In Vespa orientalis, as in other Hymenoptera, a myogenic rhythm of wing-beat is observed. In myogenic insects, the energy to maintain a wing-beat frequency can only be drawn from fibrilar muscles. A mechanical trace from the thorax of an active wasp[7] points to a frequency of 155 Hz, whereas an electrical trace from the same wasp yields a considerably lower frequency. In the latter instance, the impulses in motor nerves supplying the main flight muscles are not synchronous with the wing beats. Our method of recording, when coupled to a processing via correlator, permits an accurate analysis of the ventilation noise of an insect without interfering with its normal activity. The recorded differences in duration of ventilation activity among various hornets probably represent differences in the physical endurance of individual hornets.

7 J. W. S. Pringle, in: Physiology of Insecta, p. 433. Ed. Morris Rockstein. Academic Press, New York III 1974.

Non-uniformity of regional vasomotor activity indicating the existence of 2 different systems in the sympathetic cardiovascular outflow

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Summary. In rabbits, 2 populations of sympathetic postganglionic fibres innervating the skin, heart, muscle and kidney could be classified by their different spike heights and their different susceptibility to noradrenaline and angiotensin amide. The ability of the 2 populations to respond to physiological stimuli in a highly differentiated manner leads to the assumption that 2 different systems in the cardiovascular sympathetic outflow exist.

Experiments performed within the last few years demonstrate the ability of the sympathetic vasomotor system to respond to various physiological stimuli with a high degree of differentiation of regional sympathetic outflow (for review of literature, see Simon and Riedel[1]). By compilation of these changes in regional sympathetic activity or changes in blood flow, a pattern results as the creation of the vasomotor control center in response to the entire information – neural and humoral – during a given stressful situation. In the analysis of the components of the diverse patterns of autonomic outflow by direct recording of regional vasomotor activity in rabbits, non-uniformity up to the degree of opposite changes of activity was found in different filaments innervating the same vascular regions or organs, e.g. the heart. This indicates the ability of the autonomous nervous system to functional differentiation of its outflow to single organs, which may be based on the existence of different fibre populations. This, in fact, could be shown for the innervation of the heart where changes of activity in some filaments always correlated with changes of heart rate and changes in other filaments appeared to be associated with changes in myocardial function[2]. Functionally different populations of vasomotor fibres have recently been identified in the vasomotor supply to the muscle by Horeyseck et al.[3] and to the skin by Gregor et al.[4] in cats. As in the heart we have found differently reacting fibre populations in the vasomotor supply to the muscle, skin and kidney of rabbits, whose function we do not yet know in detail. They showed some common intrinsic properties which may allow a general classification.

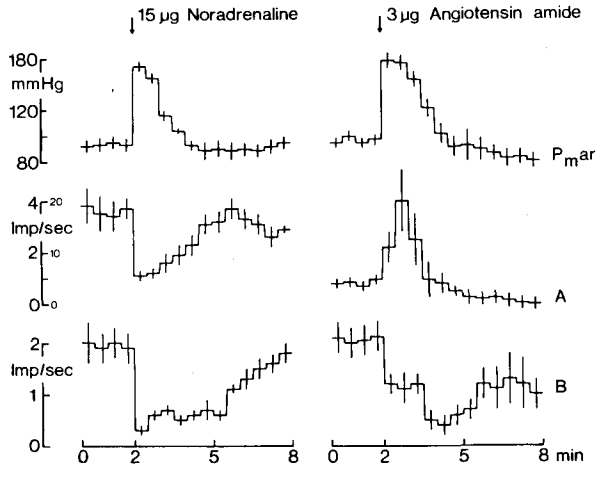

Fig. 1. Response of renal sympathetic efferents (fibre type A and B) and of arterial mean blood pressure ($P_m$ar) to i.v. injections of noradrenaline (15 µg) and angiotensin amide (3 µg). Mean values with standard deviations obtained from 9 animals. The right scale of the ordinate for fibre type A refers to the effect of angiotensin amide.

Materials and methods. 32 rabbits, weighing 3.2–4.8 kg, were anesthetized with nembutal sodium (30 mg/kg as initial dose). Subsequent anesthesia was maintained by artificial ventilation with 30% O_2 and 70% N_2O. In addition, a continuous infusion of either pentobarbital (5 mg/animal/h) or Althesin (Glaxo, 0.5 ml/animal/h) was given via the femoral vein. Relaxation was maintained with either succinyl choline (10 mg/animal/h) or gallamine (5 mg/animal/h). The femoral artery was cannulated for blood pressure recording. Sympathetic activity was recorded from fine nerve strands after removing the perineurium. Filaments containing one or few functioning fibres were put on a platinum electrode under paraffin oil. The fibre activity was amplified (band width 0.06–1.5 kHz) and displayed on an oscilloscope. Fibres discharging with different spike amplitudes could be separated by means of a window discriminator and were stored together with the original spikes and the blood pressure on magnetic tape. Numerical evaluation of the impulse rates and of arterial pressure was performed

1 E. Simon and W. Riedel, Brain Res. *87*, 323 (1975).
2 W. Riedel and W. Peter, Pflügers Arch. *365*, R 37 (1976).
3 G. Horeyseck, W. Jänig, F. Kirchner and V. Thämer, Pflügers Arch. *361*, 231 (1976).
4 M. Gregor, W. Jänig and W. Riedel, Pflügers Arch. *363*, 135 (1976).

using an IBM-1130 computer. Cardiac output was determined by means of the thermodilution method. The statistical significance of differences between paired observations were tested using the Wilcoxon matched-pairs signed-ranks test.

Results and discussion. In all investigated sympathetic postganglionic efferents to the heart, the skin, the muscle and the kidney, 2 types of fibres could be separated by their different spike heights: fibres discharging with smaller spikes were classified as type A fibres and fibres discharging with approximately twice the spike height of type A were classified as type B fibres. Type A fibres were not always spontaneously active. When both types were spontaneously active, the activity of type A fibres was always higher at normal core temperature, either in intact or vagotomized or baroreceptor deafferentated animals. While type B fibres exhibited marked respiratory grouped activity, type A fibres showed this only occasionally. However, type A fibres had rhythms of longer duration (1–3 min) which were not simultaneously detectable in type B fibres. The activity of both populations could be completely inhibited by ganglionic blockade with hexamethonium (5–10 mg/kg). The quantitative distribution of the 2 fibre populations differed in the investigated cardiovascular sections: type A fibres were predominantly found in the skin and the kidney, whereas type B fibres preponderated in the heart and the muscle innervation.

To characterize further these 2 types of fibres, circulation was altered by means of bolus injections of hypertensive drugs: noradrenaline (15 µg) and angiotensin amide (Hypertensin, 3 µg). The changes of activity induced by these stimuli in either population were qualitatively identical in all investigated cardiovascular sections, and quantitatively most prominent in the renal innervation, that is, the populations responded partially differently. Figures 1 and 2 show the results found in the renal innervation of 9 rabbits where both fibre populations were simultaneously active. As seen in figure 1, both fibre populations were depressed by the noradrenaline-induced blood pressure rise. Type B fibres showed a sustained depression as long as blood pressure was elevated, the activity of type A fibres rose after an initial depression reaching prestimulation values at the same time as blood pressure. Injections of 3 µg angiotensin amide caused a similar blood pressure rise as noradrenaline. Whereas the activity of type B fibres was depressed, the activity of type A fibres increased markedly, reaching a maximum at about 60 sec after injection, then activity declined to below prestimulation level. The activity of both fibre types then remained depressed until the 6th min, after which it slowly rose to prestimulation values. To compare the effect of a pure baroreceptor signal, both sinus nerves and both depressor nerves were cut. The central end of the left depressor nerve was then stimulated with 0.1 msec square pulses, 6–12 V, and a frequency of 100 pulses/sec for 1 min (figure 2). This baroreceptor signal inhibited the activity in both fibre populations. The activity of type B fibres remained depressed throughout the stimulation period, the activity of type A fibres rose after an initial inhibition, reaching approximately prestimulation level at the end of the stimulation period. After the end of the stimulation, both fibres responded with an overshoot of activity lasting for approximately 60–90 sec. During a continuous infusion of angiotensin amide (10 µg/animal/min), this response of type A fibres to depressor nerve stimulation became more pronounced. To find whether the activating effect of angiotensin amide on fibre type A was facilitation of ganglionic transmission, the preganglionic activity in the splanchnic nerve was recorded. About 30% of the fibres which were depressed by a blood pressure rise due to noradrenaline injection, responded to injection of angiotensin amide with an increase of activity. This indicates a more central site of action of this drug as far as its activating effect of sympathetic population A is concerned. After cutting all baroreceptors in the neck, angiotensin amide clearly activated type A fibres, with type B fibres only being effected to a minor extent.

Using the criteria of different spike height, different susceptibility to noradrenaline which appears to act mainly via the baroreceptors, and to angiotensin amide which acts on type B fibres presumably via the baroreceptors and on type A fibres by central activation, 2 sympathetic postganglionic fibre populations could be classified. Based on the existence of these 2 fibre populations non-uniformity of vasomotor outflow is found in the diverse cardiovascular sections at a given experimental condition. An example is given in the table. While in the innervation of a single organ fibres of each type respond rather uniformly, each population may exhibit in itself a differentiated response pattern if the innervation of different organs is analysed. Our findings indicate the existence of 2 different systems in the cardiovascular sympathetic outflow which both possess the ability of differential control of diverse cardiovascular sections.

Changes of activity of type A (A) and type B (B) fibres supplying the heart and the kidney, and of heart rate (HR), and cardiac output (CO) in 8 vagotomized rabbits during central heating at different skin temperatures

	Cardiac sympathetic				Renal sympathetic	
	A	B	HR	CO	A	B
Peripheral warming	++	−	++	−	+	−
Peripheral cooling	+	+	+	++	−	++

+, activation; −, depression.

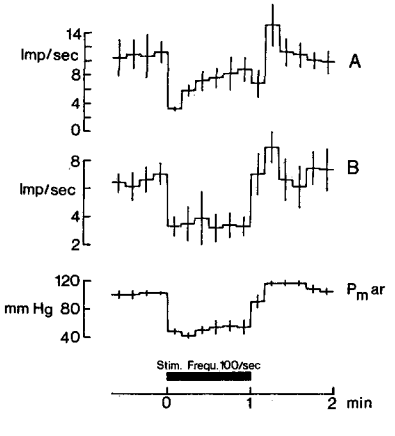

Fig. 2. Response of renal sympathetic efferents (fibre type A and B) and of mean arterial blood pressure ($P_m ar$) to baroreceptor stimulation of 1 min duration. Mean values with standard deviations from 4 animals. Stimulus intensity 9 V, frequency 100 pulses/sec.