UNIVERSITY TRAINING OF ZOOLOGISTS

AT a recent meeting in the rooms of the Zoological Society of London, the Association of British Zoologists held a discussion on the training of zoologists in the university, giving an opportunity to discuss the address which its president, Prof. H. Graham Cannon, had delivered when presiding over Section D of the British Association at Brighton last September. A large attendance of members pointed to the interest which this subject clearly has for zoologists at the present time.

The discussion was begun by Prof. D. M. S. Watson, who outlined the historical development of courses of zoology in London since they were first begun by Grant at University College in 1828. During the second half of last century, there took place the gradual establishment of the 'type' system, largely due to the work of Huxley at the Royal School of Mines and the Normal School of Science, and to that of Ray Lankester at University College; and this has survived to the present day as the basic plan upon which courses for degrees in zoology are built. As Prof. Cannon had pointed out in his address at Brighton, there was in the nineteen-twenties a general revolt against the dominating position of comparative anatomy in zoological education, and Prof. A. C. Hardy illustrated from the arrangement of courses in the Department of Zoology at Oxford how much time had now to be devoted to other parts of the subject. During the period 1943–45, 71 per cent of the lectures were allotted to a systematic treatment of the various groups of the animal kingdom, and the remaining 29 per cent to such general topics as ecology and the distribution of animals, genetics, evolution, physiology, embryology, cytology and histology. For the years 1946–48, the figures were markedly different—45 per cent only of lectures were devoted to a morphological treatment of groups; another 45 per cent to the general topics mentioned above, while the remaining 10 per cent went to a course on the history of zoology and to discussion of research topics, a weekly debate on controversial subjects. It seems doubtful, he said, whether the treatment of groups can be profitably or desirably reduced from this, as an understanding of their anatomy and relationships is necessary for the proper treatment of the more general part of the course.

Prof. Hardy emphasized that a course on zoology such as this is essential for the training of professional zoologists: for the general education of the university student reading other subjects, he was prepared to agree with Prof. S. Mangham, who addressed the Association on the recent memorandum prepared by the Association of Scientific Workers on the teaching of biology in universities. This memorandum proposes what is, in effect, the disappearance of separate university departments and courses of botany and zoology, and their replacement by a single integrated department and course of biology, on the ground that world conditions emphasize the need for a new approach to social and food problems, and that this could be well achieved through biology. A biological training, too, would produce not only good technicians but also good citizens, and so could well become a regular part of the curriculum for arts as well as for all kinds of science degrees. So far as the content of the courses was concerned, there was suggested the same kind of distribution of emphasis as indicated by Prof. Hardy (and which later discussion showed was, in fact, general throughout the universities)—a reduction in the teaching of evolutionary morphology, the time thus gained being used to give a more generous treatment of ecology, genetics, physiology, parasitology, human biology and the history of science.

Mr. H. W. Parker, speaking on the needs of the museums, emphasized that they require *educated* zoologists. The fields of knowledge needed in a museum zoologist's career would appear to be essentially compatible with a good general education, and no radical changes in the present zoological courses are called for, though changes of emphasis and timing might be beneficial. For example, natural history, being ill suited to laboratory methods, receives insufficient attention, and taxonomy is out of fashion now that the pertinent question is "How does evolution take place?" rather than "Has it taken place?" Yet, although geneticists and others may show how evolution can take place, the taxonomist can show how it has done so, or is doing so now. Greater taxonomic training would also lead to greater appreciation of the vast range and complexity of animate Nature, a matter which the 'type' system under-emphasizes. Museums must obtain recruits with knowledge suitable for developing new lines of attack: the scant attention by taxonomists to myology, compared with osteology, Mr. Parker said, reflects the different emphases on these two subjects in the universities, and the preponderant attention to marine zoology in most courses has repercussions in the museums. For the proper understanding of the relationships of recent animals, knowledge of the environmental conditions of the immediate past is essential, and this calls for acquaintanceship with geophysics and climatology. Finally, since abiding interests develop more readily in familiar than in unfamiliar fields, Mr. Parker pressed for greater collaboration and for the encouragement of students to visit and actually work in the museums.

RELATION OF A CLOVER JUICE FACTOR CAUSING PARALYSIS OF SMOOTH MUSCLE TO BLOAT IN RUMINANTS

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FERGUSON[1] observed that whereas the juices of the most prevalent pasture grasses in Great Britain had little effect on the isolated rabbit intestine, those from certain legumes (for example, clover, lucerne) caused relaxation and paralysis. He excluded the possibility of certain inorganic ions, protein and alkaloid components from being responsible for this phenomenon. The importance of this finding in problems associated with the 'pasture-grazing animal' interrelationships is apparent.

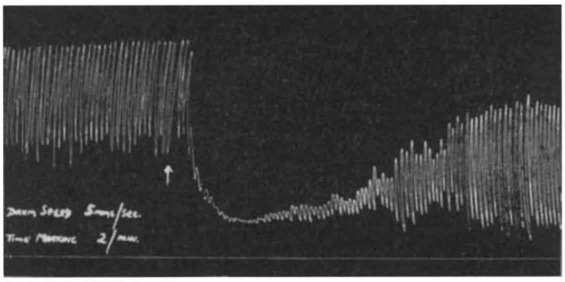

Fig. 1. Typical tracing of rabbit intestine treated with clover juice (2 ml. added to the Tyrode bath of capacity 50 ml.). Similar results obtained with known cytochrome poisons, see text

The cause of bloat, fog-fever, and ruminal atony in cattle and sheep, together with tympanitic colic and grass-sickness in horses, has not yet been established, although a particular pasture environment is usually incriminated. In bloat[2], it is believed that there is an inhibition of the eructation reflex associated with ruminal stasis; the animal, being unable to belch, cannot void the gases produced in the paunch as a result of fermentation.

Working with the leaf juice of a white clover, we have shown that one of the factors responsible for the effect on the rabbit intestine is hydrocyanic acid. The evidence leading to this conclusion is as follows:

(1) The principle is absent from the residue of either the intact leaves or crude juice after drying at 100° C. in a well-ventilated oven.

(2) Separation of the crude juice into acid, neutral and basic fractions shows that the activity is concentrated in the ether-soluble acid fraction.

(3) Acidified clover juice was steam-distilled, and the distillate collected into ice-cold alkaline Tyrode solution. The distillate possessed the whole of the activity of the juice when tested on the rabbit intestine. It also gave all the chemical tests for a weak solution of hydrocyanic acid. The same acidified clover juice, treated similarly with respect to temperature, in a sealed tube, showed comparable activity with the original, after cooling and neutralization, but in an open tube had lost all activity. This illustrates the volatility of the factor, which caused erratic results in its concentration, until steps were taken to counter it.

(4) Crude clover juice, and a solution of hydrocyanic acid of the same CN' concentration (estimated by the method of van der Walt[3]), produced almost identical responses on the isolated rabbit intestine (Fig. 1).

Several substances, both synthetic and of natural origin, were tried for their action on the isolated rabbit intestine; the well-known poisons of the cytochrome system all produce a response similar to that shown in Fig. 1, namely, for small doses, relaxation, and diminution of amplitude, with subsequent recovery, but with increased dosage, irreversible paralysis in the relaxed state. The necessary concentrations differ widely: for example, sodium cyanide (1/100,000); sodium sulphide (1/2,000); sodium azide (1/2,000). Hydroxylamine (1/5,000) has a similar effect. Hydrotropic substances like sodium desoxycholate, and sodium taurocholate (1/5,000) and surface-wetting agents (for example, the detergents 'Cetavlon', 'Teepol'), also possess a well-marked relaxing effect leading in some cases to paralysis. Saponin (1/5,000) paralyses the rabbit intestine in the contracted state.

It is known that some pasture plants, especially legumes, may contain cyanogenetic glucosides (*Trifolium repens* contains lotaustralin and linamarin)[4] which produce hydrocyanic acid by hydrolysis with the appropriate enzyme. Again, hydroxylamine has been postulated as an intermediate in nitrogen metabolism by plants and bacteria. The analysis of rumen gases shows 0·1 per cent hydrogen sulphide to be a fairly normal figure, while Dougherty[5] reports the presence of carbon monoxide in concentrations up to 0·17 per cent. Certain plants, especially legumes, are rich in saponin-like substances.

We have already shown that one litre of clover juice (equivalent to about 5 lb. fresh clover) introduced directly into the rumen of a sheep paralysed its movements immediately. After some time, however, the animal showed general symptoms of acute poisoning, namely, dyspnœa, dilatation of the pupils, and finally succumbed in a tetanic convulsion 2 hr. after administration of the juice. The post-mortem findings were consistent with poisoning by hydrocyanic acid. Estimation showed 200 mgm. hydrocyanic acid per litre in the crude clover juice, which is double the lethal dose[3] for sheep of this size (Welsh Mountain, wt. 100 lb.). During the first 90 min., no ruminal movements were recorded; towards the end they were re-appearing again spasmodically but with diminished force (Fig. 2).

In an attempt to produce bloat in the field, three two-year-old Welsh Black cattle (a bullock and two heifers), starved for 12 hr., were turned to graze a white clover pasture. The three animals grazed the clover avidly for 15 min.; the two heifers then stopped, stood listlessly for a while, and then wandered and grazed rough herbage other than the clover, which they deliberately avoided. The bullock persisted with the clover grazing for a further 5-min. period, and then behaved as the heifers had done. Within a period of 30 min. the bullock showed definite

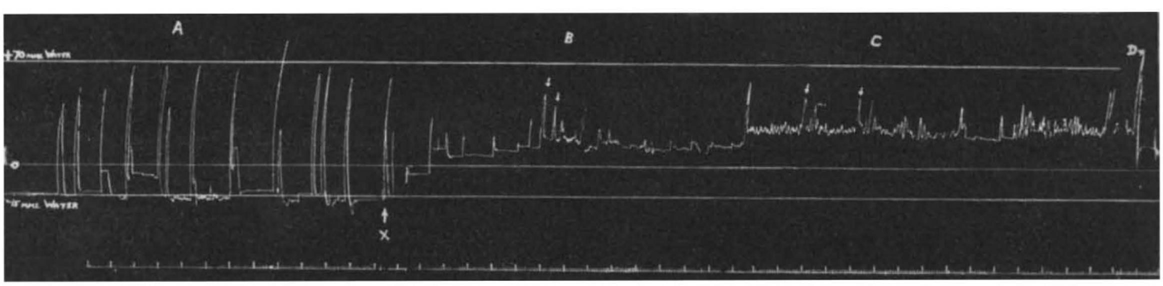

Fig. 2. *A*: Normal rumen activity. Drum speed, 5 mm./min.; time marker, 10 per min. *X*: Point of introduction of clover juice (1 litre). *B*: Tracing after addition of the juice. *C*: One hour after dosing, showing rapid respiratory movements and the re-appearance of spasmodic rumen contractions (arrows). *D*: Denotes a marked increase in pressure, when sheep was in a convulsive state

symptoms of distress (respiration 95 per min., pulse 120 per min.) and was slightly blown; the heifers, although full in the flank, were neither blown nor showing signs of discomfort. Blood samples taken at this stage were analysed for hydrocyanic acid content; the bullock's blood contained 0·1 mgm. hydrocyanic acid per 100 ml. blood, while the heifers' had 0·04 mgm. per 100 ml. blood.

The possible rôle of hydrocyanic acid in the etiology of acute bloat in sheep has been considered before by Clark and Quin[7], but they prefer the 'saponin foam theory' of its pathogenesis (see also Clark[8]).

It seems probable to us that in a complex syndrome like bloat several factors may operate; a satisfactory theory of the cause must not only account for the sequence of symptoms in the animal, but must also explain observations of agriculturists on predisposing environmental conditions. We believe that our findings are significant in this connexion.

We wish to acknowledge our grateful thanks to the Welsh Plant Breeding Station for providing facilities in the field.

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DETERMINATION OF ABSOLUTE INTENSITIES OF X-RAY REFLEXIONS FROM RELATIVE INTENSITY DATA

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RECENTLY, owing to the advent of various methods[1] of direct determination of phase angles of Bragg reflexions from a crystal, a convenient method of determination of absolute intensities of Bragg reflexions seems urgently needed[2]. In 1942 I proposed a simple method of determination of absolute from relative intensities[3], which has since been made rigorous and so should be reliable in general cases if used properly. Accordingly, I present here the final result of the method, which is applicable to practical cases immediately.

Suppose we have a crystal containing t atoms in the unit cell, the number of shell electrons of the ith atom being Z_i. Let the relative intensities of reflexions for the crystal at room temperature be denoted by $I'(hkl)$ for hkl and $I'(000)$ for 000. We have

$$|F(hkl)|^2 = \frac{F^2(000)}{I'(000)} I'(hkl). \qquad (1)$$

We see that if we can determine $I'(000)$ we can deduce $|F(hkl)|^2$ from $I'(hkl)$, for we have the known $F(000) = \sum_{i=1}^{t} Z_i$. Let us introduce

$$\bar{f}(hkl) = \sum_{i=1}^{t} f_i(hkl) \Big/ \sum_{i=1}^{t} Z_i, \qquad (2)$$

where $f_i(hkl)$ is the atomic structure factor at room temperature of the ith atom in the cell. If only $f_i(hkl)$ for atoms at rest are available, such as those obtained from James and Brindley's table, suitable temperature correction must be made in order to obtain the room temperature value of $f_i(hkl)$. We further form the sum $\sum_{i=1}^{t} Z_i^2$. Then from the theory of a new X-ray synthesis developed by me, it can be shown that:

$$I'(000) = F^2(000) \; \frac{\Sigma' U_{n_1h} U_{n_2k} U_{n_3l} I'(hkl)/\bar{f}^2(hkl)}{\sum_{i=1}^{t} Z_i^2 - U_{n_1o} U_{n_2o} U_{n_3o} \,.\, F^2(000)}, \qquad (3)$$

where Σ' denotes the sum $\sum_{h=-\infty}^{\infty} \sum_{k=-\infty}^{\infty} \sum_{l=-\infty}^{\infty}$, excluding the term of $h = k = l = 0$. U_{nh} are known functions of n and h, the numerical values of which are negligibly small for $h > n/2$; $U_{nh} = U_{n\bar{h}}$ when $\bar{h} = -h$. Thus, if the maximum h, k, l of our available set of $I'(hkl)$ are h_M, k_M, l_M, we may choose $n_1 \doteq 2h_M$, $n_2 \doteq 2k_M$, $n_3 \doteq 2l_M$. The values of U_{nh} for some values of n and h are given below:

$U_{nh} \times 10^4$

n / $\pm h$	48	44	40	36	32	28	24	20	16	12
0	334	364	400	443	498	568	660	790	981	1297
1	325	354	388	430	481	547	633	751	920	1187
2	315	341	371	409	455	511	584	679	809	989
3	303	328	357	391	433	484	547	626	729	848
4	294	316	342	372	407	449	499	557	617	646
5	282	303	327	354	386	421	462	505	540	528
6	272	291	311	334	360	387	414	433	422	176
7	256	278	296	316	338	359	377	385	360	
8	251	265	280	296	312	324	328	308	131	
9	239	253	266	278	290	297	294	272		
10	230	240	250	258	263	261	240	104		
11	218	227	235	240	242	235	216			
12	209	215	219	220	215	196	87			
13	198	202	204	203	196	181				
14	187	189	189	181	164	73				
15	177	177	174	167	155					
16	166	164	157	142	64					
17	156	152	145	135						
18	144	138	124	57						
19	135	128	120							
20	122	110	51							
21	115	108								
22	99	46								
23	98									
24	42									
ΣU_{nh}	0·9998		1·0010		1·0016		1·0022		1·0037	

The last row gives the sum $\sum_{-h_M/2}^{h_M/2} U_{nh}$ for $n = 48$, 40, 32, 24, 16. Apparently all the sums differ from the theoretical limit $\sum_{h=-\infty}^{\infty} U_{nh} = 1$ only by fractions of 1 per cent, indicating the rapidity of convergence of the infinite series.

The accuracy of $I'(000)$ deduced from (3) depends essentially upon the following four factors:

(1) The accuracy of the observed $I'(hkl)$.

(2) The order of approximation of the equation

$$f_i(hkl) = Z_i \,.\, \bar{f}(hkl), \qquad (4)$$

which forms the basis of equation (2). The error introduced by the failure of equation (4) is usually not very serious.

(3) The proper correction of the temperature effect in $f_i(hkl)$. If we actually do a suitable experiment to correct this effect, the error introduced is, of course, limited. Otherwise we have to correct the effect with reference to similar crystals of known structures, and