Sucrose-Gap Recording of Electrical and Mechanical Activity in the Smooth Muscle of the Isolated Metacarpal Vein of the Bat

The direct correlation between electrical and mechanical activity of smooth muscle cells in the pulsatile veins of the bat wing, was first demonstrated by MISLIN[1], by means of external electrodes. Intracellular recordings were recently obtained from the interdigital venules by SPEDEN and NICOLL[2]. The mechanical responses of the metacarpal veins of *Pteropus giganteus* have been described recently (PERISTIANY and HUGGEL[3,4]), and the aim of the present study was to find out what kinds of electrical events were associated with the contractions of this venous smooth muscle. A sucrose-gap technique previously applied to the analysis of electromechanical relationships in rat portal vein (AXELSSON et al.[5]) was used for this purpose.

A segment of vein between 2 valves and approximately 3 cm in length was dissected out of the neuro-vascular bundle and ligated at both ends. Secondary venules were cauterized in situ to avoid collapse of the vessel, in which case recording was unfavourable. The vessel was then mounted in the sucrose gap apparatus. One end was fixed and superfused with depolarizing, high K^+ solution, and the other end, which was connected to the force transducer (Grass FTO3), was bathed in normal 'C.S.3. solution' (PERISTIANY, LANE and HUGGEL[6]) at 37 °C. Since the smooth muscle is essentially arranged in a circular manner or in the form of a close helix contraction will mostly be associated with a drop in the longitudinal force as recorded in the present experiments. However, where the preparation was stretched to a relatively greater length, active increases in longitudinal force were seen.

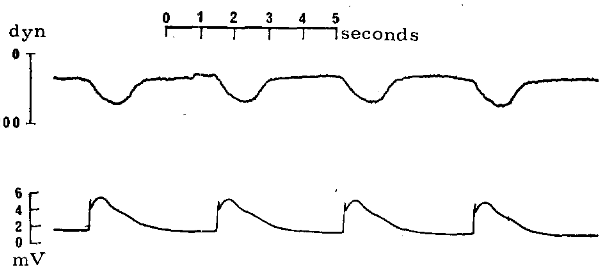

Fig. 1. Recording of electrical acitvity (below) and longitudinal isometric force (above) during spontaneous circular contractions of isolated metacarpal vein from bat wing.

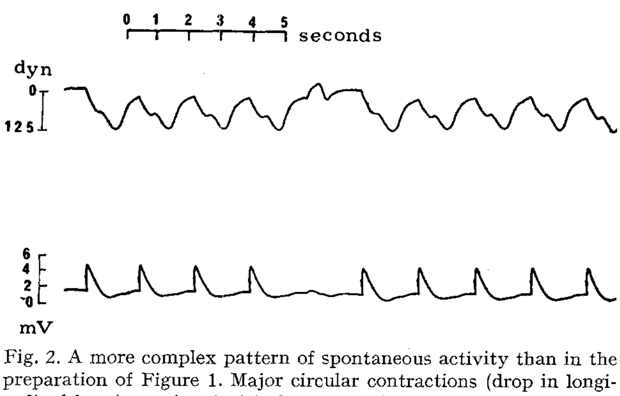

Fig. 2. A more complex pattern of spontaneous activity than in the preparation of Figure 1. Major circular contractions (drop in longitudinal force) associated with clear-cut action potentials, and smaller increases in force with little change in the electrical recording. The latter type of contraction, which probably takes place in a distant circumscribed area of the preparation, is seen most clearly when one of the major beats drops out.

The normal pattern of activity observed in these veins is illustrated in Figure 1. Circular contractions causing a drop in longitudinal force, occurred at a frequency of about 15 per min. Each contraction lasted about $1^1/_2$ sec and was associated with electrical responses consisting of an early rapid spike component followed by a later slow depolarization and a prolonged repolarization.

More complex recordings were sometimes obtained from virtually normal preparations. One example is shown in Figure 2. Here the decreases in tension following the action potentials were more longlasting than in Figure 1 and were interrupted temporarily by positive notches. The latter were probably due to regular activity with positive tension development in some distant part of the preparation as indicated by the pure rise in force observed when one action potential and its major contraction wave failed. It appears that, for some reason, this vessel did not operate as a functional 'single unit'.

In 'fatigued' preparations, after several hours of recording, we observed various degrees of irregularities in the electrical activity and of apparent electro-mechanical dissociation. Such findings are exemplified in Figures 3 and 4. Figure 3 shows a fairly regular activity of slow depolarizations, most of which appear to be subthreshold. Some of them do, however, lead to firing of action potentials and increase of longitudinal force. In Figure 4 electrical activity is recorded from a focus with very high frequency of firing (about 40 per min). The individual action potentials are not reflected in the mechanical recording, either because there is a fused tetanus or, more probably perhaps, because the potentials fail to propagate. One strong phasic contraction occurred in the midst of this activity. The slow depolarization seen at this point could be due to electrotonic spread from distant portions of the vein, but it might also be just a movement artefact due to a slip of the muscle in the sucrose gap.

The results have shown that contractions of the circular muscle in metacarpal veins of the bat wing are normally associated with action potentials of the plateau type resembling those of cardiac muscle. Studies of small venules in the wings of other species of bats by microelectrode technique (SPEDEN and NICOLL[2]) have demonstrated a very similar pattern of electrical activity. Action potentials of the plateau type have previously been described also for vascular smooth muscle from turtle aorta (RODDIE[7]), but rhythmic activity in venous muscle from higher animals seems more often associated with prolonged bursts of spike-like potentials (for ref. see JOHANSSON[8]). The action potentials obtained in our

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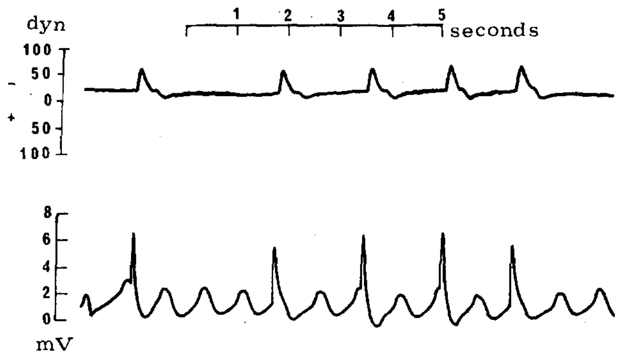

Fig. 3. Recording from 'fatigued' preparation. Regular appearance of slow waves, most of which are sub-threshold. Action potentials and increases in force at irregular intervals.

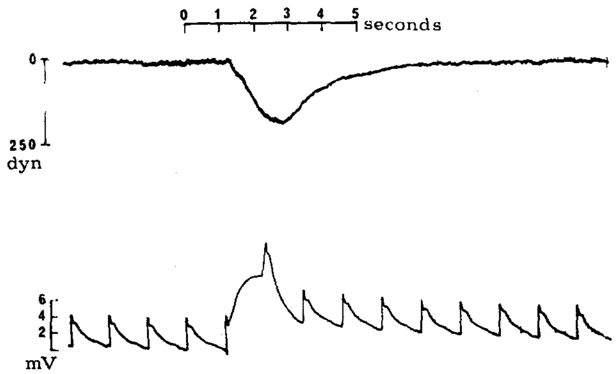

Fig. 4. Recording from 'fatigued' preparation. Focal discharge of action potentials at high frequency. A single synchronized contraction occurs in the record.

experiments were sometimes preceded by slow depolarizations resembling pacemaker potentials (Figure 2 and 3).

The strict correlation between electrical and mechanical activity in most of the present experiments (Figure 1), indicates that a single pacemaker regulates rhythmical contraction of a whole segment of vein between 2 valves. This mechanism may play a significant role in promoting venous return from the bat's wing. More complex patterns of mechanical activity with partial dissociation of electrical and contractile events (Figure 2) might occur in the in vitro situation as a result of traumatic interference with the mechanisms of synchronization. However, a phenomenon of 'active dilatation' has previously been observed in vivo in the intact vessel, particularly when the perfusing pressure was artificially reduced by 10–20 cm H_2O (PERISTIANY and HUGGEL[3,4]). It was considered that this mechanism may contribute to the regulation of local blood flow in the bat's wing.

Zusammenfassung. Die isolierte pulsatile Flughaut-Vene der Fledermäuse zeigt mit dem «Sucrose-gap» eine enge elektro-mechanische Korrelation. Das AP ist oft von einem Schrittmacher-Potential eingeleitet. Solche AP sind äusserst selten bei den Gefässmuskeln.

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[9] This study was supported by grants from the Swedish Medical Research Council (28–14 x), the G. and A. Claraz-Schenkung and the Swiss National Scientific Research Funds, and was carried out in the Department of Physiology, University of Lund, Sweden.

A Comparative Study of Growth, Development and Survival of the Cricket *Plebeiogryllus guttiventris* Walker Reared Singly and in Groups

The phenomenon of 'group effect' has been reviewed by CHAUVIN[1] in orders like Lepidoptera, Coleoptera and Orthoptera and some Social insects. CHAUVIN[2] has also shown that rearing of *Acheta domestica* in groups of 2 or 3 insects accelerated better growth, and in groups of 5 and 10 slowed down the growth compared to the rearing of single larvae. MC FARLANE[3] working with the same insect found that rearing of larvae in groups of 10 accelerated growth better than single rearing. Since the two authors used different rearing jars the differences in their results suggest that the group effect for optimal growth does not depend on the absolute number of individuals per group but on the relative number per unit of volume or area. So far no work on the group effect in *Plebeiogryllus guttiventris* is on record. An experiment was therefore conducted to discover the effect of grouping on the growth, development and survival of this cricket. The present paper deals with the comparative study of such effects and also suggests that a group of 10 accelerated better growth than any other group.

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Table I. The number and average weights of nymphs of *P. guttiventris* reared singly and in groups after 10, 20 and 30 days

Time (days)	Single		5		10		15		20	
	No.	wt (mg)	No.	wt (mg)	No.	wt (mg)	No.	wt (mg)	No.	wt (mg)
Commencement	60	—	60	—	60	—	60	—	60	—
10	49	5.6	33	6.5	52	7.1	45	6.8	41	5.9
20	34	23.0	31	26.3	51	29.3	41	25.4	39	20.5
30	34	42.5	30	114.0	49	137.7	41	126.5	34	98.7