systems in the areas where the research had been carried out, it was not always easy to use the same data for engineering purposes in different geographical regions. It is clearly not practicable always to make pilot investigations before every engineering application, and the aim must therefore be to achieve the best fundamental understanding of the propagation phenomena from those experiments which are made, and thus so far as possible to ease the task of extrapolation.

The papers presented at the symposium and the discussion are to be published in a special issue of the *Proceedings of the Institution of Electrical Engineers* (**105**, B; 1958). J. A. SAXTON

MACHINES AS MODELS IN BIOLOGICAL EXPERIMENTS

IN May 1957 the Laboratory Animals Bureau arranged a symposium on humane technique in the laboratory. In a paper now available separately*, Dr. W. Grey Walter showed how machines could be used as models in biological experiments.

Walter first showed how the classical method of demonstrating physiological laws and principles are derived from those worked out for the physical sciences. The essence of these methods is the isolation of a single variable and the observation of this variable in various experimental conditions. In order to achieve this situation with living creatures, some sort of preparation is required. This involves dissection, mutilation or anæsthesia, often all three, and in this way a whole animal can be transformed into a working model of some particular function. For example, the Sherringtonian approach to reflex action of the spinal cord depended upon decerebration of a complex animal such as a cat and the restriction of attention to one, or occasionally two, reflex circuits. The results obtained in this way form the basis for much thinking about the nervous system, but it is now realized that the general picture of central nervous action derived from these studies of isolation, though admirably clear, lacks perspective and detail when related to animal behaviour.

If it is accepted that animal preparations are essentially models of working hypotheses, it follows that such hypotheses may as legitimately be embodied in machines as in mutilated animals. The use of machines may even present certain advantages: the components of a mechanical system can be accurately enumerated and specified, and the principle of parsimony, so important to fertile thinking, can be adhered to without inconvenience. For example, it is difficult to prove that a spinal cord preparation contains only those components necessary for the reflex action under investigation, but it is quite simple to demonstrate that a reflexive machine contains only essential elements.

The principles to be observed in the construction and use of animal models may be summarized as follows: (1) the system to be modelled should contain more than one variable; (2) the model must contain no redundant components, in order to maintain parsimony; (3) the behaviour of the model should exhibit more features of behaviour than were originally planned or foreseen. Applying these principles, a number of models of animal function and behaviour have been constructed and are in frequent use both for the design of fresh experiments and for teaching purposes. These are:

(1) NERISSA—A Nerve Excitation, Inhibition and Synaptic Analogue. This demonstrates particularly the relationship between the various parameters of nervous action such as finite propagation-rate, excitation threshold, all-or-none conduction, strength-duration curves of excitability, refractory periods, Wedensky inhibition, synaptic facilitation and inhibition, inhibitory escape and rebound, transmission or information by pulse-interval modulation, and anomalies of 'inhibition of inhibition' and 'inhibition of inhibition of inhibition' during rhythmic as opposed to sustained stimulation.

(2) IRMA—Innate Releaser Mechanism Analogue, demonstrating the exclusive action of an excitatory state maintained by a cascade of neuronic elements and the effect upon this condition of variations in excitatory level.

(3) ELMER—Electro-Mechanical Robot, containing two elements equivalent to synaptic junctions, with two receptors and two effectors, to demonstrate the complexity of behaviour arising from the interaction of two reflex circuits coupled to a complex environment. The behaviour patterns observable include goal seeking, obstacle avoidance, discrimination between immediate and remote goals, choice between two equivalent goals, tendency to seek optima rather than maxima and elements of self- and social-classification.

(4) CORA—A Conditioned Reflex Analogue, demonstrating the action of selective and storage mechanisms in the establishment of a contingency association between signals on a basis of statistical significance.

Such models provide both student and experimenter with an opportunity to classify observations of real animals and to design crucial experiments.

* Laboratory Animals Bureau. Collected Papers, Vol. 6, 1957. Pp. 81. (London: Laboratory Animals Bureau, M.R.C. Laboratories, 1957.) 10*s*.

EDIBLE LIZARDS

ALLAN R. HOLMBERG, of the Department of Sociology and Anthropology of Cornell University, has described how natives of the north coast of Peru capture small lizards called cañanes partly for their nutritive but especially for their curative and aphrodisiacal properties*.

The lizards, *Dicrodon hoombergi*, are found in the Chao Valley and dig their holes in the desert sand around clusters of the guarango tree (*Prosopis juliflora*)—called algarrobo in Viru—the fruits of which constitute their sole means of subsistence. They are not gregarious, but hundreds of pairs of them make their homes around nourishing stands of algarrobo. The full-grown males are bluish in

* Fieldiana Anthropology, **36**, No. 9. (Chicago Natural History Museum, 1957.) 75 cents.

colour and attain an over-all length of about 20 inches; the females, more brownish in colour, seldom grow to three-fourths of this size. Both males and females have speckled backs, and most of their length consists of tail. Viruñeros claim that cañanes are ovoviviparous.

Cañanes spend most of their lives underground. Here they hibernate during the winter (April to November) and here they raise their young. Only when the summer months appear do heat and hunger drive them from their holes, and then only for a few hours on days when the sun is shining. When the weather is warm, they raise their heads out of their holes at about 9 o'clock in the morning, and begin to feed on the green fruits of the algarrobo. Since few tender ones are to be found on the ground, the cañanes usually climb the spiny trees. In this way they not only reach the more luscious pods, but also avoid attacks by larger lizards locally known as iguanas, and by foxes, vultures and hawks, which sometimes kill them when they are caught in the open. After eating for a few hours, the cañanes return to their holes, sometimes taking with them pods which are stored for winter.

Cañanes are usually caught in traps. These consist of long, low fences made from small, roughly rectangular staves of maguey—about 15 inches long, ½ inch wide, and ¼ inch thick—twined in a series with cotton string. When rolled up, a trap has the appearance of a drum or tambor, as it is called in Viru.

At the site, the traps are rolled out flat on the sand at about a yard from the low-lying algarrobo branches containing fruit. Then they are gradually set up—inclined slightly inward—and banked on the bottom (both inside and out) with sand. A cañan trap, when set up, thus presents the appearance of a miniature picket fence, inclining slightly inward and enclosing a large open space within which lie holes of cañanes and outside of which lie clusters of algarrobo.

Meanwhile, the cañanes have come out of their holes to eat. On their way, they encounter the barrier of the trap. Instead of returning to their holes, they continue to search for some avenue of escape to the algarrobo fruits, but everywhere they go they encounter the trap or its curled ends—a difficulty which their lack of intelligence does not permit them to overcome.

The hunter then gathers up his cañanes, breaks their front legs and backs—they are thus paralysed but remain alive—and places them in a pair of woven saddle bags.

In Viru there still persists the flavour of the fiesta in the cañan hunt. Until recent times, no Viruñero thought of dedicating all his time to this pursuit or of making a living from it, but most of the hunters possessed traps which they occasionally set during the season to enjoy a day of fiesta. To-day, a few skilled hunters have dedicated themselves to the hunt for commercial reasons, since there is an excellent market for cañanes both in the valley and in the neighbouring cities, where they sold for as much as four soles a dozen in 1948.

After being collected from the trap, the paralysed cañanes are laid out in a row near the ashes of a dying fire. They are thrown into the embers and are scorched to death.

Cañanes subjected to the scorching and cooking treatment may be eaten as they are, may be prepared in various ways, or may be stored for as long as a year. They may be eaten raw. Commonly, however, they are prepared in seviches, soups, stews, or omelettes.

MUSCLE-RELAXING FACTORS

By J. R. BENDALL

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BRIGGS and Portzehl[1] and Portzehl[2] have recently published detailed observations on the nature of the muscle-relaxing factor discovered by Marsh[3] which show that:

(*a*) The factor is not identical with phosphokinases such as creatine phosphokinase (C.P. kinase) or phosphopyruvate-kinase (P.P.-kinase), as suggested by Goodall and Szent-Györgyi[4], Lorand[5] and Moos and Lorand[6], nor, by implication, with myokinase (ADP-kinase) as suggested by Bendall[7]. In other words, its mode of action is not through the maintenance of the adenosine triphosphate (ATP) level against the inroads made by the myofibrillar adenosine triphosphatase (ATP-ase), which can be summarized by the equation:

$$\text{ATP} \longrightarrow \text{ADP} + \text{P}_i \qquad \text{ATP-ase}$$

$$\text{ADP} + \left\{ \begin{array}{l} \text{ADP-kinase} \\ \text{C.P.-kinase} \longrightarrow \text{ATP} \\ \text{P.P.-kinase} \end{array} \right.$$

Nevertheless, these enzymes can serve to carry adenosine triphosphate to the centre of thick bundles of fibres where otherwise it could not penetrate, and it is in this ability that their apparent factor activity resides. These other 'relaxing' systems are without effect, however, in exhaustively washed or very old fibre bundles[7], nor will they inhibit the adenosine triphosphatase activity of washed myofibrils[8,9], and it is obvious, therefore, that some other substance is responsible for the inhibition and relaxing effect of adenosine triphosphatase which can be obtained by addition of crude muscle-extracts to such washed systems.

(*b*) The activity of the true relaxing-factor, dialysed free of phosphate esters and other soluble metabolites, is dependent upon *p*H, and, when present in trace amounts, is more active at low *p*H (~6·2) than at high (~7·2). This explains why the relaxing effects which Goodall and Szent-Györgyi[4] attributed to creatine phosphokinase were only observed at low *p*H values.

(*c*) Factor activity mainly resides in the particulate material of the muscle-extracts, which can be centrifuged down between 20,000 and 80,000 *g*[10]. This fraction probably consists of the smaller granules of Chappell and Perry[11] and makes up a large part of the active factor preparation of Kumagai, Ebashi and Takeda, called by these workers fraction *A*.