, in which they are used under water as feelers, just as are the antennæ of Dytiscus.

Passing over other less remarkable differences in the heads of the two types and coming to the body, one at once notices the different disposition of the legs: in Dytiscus the first two pairs are close together, in Hydrocharis the three pairs are about equidistant. In Dytiscus the basal segment of each hind leg—the

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coxa marked 3*—on the screen is large, and the two coxæ are fused into a single piece which is firmly fixed into the body. In Hydrocharis the coxa is long and narrow; the two coxæ are separate, and each is hinged on to the body. The firm fixing in Dytiscus gives it a much more powerful leg-drive than the hinging gives to Hydrocharis, and hence Dytiscus is a more efficient swimmer.

These differences between the two types are therefore connected with differences in function. The antennæ of Dytiscus are feelers, while those of Hydrocharis are connected with breathing, and the disposition of the legs and their methods of attachment to the body are connected with differences in mode of progression, Dytiscus being a "swimmer," and Hydrocharis chiefly a "creeper" on the submerged vegetation.

In these two groups of water-beetles, the Hydradephaga represented by Dytiscus and the Palpicornia represented by Hydrocharis, we have two types of adaptation to an aquatic existence. Each type has originated independently of the other—that is, they are not descended from a common aquatic ancestor. Each represents a part of a large terrestrial family, and each has probably developed an aquatic habit as a result of competition, stronger land forms having driven the weaker off the land and into the water.

Just as each group has originated under the stimulus of competition, so, within each group, competition has moulded the different forms, and the peculiar details in the life-history of any one form are just those which enable it to retain its place in the community to which it belongs, and to hold its own in the great struggle for existence.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE announcement is made of the resignation of Dr. A. L. Bowley of the professorship of mathematics and economics at University College, Reading.

PROF. J. S. KINGSLEY, of Tufts College, has been appointed professor of zoology, in charge of vertebrates, in the University of Illinois.

DR. K. F. MEYER, director of the laboratories of the Pennsylvania State Livestock Sanitary Board, has vacated that position to fill the chair of bacteriology at the University of California. Dr. J. B. Hardenbergh has been appointed to succeed Dr. Meyer in the first-named post.

PROF. HERBERT V. NEAL, who has held the chair of biology at Knox College, Illinois, since 1897, has accepted an appointment to a similar post at Tufts College, Massachusetts. He has already had some acquaintance with the work of that college, having been for the last five years an associate director of the Tufts biological laboratory at S. Harpswell, Maine.

IT is announced in *The Indian Medical Gazette* that the scheme for the establishment of a School of Tropical Medicine in Calcutta is now so far advanced towards fulfilment that there is every reason to hope that it will be opened in the autumn of next year. Already valuable work on cholera, epidemic dropsy, dysentery, and other diseases has been done by a few workers in Calcutta. What is now wanted is money. Our Indian contemporary asks for substantial endowments of three or four lakhs for several additional research chairs, or annual subscriptions of 20,000 rupees for each.

AN effort is about to be made to raise a fund of 20,000*l.* for the foundation of a chair of engineering chemistry at Princeton University. This campaign will be undertaken mainly by members of the federation of Princeton clubs of New Jersey, with the object of the advancement of chemical industries in that State. The course of instruction to be given by the occupant of the proposed chair will supply engineering students with a knowledge of the commonest construction materials of the chemical industries, and of various materials that now take the place of the direct products of the soil.

A COURSE of lectures on tuberculosis, for general practitioners and especially for candidates as tuberculosis officers, has been arranged by the Royal Institute of Public Health. The introductory lecture will be delivered by Prof. G. Sims Woodhead on October 10. Subsequent discourses will be given by Dr. C. Porter ("The problem of Tuberculosis in relation to Insurance and Public Health"), by Prof. Woodhead ("The Spread of Tuberculosis"), by Dr. J. E. Squire ("Diagnosis"), by Dr. T. N. Kelynack ("Tuberculosis in Childhood"), by Dr. C. Wall ("General Treatment"), by Dr. C. Riviere ("Specific Treatment," &c.), by Dr. T. D. Lister ("Sanatorium Treatment"), by Dr. A. Greenwood ("The Prevention of Tuberculosis"), and Dr. H. O. West will outline a co-ordinated scheme for dealing with the malady.

THE medical schools of London and the provinces are beginning to announce the opening functions of their winter session. Prof. Sir William Osler, Bart., F.R.S., is to distribute the prizes and deliver an address at St. George's Hospital on October 1; at St. Mary's Hospital, Paddington, the prizes will be presented and an address given by Sir John Prescott Hewett, K.C.S.I., on the same date; Mr. W. Sampson Handley will deliver an address and Sir Squire Bancroft distribute the prizes at the Middlesex Hospital on October 1, on which date also Sir Charles Pardey Lukis, K.C.S.I., will give an address at the London School of Medicine for Women. On October 7 a lecture will be delivered at the University of Birmingham by Prof. Arthur Keith, F.R.S., on "The Present Problems relating to the Antiquity of Man."

MUCH interesting information as to the progress of secondary education in England is contained in the recently published Blue-book (Cd. 6934), "Statistics of Public Education in England and Wales, Part i. Educational Statistics, 1911–12." During the school year dealt with, there were in England 885 efficient secondary schools receiving grants from the Board of Education; of these 358 were for boys, 311 for girls, and 216 admitted both boys and girls. The teaching in these schools was in the hands of 9126 full-time teachers, of whom 4584 were men and 4542 women; and they were assisted by 3082 part-time instructors. The schools were attended by 150,605 pupils—81,383 boys and 69,222 girls. Of the total number of pupils 39,427 were under twelve years of age, 98,623 were between twelve and sixteen years of age, 11,559 between sixteen and eighteen years of age, and 996 more than eighteen years of age. As regards the management of the schools, it may be pointed out that 328 were provided by local education authorities, 427 were foundation and other schools, 48 were Roman Catholic schools, and 28 Girls' Public Day School Trust schools.

THE prospectus for the session 1913–14 of the Day and Evening College for Men and Women at the South-Western Polytechnic Institute, Chelsea, has been received. The day college is intended for students above the age of sixteen, and the courses of study are suited for technological and university purposes. The prospectus, we observe, points out that those who enter for technical instruction should have received previously a sound English education and should have acquired an elementary knowledge of mathematics and, if possible, of physics and chemistry. The courses are arranged to occupy three years.

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