spectively were 300,000*l.* and 250,000*l.* The largest item of expenditure was to Fellows of Colleges—Oxford, 102,000*l.*; Cambridge, 103,000*l.* The smallest item was for scientific institutions, being under 2,000*l.* for each University. Mr. Parker remarked that this was hardly what might have been expected by the general public. A satirical person might even suggest as an improvement the reversal of the order. Seriously, the distribution came to this. Taking the residents in the University at about 400 graduates and 1,400 undergraduates, almost all the former and about half the latter received substantial aid from endowments. Mr. Parker examined various schemes which had been put forward, and expressed an opinion that, provided the central life were maintained with vigour, it was much to be desired that the Universities should occupy themselves with extending their connections throughout the country. Looking to their examinations in every quarter, 44,000*l.* at Oxford or 33,000*l.* at Cambridge was by no means excessive for Scholarships and Exhibitions. Some Exhibitions should be separately competed for by the unattached students who were now pursuing their studies at the Universities with so much success and at so little expense—in many cases under 50*l.* a year. To carry out needed reforms some central guidance would be necessary, either from a body appointed by the Universities themselves or, more probably, from a Parliamentary Executive Commission. But if such a Commission should be appointed, it was desirable the public should understand that it had not to deal with a retrograde, obstinate, or lethargic corporation, but to cooperate with the Universities and Colleges. Oxford and Cambridge, in respect of learning, had not held their own against the great German Universities, but a change had begun, and in Mr. Parker's opinion they were yearly commanding more respect throughout Europe.

In the discussion which followed, the Hon. G. Brodrick deprecated an attempt to subsidise, at the expense of Oxford and Cambridge, wealthy towns which, had they existed in America, would long ago have provided Universities of their own. On no account should resources which ought to be concentrated upon Oxford be frittered away upon the great cities of England and Scotland.

Sir G. Campbell said that in his belief it was these endowments which seemed to render reform impossible. They acted as an immense bribe to a continuance of the old monkish form of education, which he believed to be a mere superstition. He believed that the devotion of the time and talent of our youth to the learning of the regular verbs of Greek and Latin, and even the higher mathematics, was a gymnastic, and not a practical education. If endowments were to be continued, they must be taken in hand and, apart from the wills of founders, devoted to those branches of education which experience showed to be really useful and practical.

An important paper On the place of technical education was presented to the Section by Mr. B. Samuelson, M.P. This we shall give on a future occasion.

PITCHER-PLANT INSECTS *

THE insect-catching powers of these curious plants, the Fly-traps (Dionæa), the Sundews (Drosera), and the Trumpet-leaves (Sarracenia), have always attracted the attention of the curious, but renewed interest has been awakened in them by virtue of the interesting experiments and observations on their structure, habit, and function, that have lately been recorded, and especially by the summing up of these observations in some charming papers by Prof. Asa Gray, which recently appeared in the *Nation* and the *New York Tribune* under the title of "Insectivorous Plants."

Through the courtesy of Dr. J. H. Mellichamp, of Bluffton, and of H. W. Ravenel, of Aiken, S.C., who have sent me abundant material, I am able to submit the following notes of an entomological bearing on the Spotted Trumpet-leaf (*Sarracenia variolaris*), which must henceforth rank with the plants of the other genera mentioned as a consummate insect catcher and devourer.

The leaf of Sarracenia is, briefly, a trumpet-shaped tube with an arched lid, covering, more or less completely, the mouth. The inner surface, from the mouth to about midway down the funnel, is covered with a compact decurved pubescence which is perfectly smooth and velvety to the touch, especially as the finger passes downward. From midway it is beset with retrorse bristles, which gradually increase in size till within a short distance of the bottom, where they suddenly cease, and the surface is smooth. There are also similar bristles under the lid. Running up the front of the trumpet is a broad wing with a hardened emarginate border, parting at the top and extending around the rim of the pitcher. Along this border, as Dr. Mellichamp discovered, but especially for a short distance inside the mouth, and less conspicuously inside the lid, there exude drops of a sweetened, viscid fluid, which, as the leaf matures, is replaced by a white, papery, tasteless, or but slightly sweetened sediment or efflorescence; while at the smooth bottom of the pitcher is secreted a limpid fluid possessing toxic or inebriating qualities.

The insects which meet their death in this fluid are numerous and of all orders. Ants are the principal victims, and the acidulous properties which their decomposing bodies give to the liquid doubtless render it all the more potent as a solvent. Scarcely any other Hymenoptera are found in the rotting mass, and it is an interesting fact that Dr. Mellichamp never found the little nectar-loving bee or other Mellifera about the plants. On one occasion only have I found in the pitcher the recognisable remains of a Bombus, and on one occasion only has he found the honey-bee captured. Species belonging to all the other orders are captured, and among the other species that I have most commonly met with, which, from the toughness of their chitinous integument, resist disorganisation and remain recognisable, may be mentioned *Asaphes memnonius* and *Euryomia melancholica* among Coleoptera, *Rentatoma higens* and *Orsilochus variabilis*, var. *complicatus*, among Heteroptera; while kyatids, locusts, crickets, cockroaches, flies, moths, and even butterflies, and some Arachnida and Myriapoda, in a more or less irrecognisable condition, frequently help to swell the unsavoury mass.

But while these insects are decoyed and macerated in order, as we may naturally infer, to help to support the destroyer, there are, nevertheless, two species which are proof against its siren influences, and which, in turn, oblige it either directly or indirectly to support them.

The first is *Xanthoptera semicrocea* Guen., a little glossy moth, which may properly be called the Sarracenia Moth. It is strikingly marked with grey-black and straw-yellow, the colours being sharply separated across the shoulders and the middle of the front wings. This little moth walks with perfect impunity over the inner surface of the pitcher, which proves so treacherous to so many other insects. It is frequently found in pairs within the pitchers soon after these open, in the early part of the season or about the end of April. The female lays her eggs singly, near the mouth of the pitcher, and the young larva, from the moment of hatching, spins for itself a carpet of silk and very soon closes up the mouth by drawing the rims together and covering them with a delicate, gossamer-like web, which effectually debars all small outside intruders. It then frets the leaf within, commencing under the hood and feeding downward on the cellular tissue, leaving only the epidermis. As it proceeds the lower part of the pitcher above the putrescent insect collection becomes packed with ochreous excrementitious droppings, and by the time the worm has attained its full size the pitcher above these droppings generally collapses. This worm when full grown is beautifully banded transversely with white and purple or lake red, which Dr. Mellichamp poetically likens in brightness to the Tyrian dye. It is furthermore characterised by rows of tubercles, which are especially prominent on the four larger legless joints. It is a half looper, having but six prolegs, and keeps up, in travelling, a constant restless, waving motion of the head and thoracic joints, recalling *paralysis agitans*. The chrysalis is formed in a very slight cocoon, usually just above or within the packed excrement. The species, kindly determined by Mr. A. R. Grote, was many years ago figured by Abbott, who found it feeding on *Sarracenia variolaris*, in Georgia. Guenée's descriptions were made from these figures, for which reason I append [the more technical matter relating to the species is here omitted] a few descriptive notes from the living material. It feeds alike on *S. variolaris* and *S. flava*, and there are two broods each year,

* A paper read by Prof. C. V. Riley, of St. Louis, Mo., before the American Association for the Advancement of Science, August 1874.

the first brood of larvæ found during the early part of May, the second toward the end of June, and disappearing with the dying of the leaves, the latter part of July.

The second species is a still more invariable living accompaniment of both kinds of Sarracenia mentioned. By the time the whitish efflorescence shows around the mouth of the pitcher, the moist and macerated insect-remains at the bottom will be found to almost invariably contain a single whitish, legless, grub or "gentile," about as large round as a goose-quill, tapering to the retractile head, which is furnished with two curved, black, sharp hooks, truncated and concave at the posterior end of the body.

This worm riots in the putrid insect remains, and when fed upon them to repletion bores through the leaf just above the

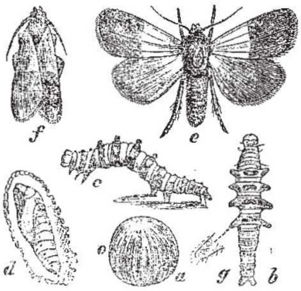

FIG. 1.—*Xanthoptera Semicrocea.* *a*, egg, enlarged, the natural size indicated at side; *b*, *c*, larva, back and side views; *d*, chrysalis: *e*, moth, normal form, with wings expanded; *f*, pale variety with wings closed.

petiole and burrows into the ground. Here it contracts to the pupa state, and in a few days issues as a large two-winged fly, which I have described in the Transactions of the St. Louis Academy of Science as *Sarcophaga sarraceniæ*—the Sarracenia Flesh-fly.

The immense prolificacy of the Flesh-flies, and the fact that the young are hatched in the ovaries of the parent before they are deposited by her on tainted meat and other decomposing or strong-smelling substances, have long been known to entomologists, as has also the rapid development of the species. The viviparous habit among the Muscidæ is far more common than is generally supposed, and I have even known it to occur with the common house-fly, which normally lays eggs. It is also possessed by some Œstridæ, as I have shown in treating of *Œstrus ovis*, the Sheep Bot-fly.

But the propensity of the larvæ for killing one another and their ability to adapt themselves to different conditions of food supply are not sufficiently appreciated. I have long since known, from extensive rearing of parasitic Tachinidæ, that when, as is often the case, a half-dozen or more eggs are fastened to some

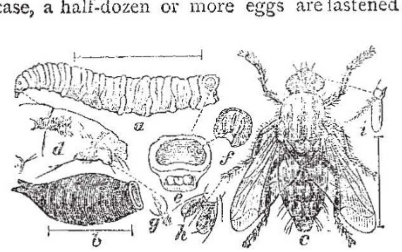

FIG. 2.—*Sarcophaga Sarraceniæ.* *a*, larva; *b*. pupa; *c*, fly, the hair lines showing average natural lengths; *d*, enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracle; *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*, tarsal claws of fly with protecting pads; *i*, antenna of same. All enlarged.

caterpillar victim only large enough to nourish one to maturity, they all hatch and commence upon their common prey, but that the weaker eventually succumb to the strongest and oldest one, which finds the juices of his less fortunate brethren as much to his taste as those of the victimised caterpillar. Or, again, that where the food-supply is limited in quantity, as it often is and must be with insects whose larvæ are parasitic or sarcophagous, such larvæ have a far greater power of adapting themselves to the conditions in which they find themselves placed, than have herbivorous species under like circumstances.

Both these characteristics are strongly illustrated in *Sarcophaga sarraceniæ*. Several larvæ, and often upwards of a dozen, are generally dropped by the parent fly within the pitcher; yet a fratricidal warfare is waged until usually but one matures, even where there appears macerated food enough for several. And if the Xanthoptera larva closes up the mouth of the pitcher ere a sufficient supply of insects have been captured to properly nourish it, this Sarcophaga larva will nevertheless undergo its transformations, though it sometimes has not strength enough to bore its way out, and the diminutive fly escapes from the puparium, only to fiud itself a prisoner unless deliverance comes in the rupture or perforation of the pitcher by the moth larva or by other means. This rupturing of the pitcher does not unfrequently take place, for Dr. Mellichamp writes under date of June 27 as follows:—"Most old leaves now examined—I might almost say all—instead of being bored, seem ripped or torn, as if by violence, apparently from without. You see occasionally shreds of the leaves hanging. Surely the legless arva of Sarcophaga cannot do this! What then—toads, or frogs, or crawfish abounding in these moist, pine lands? or rather is not the fat maggot the occasion of the visits of the quail which lately I have observed here?"

[Here follow some technical facts and descriptions of interest only to specialists.]

These two insects are the only species of any size that can invade the death-dealing trap with impunity while the leaf is in full vigour, and the only other species which seem at home in the leaf are a minute pale mite belonging apparently to *Holothyrus*, in the Gamasidæ, and which may quite commonly be found crawling within the pitcher; and a small Lepidopterous leaf-miner, which I have not succeeded in rearing. There must, however, be a fifth species, which effectually braves the dangers of the bottom of the pit, for the pupa of Sarcophaga is sometimes crowded with a little chalcid parasite, the parent of which must have sought her victim while it was rioting there, as larva.

But all other insects, so far as we know, tumble into the tubn and there meet their death. The moth is doubtless assisted in walking within the tube by the spurs on the legs which it, iy common with most other moths, possesses; while the Flesh-fle manages to hold its own by its widely extended legs and stout bristles. Dr. Mellichamp says that when disturbed it buzzes violently about, just as if an animated sheep-bur had fallen into the tube—not apt to go down, because it will hitch and stick, and finally, by main force, it generally emerges, but once in a while also succumbs.

Two questions very naturally present themselves here:—(1) What gives the Flesh-fly more secure foothold on the slippery pubescence than the common house-fly exhibits? (2) What enables the larva of the Flesh-fly to withstand the solvent property of the fluid which destroys so many other insects? I can only offer, in answer, the following sugg stions: the last joint of the tarsus of the common house-fly has two movable, sharp-pointed claws and a pair of pads or "pulvilli." These pads were formerly supposed to operate as suckers, and all sorts of sensational accounts of this wonderful sucker have been given by popular writers, who forgot that there are any number of minute insects having no such tarsal apparatus, which are equally indifferent to the laws of gravitation so far as walking on smooth, upright surfaces, or on the ceiling, is concerned. In reality, these pads are thickly beset on the lower surface with short hairs, most of which terminate in a minute expansion kept continually moist by an exuding fluid—a sort of perspiration. Take the human hand, moistened by perspiration or other means, and draw it, with slight pressure, first over a piece of glass or other highly polished surface, and then over something that has a rougher surface, such as a planed board, a papered wall, or a velvety fabric, and you will experience much greater adhesion to the smoother objects, and may understand the important part which these moist pads play in the locomotion of the fly; they also act, in part, like the cushions of a cat's paw in protecting and preventing abrasion of the claws, which are very useful on the rougher surfaces, where the pads are less serviceable.

Now, compared with *Musca domestica*, the claws of *Sarcophaga sarraceniæ* are much the longest and strongest, and the pads much the largest, presenting three or four times the surface. These differences are, I think, sufficient to explain the fact that while the common fly walks with slippery and unsteady gait on the smooth pubescence (the retrorse nature of this pubescence sufficiently explaining the downward tendency of the movements), its sarcophagus congener manages to get a more secure footing;

for not only does the latter present a larger adhesive surface, but the longer claws are more likely to reach beyond the pubescence and the bristles, and fasten to the cellular tissue of the leaf beyond.

In answer to the second question, I can only say that there is nothing exceptional in the power of the larva to withstand the solvent quality of the fluid ; it is, on the contrary, in accordance with the facts known of many species of Muscidæ and Estridæ, some of which, like the well-known horse-bot, revel in a bath of chyme, while others are at ease in the intestinal heat of other warm-blooded animals. It is also well known that they will often live for hours in strong liquids, such as alcohol and turpentine.

Conclusion.—To one accustomed to seek the why and wherefore of things, the inquiry very naturally arises as to whether Xanthoptera and Sarcophaga play any necessary or important rôle in the economy of Sarracenia. Speaking of the Sarcophaga larvæ, Mr. Ravenel asks, "May he not do some service to Sarracenia as Pronuba does to Yucca?" And if so, may not all this structure for the destruction of insects be primarily for his benefit? Can he be merely an intruder, sharing the store of provision which the plant, by ingenious contrivance, has secured for itself, or is he a welcome inmate and profitable tenant? Self-fertilisation does not take place in Sarracenia, and the possibility that the bristly Flesh-fly aids in the important act of pollination lends interest to the facts. No one has witnessed with greater pleasure than myself the impulse which Darwin has of late years given to such inquiries ; but we should be cautious lest the speculative spirit impair our judgments or our ability to read the simple lesson of the facts. My own conclusions summed up are :—

1. There is no reason to doubt, but every reason to believe, since the observations of Dr. Mellichamp, that Sarracenia is a truly insectivorous plant, and that by its secretions and structure it is eminently fitted to capture its prey.

2. That those insects most easily digested (if I may use the term) and most useful to the plant are principally ants and small flies, which are lured to their graves by the honeyed path, and that most of the larger insects, which are not attracted by sweets, get in by accident and fall victims to the peculiar mechanical structure of the pitcher.

3. That the only benefit to the plant is from the liquid manure resulting from the putrescent captured insects.

[Mr. Ravenel, in making a transverse section near the base of the young leaf, noticed large tubular cells passing down through the petiole into the root, and much of the liquid manure may possibly pass through these into the root stalk.]

4. That Sarcophaga is a mere intruder, the larva sponging on and sharing the food obtained by the plant, and the fly attracted thither by the strong odour, as it is to all putrescent animal matter or to other plants, like *Stapelia variegata*, which give forth a similar odour. There is nothing to prove that it has anything to do with pollination, and the only insect that Dr. Mellichamp has observed about the flowers with any frequency, is a Cetoniid beetle, the *Euryomia melancholica*.

5. That Xanthoptera has no other connection with the plant than that of a destroyer, though its greatest injury is done after the leaf has performed its most important functions. Almost every plant has its peculiar insect enemy, and Sarracenia, with all its dangers to insect-life generally, is no exception to the rule.

6. That neither the moth nor the fly have any structure peculiar to them, that enables them to brave the dangers of the plant, beyond what many other allied species possess.

ON EVOLUTION AND ZOOLOGICAL FORMULATION *

IN the means which he has at his disposal for expressing the relative values of the facts of his science the chemist has an advantage over the zoologist which cannot be over-estimated. By a chemical rational formula it is possible to express, in a very small compass, facts of composition and decomposition, as well as many of the other relations borne by the constituents of a compound body one to the other.

* The substance of a lecture, introductory to the evening class of Zoology, at King's College, Strand. By Prof. A. H. Garrod, Fellow of St. John's College, Cambridge.

In zoology formulation has received but little application ; it has been employed to represent dental series and one or two other numerical points only ; the cumbrous method of detailed verbal description being still resorted to in all cases, even when continuous observation has so accumulated facts, that it is almost impossible to retain the grasp of them without some auxiliary appliances. A method of zoological formulation, which, whilst expressing the facts of anatomical structure, attracts the attention to the relative importance of the observed differences, rather than to the details of the differences themselves, is a great desideratum ; and it will be my endeavour on the present occasion to show how such a method can be made to assist in solving a problem so involved as the true affinities of a group of animals whose variable characters are fairly understood.

But the chemist has the atomic theory as a basis whereon to build ; is there any principle in biology so inclusive as to yield a foundation on which to construct the desired system? Until the introduction of the theory of evolution and the doctrine of natural selection there was not. As long as the negative hypothesis of "special creation" held sway, the interest attached to the study of the mutual relations of organised beings was *nil*. No such relation could, in fact, have existed. But now, through the insight into nature arrived at by the all-embracing theories of Lamarck and Darwin—the Daltons of biology—the pedigree of the animal and vegetable kingdoms will form a problem which it will require many generations of the ablest zoologists to solve, even approximately, by the careful correlation of the undigested, unrecorded, and unobserved facts at their disposal.

Let us stop for a moment to glance at this doctrine of descent, in which, through the struggle for existence, by a process of natural selection, the fittest (for want of a better term) are said to survive. We may compare the living body of one of the higher animals to a cannon counterpoised on a Palliser gun-carriage, so fixed that it will hit a target situated at 1,000 yards distance. Before firing let marks be so made that the different parts of the whole engine can be afterwards adjusted to their former position. The gun is fired ; the target is struck ; a well-defined perforation or indentation is the result. A second similar shot is arranged for, by re-adjusting the engine with the assistance of the marks previously made ; but on this occasion no direct aim is taken. The gun is again fired ; but this time the target is missed, or it is hit in a different part. Why is this? It is because, in the former of the two firings, by the strain it caused to the whole machine, by the wear it produced in the rifling of the gun, and by the slight differences in the quality and quantity of the powder, the shot left the muzzle under different circumstances on the two occasions. The amount of this difference was sufficient, at the long range selected for illustration, to make the alteration in the course taken by the projectile perceptible. An external influence, the wind, is almost certain to have affected the result. This example shows how that minute differences, firstly in internal, and secondly in external circumstances, are sure to prevent the exact accordance of consecutive phenomena which might reasonably have been expected to be fac-similes one of the other.

As a general inference from every-day observation we are similarly led to expect that the offspring of living organisms will resemble their parent forms. But, as with the cannon, there are minor forces which in living beings come into play to produce slight changes in the progeny on all occasions. These changes are likewise of two kinds, depending on the circumstances connected with the parents themselves, and on those acting directly on the offspring from the time of its conception onwards. Amongst the former of these may be included differences in the actual and relative ages of the parents, both of which factors vary with each one of their progeny ; their