group early in development that lasts longer than in WKY. The potential significance of this discordance in the evolving hypertension in SHR is further supported by studies of renovascular hypertension in which there is a transient surge in NAD-PGDH 10 days after initiation of hypertension[13]. Thereafter, the PGDH returns to normal despite maintenance of the hypertension.

The validity of the assay utilizing PGE_1 as substrate has been previously documented[1,5]. Endogenous NADH oxidase in kidney does not interfere with the assay and the conditions minimize reaction by other prostaglandin-degrading enzymes. The concentration of PGE_1 for half-maximal activity was less than 1 μM for NAD-PGDH and NADP-PGDH in these homo-genates, even though a value of 1 μM was noted for purified rat kidney NAD-PGDH[5], and 153 μM for purified swine kidney NADP-PGDH[2]. The latter enzyme is a nonspecific dehydrogenase and exists in multiple enzymatic forms in crude tissue[2]. Purification of the enzymes may select certain forms or remove factors modifying activity.

In view of the known multifactorial nature of hypertension and the temporal patterns found in this study, it is concluded that changes in PGDH and HK in kidney during early development in SHR may reflect a primary etiological derangement in prostaglandin and carbohydrate metabolism that the expressed as elevated pressure in the latter stages of development.

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The significance of temperature and barometric pressure changes for the snow surface activity of Isotoma hiemalis (Collembola)[1]

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Summary. Temperature is limiting for the snow surface activity of Isotoma hiemalis: values below a threshold of $-2.5°$ to $-3°C$ are avoided. Changing barometric pressure leads to increased surface activity, thus being responsible for mass appearances. These experiments provide the first evidence for sensitivity to and reaction to barometric pressure changes in insects.
Key words. Collembola; snow; activity; temperature; barometric pressure changes.

The emergence of Collembola from the snow has always attracted the interest of naturalists. Many detailed reports can be found in the older literature[2-5]. Even the few recent papers do not deal with all aspects of the phenomenon[6-10]. Experimental work has only been done in the field of cold hardiness (for a review see Sømme[11]). Unfortunately, the weather conditions accompanying the observations of mass appearances have not been considered sufficiently. However, in most cases changing weather seems to coincide with spectacular mass occurrences. It is evident that mild temperatures favor the activity on the snow surface[5,7,8], but the high relative humidity usually linked with such temperatures could also be of some importance[5]. Observations on other snow-insects, like Boreus[6,12] or Chionea[13-16], cannot shed further light on the question; nevertheless, these papers also indicate a relation to weather changes. Nadig[15] was able to show that relative humidity is a most important environmental factor for surface activity of Chionea.

There were always situations where the presence or absence of snow-insects on the snow cover could not be explained by the existing theories. The animals often showed a strikingly different appearance pattern on apparently equivalent consecutive days. Also, there was no answer to the question of how the animals can respond to favorable weather conditions on the surface when they have retreated deep into the snow or even into the soil. Macnamara[5] has already postulated 'some kind of tropism'. The often-adopted hypothesis that melting water seeping into the ground brings Collembola up onto the surface cannot be held in most cases as mass emergences can be observed throughout the winter and e.g. I. hiemalis of the mucronata-morph living in moist drains never appear on the surface during spring[17].

Light, temperature and relative humidity can be excluded as triggering factors for a mass emergence, as they remain almost constant within or below the snow cover. For foresters 'lots of snow fleas' are the infallible sign of an approaching weather change, mostly connected with precipitation. This fact was already known to the naturalists of the last century[5,18,19]. The coincidence of weather changes with increased surface activity suggests that atmospheric pressure changes may be involved in some way.

The present paper deals with the reaction of Collembola to snow temperature and barometric pressure changes.

Materials and methods. Field observations were carried out in our research area Gurnigel in the Bernese Prealps (for site description see Zettel and v. Allmen[20]).

For the pressure experiments, animals freshly caught on the snow surface were kept in a climatic chamber on fresh snow in exsiccators of 10 l content. One vessel was hermetically closed in order to maintain constant pressure conditions. Another

one was connected to a manometer and a Masterflex pump, the pressure being continuously reduced at a rate of circa 2.2 mb/h, starting in the late afternoon under darkness. Light was switched on the next morning at 08.00 h, when the the counting series throughout the day began. The two vessels were exchanged after each experiment, in order to demonstrate that both experimental populations show the same behavior. The pressure reduction rate used corresponds to those that are observed during severe weather changes which lead to mass appearances of Collembola. Such a high rate was chosen to bring a significant percentage of the animals to surface activity. From experiments with confined populations in the field we expect only a small percentage of the population usually to be present on the surface. The experiments were run at temperatures between −1.9°C and 0°C. Lower temperatures would drastically reduce the number of surface-active animals.

Results and discussion. 1. Temperature. Snow-active *I. hiemalis* show supercooling points of −15°C and a chill-coma of −8°C. In spite of such cold-hardiness and a good motility down to − 6°C, surface temperatures lower than −2.5°C are avoided, as field observations demonstrate (fig. 1). Hence the springtails are able to retreat safely into non-hazardous lower parts of the snow layer before being immobilized by the cold. Not only the surface temperature is of importance, but also the temperature profile of the snow cover. Often no Collembola can be observed in spite of favorable surface temperatures. In most such cases a cold layer of less than −2.5°C can be found within the cover, resulting from a recent cold spell. Such cold barriers are not traversed by Collembola, thus they remaining in deeper layers until temperatures rise again (fig. 2). These barriers can be by-passed, as they exist as horizontal layers only; in deep footprints, as well as in trenches cut into the snow, Collembola soon appear on the side-walls below the cold layer. A retreat into the soil occurs only under exceptional conditions[17]. Each collembolan species has its own threshold temperature, e.g. *Isotoma propinqua* is surface-active down to −5°C, *Vertagopus westerlundi* only at air temperatures above zero. The role of temperature is also evident from the pressure experiments; under constant pressure conditions, the number of surface-active springtails decreases with decreasing temperature (see table). Another reason for an absence of Collembola on the surface is the presence of ice layers in the snow, formed during warm spells with rain, which usually represent a barrier which cannot be crossed by snow-insects (fig. 2c).

2. Changing atmospheric pressure. Collembola appear in increased numbers with both falling and increasing atmospheric pressure; both cases were tested in laboratory experiments. In all runs, more animals emerged from the snow under changing pressure, and they were also much more active, climbing up into the lid of the exsiccator. The nearer the temperature was to the cold threshold, the more evident was the stimulating effect of pressure changes (see table). The two observation series with increasing temperature seem to be exceptions, more animals being active in the control vessel. But they are in full agreement with the other results: the temperature increase of 3°C (realized with a strong additional light source) resulted in a pressure increase in the vessels of 10 mb within 5 h, thus providing changing conditions in the control vessel, whilst it virtually compensated for the pressure decrease in the experimental one. A stimulating effect was only obtained by a continuous pressure change; a sudden pressure change of even more than 50 mb caused no reaction.

It is still unknown what exactly pressure changes are effecting. In the exsiccator experiments the animals emerged from the snow only under illumination and retreated again after the lights were switched off (fig. 3c). This fact suggests a stimulation of the positive phototactic behavior which is also observed in the field. A mere increase of activity is unlikely, because even in the laboratory the animals were not surface-active in the dark. Detailed field observations reveal that

animals which have emerged do not remain on the surface. There is rather a constant movement of Collembola up and down; the number of visible animals thus stays almost constant, while it is possible to collect much a higher number from the same area over a period of time. Changing pressure conditions may reduce the downward movements, leading to an increasing number on the surface. But in addition there must be another, stimulating effect since when there are mass appearances most of the animals emerge within a short time in the morning. The experiments with increasing temperature showed that *I. hiemalis* is able to react to pressure changes within 3 h (fig. 3c).
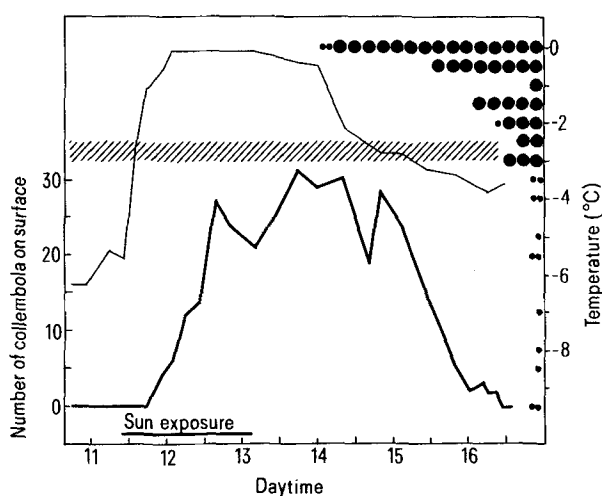

Figure 1. Number of *I. hiemalis* present on a test plot of 3 m² at Dürrbachgraben 31.1.81. The temperature threshold of −2.5 to −3°C is hatched. Animals being active at lower temperatures than −2.5°C usually stay in microspaces with slightly higher temperatures (e.g. near twigs or stems penetrating the snow). ▬▬, Number of animals; ——, surface temperature. To the right the presence (●) or absence (◦) of *I. hiemalis* in relation to (air) temperature is plotted, summing up the data of two winters.
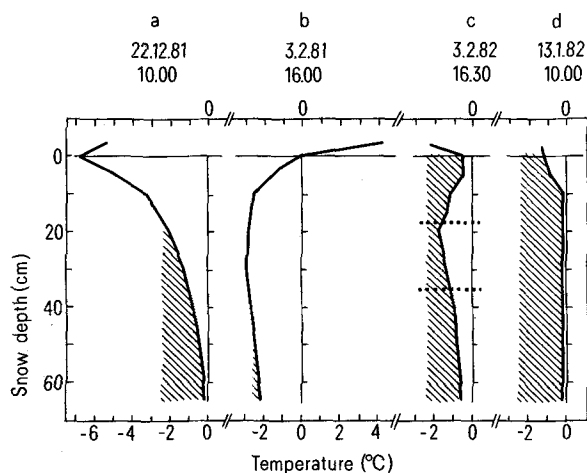

Figure 2. Influence of snow temperature on surface activity of *I. hiemalis*. Snow space above the threshold temperature of −2.5°C which is accessible to Collembola is hatched. *a* Air and surface temperature below threshold, no Collembola on the surface. *b* Air and surface temperature above threshold, but cold layer within the snow cover impedes surface activity of Collembola. *c* Air and surface temperature slightly above threshold, two ice layers within the snow cover. Only few Collembola on the surface. *d* Temperatures above threshold, full surface activity of *I. hiemalis*.

Maximal number of *I. hiemalis* active on the snow surface (out of 150 individuals) in the pressure experiments. T: temperature in °C; A: exsiccator connected to pump, with pressure reduction (−) and increase (+), respectively; B: hermetically closed exsiccator. Changing pressure conditions bring more Collembola to surface-activity. In the run with increasing temperature the pressure reduction in A was compensated during strong illumination and a pressure increase resulted in B (see also fig. 3c)

T	A	B	d
− 1.9	75 (−)	10	**
− 1.7	25 (−)	5	**
− 1.5	39 (+)	18	**
− 1.0	35 (−)	18	*
0.0	77 (−)	38	**
− 1→ +2	46 (−)	75 (+)	**
− 1→ +2	56 (−)	70 (+)	−

d, difference significant at 5% level (*) and 1% level (**), respectively (χ^2-test).
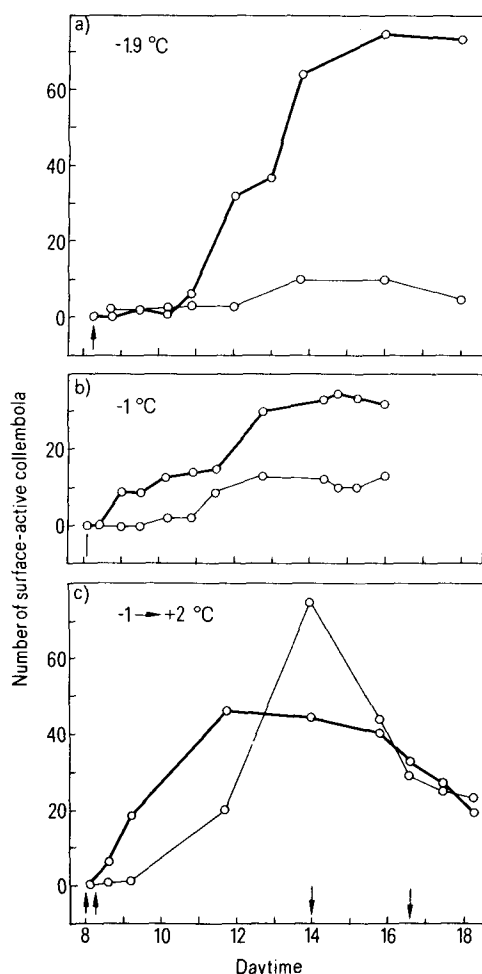

Figure 3. Surface activity of *I. hiemalis* during the day in exsiccator experiments. O——O, Vessel A with falling pressure (2.2 mb/h); O——O, control vessel B with constant barometric pressure; ↑ light on; ↓ light off. Animals already (inactively) present on the surface at the beginning of counting are omitted. *a* Constant temperature of −1.9°C. *b* Constant temperature of −1.0°C. *c* −1°C, with an additional light source rising the temperature in the vessels to +2°C. By this a pressure increase was realized in vessel B and a compensation of the pressure decrease in vessel A. The number of springtails active in B surpassed that in A within a few hours. The decline of surface-activity after the switch-off of the lights indicates a relation between surface-activity and phototaxis.

The extent of the influence of pressure changes on free living Collembola can be illustrated by the following observations. On a test plot of 3 m² the following numbers of *I. hiemalis* were counted: 20 (29.1.81), 32 (30.1.81), 583 (3.2.81). Air temperature was above zero during all observations and daytime identical. The first two days showed similar meteorological conditions, but during the last one atmospheric pressure dropped with a rate of ca. 2 mb/h for several hours. At the same time there was a mass appearance of Collembola rarely encountered on the snow surface (e.g. *Vertagopus westerlundi*) and the same phenomenon was reported from the Jura mountains[21].

At least in *Isotoma hiemalis* the phenomenon of snow-activity is even more complicated. This species accomplishes a cyclomorphosis[17, 22, 23]; only part of the population is able to appear on the snow surface (the morph *I.h. hiemalis*), another part (the morph *I.h. mucronata*) stays in or near the soil and does not exhibit the biochemical adaptations crucial for surface activity[17, 24]. Among thousands of surface-active *I. hiemalis* checked, not one belonged to the *mucronata* morph. It still has to be established whether these animals react to pressure changes. So far, the experiments have failed because the animals died within a few hours when in contact with snow. Nothing is known from literature about reactions of insects to atmospheric pressure changes. But there exist observations suggesting such a behaviour. Nadig[15] could not find any interpretation for the fact that *Chionea* was relatively rare during prolonged periods of favourable conditions but was observed in large numbers during weather changes. Matthey[25] made most interesting observations on Canadian water-striders *(Gerris remigis)*; laboratory populations left the water surface and assembled an the container walls, a behavior characteristic for animals entering diapause. But this behavior only lasted 1–2 days. It occured simultaneously in several cultures and affected only adults (winged and wingless). In 4 out of 6 observed cases, one day later a weather change with winds and precipitation occurred. Unfortunately no barometric records were available. Factors other than pressure acting as triggers seem to be unlikely, and the similarity to the observations in Collembola is striking.

The significance of surface activity for Collembola has been discussed by Leinaas[26], who proposes that dispersal on the snow is of great advantage. Soil surface and vegetation form almost insuperable obstacles in summer. In our research area all species with snow activity are hygrophilic and live in moist litter in drains and small depressions. The colonization of new habitats would hardly be possible in summer, as these are separated from each other by much dryer areas. But in winter the springtails can cover distances under optimal humidity; when staying on the last snow patches in spring, they have a good chance to find new suitable habitats.

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Prolonged vibration of cutaneous artery: absence of persisting aftereffects[1]

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Summary. 1–3 h after prolonged (3–16 h) vibration (120 Hz, 0.2–0.3 mm amplitude) of rings of canine saphenous arteries there was no significant change in the contractile response to electrical stimulation, exogenous norepinephrine or of neuronal uptake of tritium labeled norepinephrine. These results did not provide evidence for persistent aftereffects of prolonged vibration.
Key words. Arteries, canine; electrical stimulation; contractile response; aftereffects, persisting; vibration, prolonged; norepinephrine.

The present study was designed to examine possible after effects of prolonged vibration on sympathetic nerve endings and smooth muscle in isolated rings of a small cutaneous artery. Rings (outside diameter approximately 1 mm before stretching, length 2–3 mm) of canine saphenous arteries were suspended between a force transducer and a vibrator (fig. 1). The vibratory oscillations were controlled by a sine-wave generator and monitored by a strain-gauge glued to the vibrator. The rings were superfused (3 ml/min) with aerated Krebs-Ringer solution at 37 °C (mmolar composition: NaCl, 118.3; KCl, 4.7; $CaCl_2$, 2.5; $MgSO_4$, 1.2; KH_2PO_4, 1.2; $NaHCO_3$, 25.0; edetate calcium disodium, 0.026; glucose, 11.1). For stimulation of adrenergic nerve endings 2 platinum electrodes were mounted parallel to the rings[4]. To determine the aftereffects of vibration on neuronal uptake the rings were incubated with L-7-^{3}H-norepinephrine following 16 h of vibration. The rings were then washed in physiological salt solution before extracting and measuring tissue content of labeled norepinephrine[2,3]. In

all experiments control rings were run in parallel. Rings were stretched to optimal length for contraction, using a standard electrical stimulus, before each determination of contractile response. Optimal length was similar before and after vibration. On contraction many rings showed an initial maximal contraction followed by a smaller stable contraction. Maximal contractions were used for calculation. Results are expressed as mean ± SEM. Statistical evaluation of the data was by Student's t-test for paired observations.
Contractions were evoked by increasing frequencies of electrical stimulation (0.5–16 Hz, 9 V, 2 msec pulse duration) be-
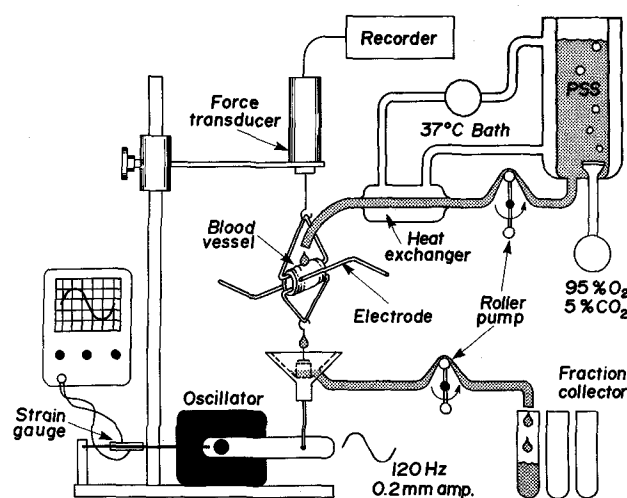

Figure 1. Technique used to determine the response to vibration of rings of canine saphenous arteries.
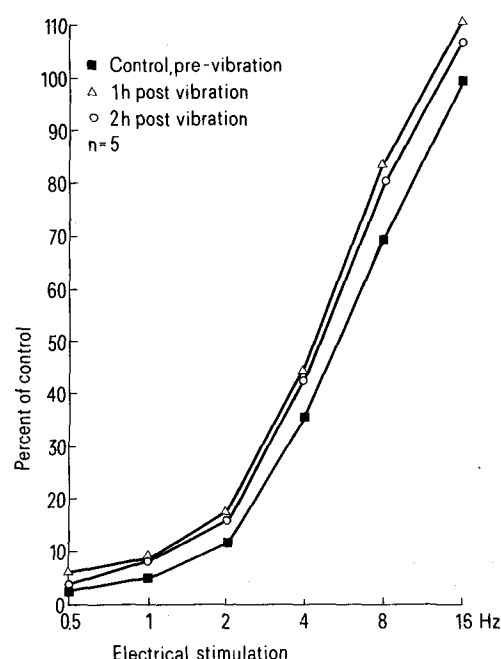

Figure 2. Contractions of rings of canine saphenous arteries to electrical stimulation with increasing frequencies (0.5–16 Hz) before and 1 and 2 h after vibration for 3 h (120 Hz, 0.3 mm amplitude). Data are expressed as percentage of maximal contraction (16 Hz).