Correlations of this type, i.e. coat colours clearly differing from the normal look of the wild animals related to behavioural changes in the direction typical for domestic animals, certainly have first rank importance as starting points for domestication achieved by chance as well as by intention. Prey animals marked by a highly unusual colour may give rise to alterations, eventually inhibition of the hunting behaviour in carnivores which rely chiefly on vision, as shown for wild kestrels having the choice between wild type coloured and albino mice[42]. A comparable behavioural change in man may easily result in relation to an animal externally and beaviourally marked in such an unusual manner as the first step towards the change in the man-animal relation decisive for a domestication, especially if such animals become objects of myths or cult interest in any way.

A clear example for such differentiated human handling resulting in all probability in the domestication of the Norway Rat, is given by reports on the rat-baiting sport popular in France and England around 1800, and in America soon afterwards[38]. As communicated by RICHTER[38], records indicate that albinos were removed from the large numbers of wild rats trapped for this purpose, that is, being killed in groups of 100 to 200 individuals by a trained terrier in a fighting pit in as short a time as possible. These albinos were then kept for show purposes and /or breeding. Obviously a similar coulor selection took place at the very starting point of the wolf's domestication. The genes responsible for the normal wolf colour seem to be completely lacking in the dingo[3]. Likewise, red, yellow and other 'dog' colours are found in primitive dogs from wolf-free regions where the 'wolf' colour hardly occurs at all. Therefore it can be assumed that the dog's history is founded on a very limited number of wolves coloured in this unusual manner such as are found now and then in some wolf populations. The author had the opportunity to examine such a dingo-coloured skin of a Kazakhstan steppe wolf, for example, when visiting the Zoological Institute of the Kazakh Academy of Sciences in Alma-Ata.

Two factors, namely certain colour types which, because of alterations in the neurotransmitter system caused by the respective colour genes, are related to behavioural traits diverging from the wild animal's norm, and secondly the minimum brain size possible in the relevant species, therefore appear to be bases for domestication either separately or in combination. These factors are expressions of the respective individual's potentiality for domestication as well as being at least partially decisive for man's readiness to keep this animal, as shown by the example of the albino rat. Future domestication research will have to examine the general validity of this thesis. Understood as a domestication strategy, its application should result in success more quickly than if only general selection of individuals, according to their docile, tractable behaviour[43], is undertaken. In addition, primary selection procedures referring to relative brain size must be prepared.

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PRO EXPERIMENTIS

A Simple System for Mechanical and Electrical Recordings from Frog Nerve-Muscle Preparation

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Summary. A device is described which can be used for simultaneous measurement of the muscle action potential and the contraction of the frog gastrocnemius nerve-muscle preparation. The apparatus is characterized by ease of construction, good accuracy and reliability.

We required for use in an introductory physiology laboratory course, a system for recording the contractions as well as the action potentials (MAP) of the frog gastrocnemius nerve-muscle preparation. For didactic reasons it was important to be able to demonstrate and measure the latency and time course of the mechanical event in relation to the MAP. Other requirements were ease and clarity of use and reliability in the student laboratory. We could not justify for this one experiment the purchase of a commercially available dual channel system, especially since several groups were to work simultaneously. We therefore designed and built the following recording apparatus, based on a commercially available linear motion transducer, for use in conjunction with a cathode ray oscilloscope.

The device (see Figure 1) is fabricated for the most part from plexiglas. It contains a shallow moist chamber with a removable cover (not shown in the figure) with provisions for holding the preparation, for nerve stimulation and for recording the MAP (Figure 1 A). The conventionally prepared nerve-muscle preparation is held by the T-shaped holder whose position can be adjusted by loosening its retaining screw and sliding the stalk in or out. The stumps of the femur and tibia should not be cut too short. By inserting the head of the muscle at its attachment to the bone into the notch in the holder with both bone stumps behind the head of the T, the muscle can be held firmly for recording. Care should be taken to avoid pinching the nerve between the bone and the plexiglass. The nerve is laid over the 0.7 mm silver stimulating electrodes which are mounted in an adjustable stalk held by a thumb screw. The 2 recording electrodes are thin silver wires, 0.25 mm in diameter, which are simply twisted around the belly and tendon of the muscle. Since they have to be replaced occasionally, they are fastened to miniature, removable banana jacks held in the frame by screws (see top view diagram for details of the holder and

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electrodes). The recording electrodes are connected by a shielded cable to an AC preamplifier operated single-ended; the output signal appears on one beam of a dual channel CRO. We place filter paper soaked in Ringer's solution in the bottom of the chamber to keep the preparation moist when the cover is in place. Not seen in the figure is a drain plug we added in the bottom to the chamber to facilitate rinsing after use without getting the electrical parts wet. For isotonic recordings, the muscle tendon is connected by means of string running over teflon guides to a basket containing weights (Figure 1B). An afterloading system happened to be available and was connected up, but if not available one could easily be made. With a suitable spring instead of weights, isometric contraction could be arranged.

The heart of the apparatus is the GLC linear motion transducer (G. L. Collins Radio Corp., Long Beach, Calif.) which is mounted as shown in the side view of the diagram in an upright position beneath the platform supporting the string guides. This transducer offers very little friction and is available in a variety of sensitivities. Ours, model SS105, gave a signal of 0.28 volts per mm travel with a working range of 16 mm. The position of the center rod in the housing determines the level of the output signal; it was attached to the muscle by means of a string connected to the other string running from the tendon to the weights. As shown, the connection is such that the very light weight center rod drops upon contraction and is pulled back up upon relaxation. Critical in the construction is that a) rather light-weight, inelastic yet supple string be used to minimize artefacts due to slack or inertia; b) low friction guides or rollers be used; and c) additional guides between the rollers be used to prevent 'bellying out' of the string. We found an inelastic, braided nylon fishing line in conjunction with teflon guides to be quite satisfactory (see Figure 1). The transducer was clamped in a vertically adjustable collar. Raising or lowering the collar permitted zeroing the output of the transducer. Finer adjustments after mounting of the muscle preparation were made by sliding the muscle holder in or out. Connections to the transducer are available at jacks built into the front of the unit. Plus and

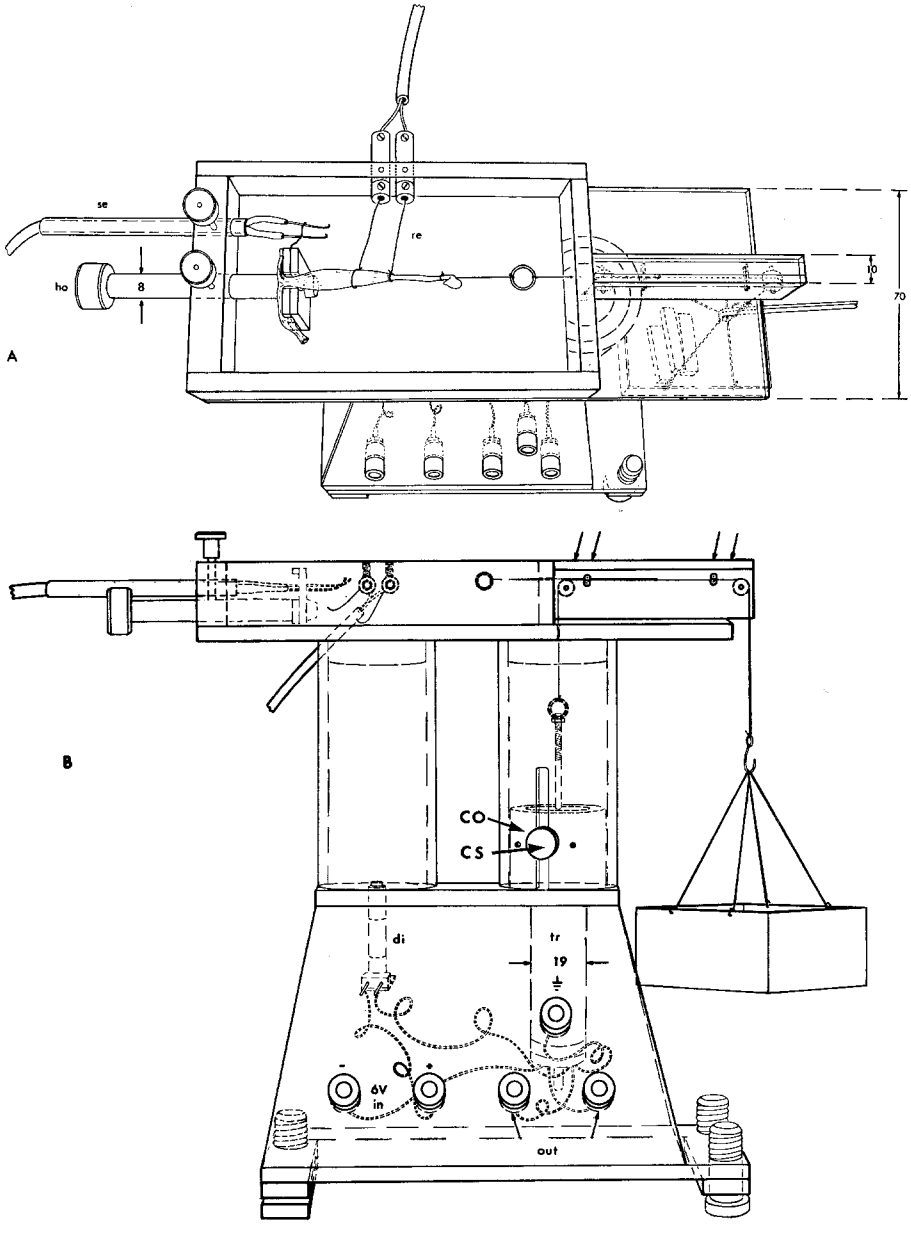

Fig. 1. Diagram illustrating construction of recording apparatus
A) Top view with details of moist chamber and mounting of muscle. Chamber dimensions: 120 × 70 × 27 mm. The nerve-muscle preparation is held by adjustable holder (ho). The nerve lies across stimulating electrodes (se) which also can be adjusted after loosening the set screw. The silver recording electrodes (re) are twisted around the muscle and tendon and connect to the pre-amplifier via plug-in cable. The muscle tendon is tied to the connecting ring.
B) Side view with details of transducer and its connection to muscle. Minimum height of apparatus 210 mm (adjustable); base width 160 mm. Transducer (tr) fixed by screws in plexiglass collar (co) which can be adjusted by loosening set screw (cs). Signal obtained from output jacks; + and — 6 volts required. Zener diode (di) protects transducer. Note connection of muscle tendon to load by string running over and through low friction guides (slanted arrows). Second string knotted to first (between arrows) runs back and reflects downward to transducer rod.

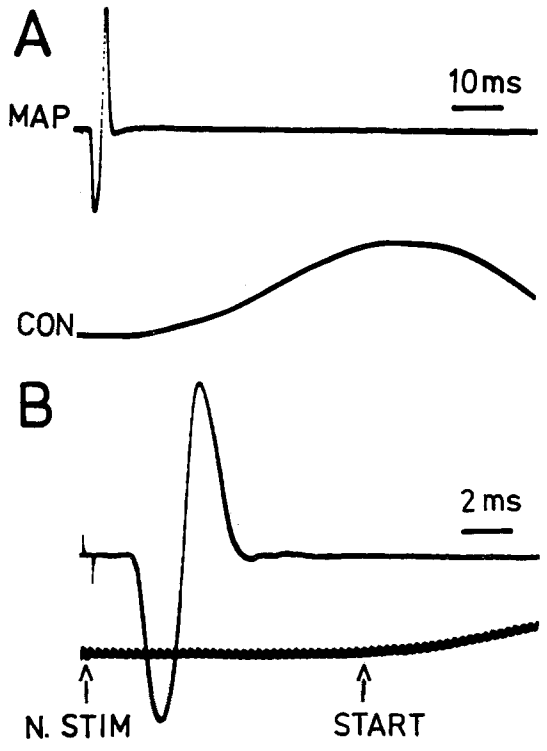

Fig. 2. Sample recordings from system.
A) Upper trace muscle action potential resulting from nerve stimulation, lower trace mechanogram. Time cal. 10 msec.
B) As above, time cal. 2 msec. Sensitivity of mechanogram increased to facilitate determination of start of contraction (arrow) in relation to MAP. Ripple in mechanogram is carrier frequency of transducer.

minus 6 volts are required. We used a stabilized power source, but a battery would also do. To protect the transducer from excessive voltage, and especially from being connected with the wrong polarity, we wired a zener diode into the system as shown. We also attached a grounding collar to the transducer to keep the carrier frequency out of the output. The output signal is connected directly to the DC input of the second beam of the CRO.

Discussion. The construction of this recording apparatus proved to be relatively uncomplicated. Care must be taken, however, in selecting and installing the guide surfaces and in using relatively supple transmission string; these are the principal points where recording inaccuracies can be introduced. The frictional errors from the transducer itself are minimal as long as the device is level. In terms of performance, it fulfilled our requirements. The nerve-muscle preparations usually maintained their initial physiological state for 2 or more hours in the moist chamber, especially if they were not unnecessarily stimulated. The mechanical recordings were of high sensitivity, stable and could faithfully follow up to the tetanus frequency of the preparation. To test the accuracy of the measurement of the latency of the myogram, we intentionally loosened in several experiments a recording electrode. The resulting movement artefact in the electrical recording always agreed in time with the onset of the myogram. Although we used a dual beam oscilloscope for simultaneous viewing of the two output signals, a single beam CRO would also suffice for alternate examination. This device has stood the test of repeated use. The principal cost, aside from construction time, is that of the transducer. This however is not altered during the construction and can be utilized for other purposes at any time or be placed in a new frame should the old one be damaged.

Vegetative Propagation of the Cactus *Mamillaria woodsii* Craig Through Tissue Cultures

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Summary. A new method of clonal multiplication is described in a representative from the Cactaceae family, which offers wide experimental and horticultural applications.

The methods of tissue cultures provide large possibilities for rapid and mass multiplication of plants. Among the techniques successfully applied in vegetative propagation in vitro belong, e.g., the cultures of stem tip meristems, axillar buds, bulb scales, and callus cultures with induced organogenesis. Using the techniques of clonal multiplication of ornamental plants through shoot regenerants from callus cultures, considerable results were obtained in the genuses *Freesia*[2], *Gazania*[3], *Crassula* and *Kalanchoe*[4], *Chrysanthemum, Dianthus, Euphorbia, Pelargonium, Asparagus, Haworthia, Saintpaulia, Gladiolus, Passiflora*, etc. (see for review MURASHIGE[5]). As far as we are informed, no report was published concerning the above-mentioned propagation techniques in plants of the Cactaceae family.

Material and methods. Starting material for our experiments were plants of *Mamillaria woodsii* species, Cactaceae family. 2-year-old plants of 1.5–2.0 cm in diameter were lifted from the soil including roots and thoroughly washed in running water. Afterwards the roots were removed and the stems were sterilized applying different techniques. The most promizing sterilization method proved to be the application of 70% ethanol in which stems were submerged for 5 min. For another 5 min the stems were put into 3% chloramin B solution with a drop of detergent and finally they were given triple rinse in sterile distilled water. From stems prepared by this manner, transverse segments of the width of approx. 3 mm were cut in a sterile box. From the cuttings the central vascular bundle was removed and the cuttings were divided into 4–5 segments to avoid in the explants the occurrence of the secondary vascular bundles reaching up

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