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EXPANSION OF A MATHEMATICAL MODEL OF THERMOREGULATION TO INCLUDE HIGH METABOLIC RATES

NAS-9-7140

Final Report - B

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J. A. J. Stolwijk

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Introduction

In the Final Report A of this contract we presented the results of a series of experiments in which subjects performed work on a bicycle ergometer at 25%, 50% or 75% of their maximum aerobic capacity in environments of 10°C, 20°C and 30°C. The time resolution of some of the measurement made, especially that of weight loss by evaporation of sweat, was such that the results could only be evaluated as essentially steady state results at the end of a prolonged period of exercise. The results of that work was reported in three papers:

1. Stolwijk, J.A.J., B. Saltin and A.P. Gagge. Physiological factors associated with sweating during exercise. J. Aerospace Med. 39, 1101-1105, 1968.

   This paper described the relationships between the independent variables, ambient temperature and metabolic rate, and the final dependent variables rate of sweat secretion and skin blood flow; in addition the variables which interpose themselves between the independent and dependent variables core temperature and skin temperature were related to the dependent and independent variables. The Final Report A also contains a Table which gives all steady state values obtained in all 72 separate experiments.

2. Saltin, B., A.P. Gagge and J.A.J. Stolwijk. Muscle temperature during submaximal exercise in man. J. Appl. Physiol. 25, 679-688, 1968.

This paper reports the results of our efforts to obtain working muscle temperature during work at various level and different ambient temperatures. There has been speculation that thermal receptors in the active muscle mass, or in the veins draining such muscles might be involved in thermoregulation. If such speculation has any basis such receptors would make their contribution felt especially in the exercising state. The results we obtained are compatible with the following somewhat oversimplified concept: at rest the muscle temperature is largely under the influence of the environmental temperature and the length of the preceding rest period. At 25 mm depth in the quadriceps muscle resting temperatures were found to be as low as 32°C and as high as 36°C. In steady state exercise the working muscle temperature at that depth was found to be about 0.8°C above the esophageal temperature, independent of work load or ambient temperature in the ranges studied. This constant relationship between working muscle temperature and esophageal temperature implies that the blood flow required to supply oxygen to the muscle also has a distinct cooling effect proportional to the heat production. The overall effect as far as muscle temperature is concerned consists of two phases: a rapid rise at the onset of exercise when heat production as well as perfusion with warm blood add heat to the muscle, followed by a slower rise which reflects the rise in central body temperature and in the temperature of the blood supplied to the working muscle. The transition from the first phase to the latter i.e. the point where muscle temperature begins to exceed oesophageal temperature is reached between 3 and 8 minutes after the start of exercise.

3. Gagge, A.P., J.A.J. Stolwijk and B. Saltin, Comfort and thermal sensations and associated physiological response during exercise at various temperatures. Environmental Res. 2, 209-229, 1969.

The comfort and sensation estimates obtained during the summer of 1967 were analyzed in the above paper. Using techniques for category estimates described in detail in the published paper we attempted to find physiological and environmental correlates with estimate of thermal sensation and thermal comfort.

It was found that thermal sensations ranging from cool to hot are principally related to air temperature and skin temperature. Such reports show little or no correlation with metabolic rate, or internal body temperatures as measured by esophageal, rectal or muscle thermocouples.

Warm discomfort is principally related to sweating and skin conductance and is thus, perhaps indirectly, also related to air temperature, metabolic rate, and skin and internal temperatures. During steady state exercise the thermal sensations appear to be dominated by skin receptors and the appreciation of thermal comfort is affected more by the thermoregulatory effector mechanisms (sweating and cutaneous vasodilatation).

The results were condensed into a chart which on a plot of ambient temperature versus metabolic rate gave loci of equal discomfort estimates.

The last section of Final report A was devoted to the description of a mathematical model of thermoregulation as it had developed from the results of previous resting thermal transient exposure and from preliminary evaluations of the exercise data obtained for the steady state. This model

Body temperatures and sweating during thermal transients caused by exercise

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SALTIN, B., A. P. GAGGE, AND J. A. J. STOLWIJK. *Body temperatures and sweating during thermal transients caused by exercise.* J. Appl. Physiol. 28(3): 000–000. 1970.—During thermal transients caused by bicycle exercise (25–75 max $\dot{V}O_2$) at ambient temperatures of 10°, 20°, and 30° C (RH $\simeq$ 40%), continuous observations were made of oxygen uptake, weight changes ($\dot{W}$), skin ($\bar{T}_s$), esophageal (T_{es}), rectal (T_r), and quadriceps muscle (T_m) temperatures, as well as skin conductance and skin evaporation (E_s). At the start of exercise, a 2- to 5-min delay was observed before E_s increased to a level effective for temperature regulation T_m rose rapidly; the response of T_{es} was faster and wider than T_r. For the lower exercise levels, $\bar{T}_s$ remained essentially unchanged; for the highest level the greatest changes in $\bar{T}_s$ happened at 10° C. Changes in T_m may relate initially to sweat secretion rate rather than $\dot{W}$. Significant linear regressions between E_s and $\bar{T}_s$, T_{es} and T_r occurred only during exercise. No linear combinations of these temperatures could predict E_s under all conditions of rest, exercise and ambient temperatures and account for more than 65% of the data. Thermoregulatory signals from the observed body temperatures may have interacted nonlinearly, or other important sources of thermal and nonthermal signals may not be represented by our temperature measurements.

temperature regulation during exercise; temperature regulation during recovery after exercise; evaporative heat loss during and after exercise; esophageal temperature during exercise transients; muscle temperatures during exercise transients; mean skin temperatures during exercise transients; limits for evaporative heat loss during rest and exercise

A NUMBER OF CLEAR RELATIONSHIPS have emerged in the recent literature dealing with thermoregulation during rest and exercise. Experimental evidence now shows that for any individual in a steady-state his internal body temperature, as measured rectally, is proportional to the metabolic rate and independent of ambient temperature (22). When subjects with varying levels of physical fitness or aerobic power are compared, internal body temperature is proportional to the work level expressed as a percentage of the individuals' maximal oxygen uptake (27). Average skin temperature in steady state is a linear function of the ambient air temperature and is relatively independent of the level of exercise (20, 22, 26, 28, 31). Finally, regulatory sweating is closely related to skin conductance, an index of skin blood flow (20, 26, 31). The two major independent experimental variables in any study of heat regulation are usually the temperature of the environment and the level of exercise. The level of sweating necessary for regulation of body temperature can be predicted reliably by these two factors (26, 31). In view of the relationships described above, regulatory sweating may also be predicted with reasonable reliability by a linear function of skin and internal body temperature whether measured in the esophagus or the rectum (20, 26, 28, 31). The above temperature-energy relationships, although somewhat oversimplified, apply primarily for steady-state conditions.

The purpose of the present study is to evaluate the effect of thermal transients, caused by varying periods and levels of exercise, on temperature regulation. From such thermal transients it may be possible to gain a closer understanding of the relationships between the various factors involved.

TABLE 1. *Anthropometric and circulatory data for test subjects*

Subj	Age, yr	Height, cm	Weight, kg	Surface Area,* m²	Maximal Heart Rate, beats/min	Maximal Oxygen Uptake		
						1/min	1/(m²·min)	ml/(kg·min)
BC	25	183	79	2.03	190	3.8	1.87	48
PM	22	189	84	2.09	235	4.2	2.01	50
BS	33	187	89	2.17	183	5.4	2.48	61

* According to DuBois (8).

TABLE 2. *Submaximal work loads (kpm/min)**

Subj	Percent of Maximal Oxygen Uptake		
	Mean 25%, low	Mean 47%, medium	Mean 73%, high
BC	300	750	1,200
PM	300	750	1,200
BS	450	1,050	1,650

* kpm/min = Kilopond-meter per minute; 100 kpm/min = 16.35 W. These figures do not include the internal friction within bicycle, which was about 8% of load at 50 rpm.

SUBJECTS

Selected anthropometric and circulatory data for the test subjects used are presented in Table 1. The experiments were performed during summer 1968. Two of the subjects (*PM* and *BS*) were the same as in our previous study (26). The submaximal work loads used for each subject are shown in Table 2.

METHODS AND PROCEDURES

The experimental chamber was the same used in our earlier study (26). The methods and procedures for the measurement of intramuscular and rectal temperatures and for oxygen uptake (metabolic rate) and heart rate were the same. A Monark bicycle ergometer was again used. The reader is referred to the above reference for a detailed description of these methods. In the present study skin tem-

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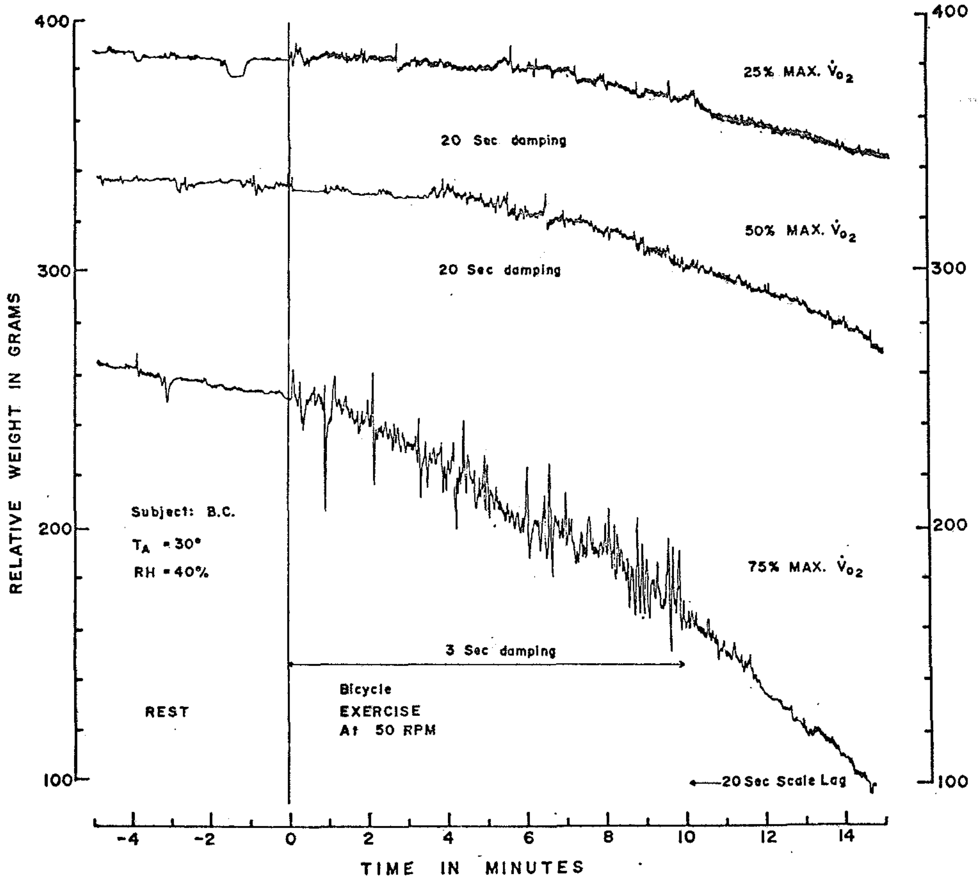

FIG. 1. Tracings of weight loss records for *subject BC* while exercising at three different work rates, "low" at the top and "high" at the bottom. Room temperature was 30° C (40% RH). The start of each exercise period has been arbitrarily set at zero time. *Ordinate* scale indicates the relative change in total body weight in grams.

peratures were measured with thermocouples placed at 10 different locations (forehead, chest, abdomen, scapular, lumbar, biceps, forearm, finger, thigh, and calf). In addition, the temperature of the esophagus was included; this thermocouple was located at the same level as the heart and was set originally by fluoroscopic guidance for each subject.

A significantly new method used in the present study was the continuous measurement of body weight during exercise. For this purpose the bicycle ergometer was placed on a Potter platform scale (described as "Potter Bed Balance" in US Patents 3,224,518 and 3,360,002). The unique feature of this scale is that thin steel ribbons (3 inches wide and with all planes parallel) are used in place of the conventional knife edges found on platform scales. By arranging the plane of the pedaling motion parallel to the four primary supporting steel ribbons of the scale, it was possible to eliminate from the weight records most of the inertial disturbance caused by exercising. The millivolt output from a linear variable differential transformer sensing circuit (supplied by the manufacturer) was used to measure on a recorder the rate of weight loss of the subject and the consequent total evaporative heat loss. A sample experimental record is illustrated in Fig. 1. Damping was controlled electrically; the 3-sec and 20-sec levels have been illustrated. For a 20-sec setting the pedaling disturbance may be reduced to approximately a 5-g displacement on the record. With a 3-sec setting the disturbance was approximately 20 g. The mode with a 20-sec damping was used for the majority of the experimental results reported here.

All the above measurements were produced in the form of a millivolt output, and for each minute these data were converted to digital form in an A-D converter and stored in the disc memory of an IBM 1131 computer for the entire 3-hr-long experimental period. In addition, it was possible to monitor continuously the rate of weight loss and any temperature on separate millivolt strip recorders. At the end of the experiment the computer was supplied the appropriate calibration constants and it converted the basic millivolt data into the corresponding thermal units—in this case, degrees Centrigrade and watts per square meter or kilocalories per square meter·hour.

PROCEDURE

Three environmental temperatures, namely 10°, 20° and 30° C, were again used at a relative humidity (RH) of 40%. The air movement about the subject in the experimental chamber resulted in a combined heat transfer coefficient of 7.0 W/(m^2·°C), when resting on the bicycle. While pedaling at 50 rpm, the combined transfer coefficient rose to 10.0 ± 1.0 W/(m^2·°C). The latter value was determined statistically from our earlier equilibrium data at 10° C, 75% max $\dot{V}_{O_2}$, at 20° C, 25%, 50%, and 75% and at 30° C, 25% and 50% where body heat storage appeared to be negligi as judged by the rate of change of rectal and skin temperature.

The protocol of each experiment was as follows. The subject dressed in shorts and gym shoes. The intramuscular thermocouples described previously were inserted at normal room temperature prior to entry into the test room. He then sat on the bicycle ergometer mounted on the platform scale and the skin thermocouples, and other temperature transducers were applied. The initial exposure before the first exercise varied from 20 to 30 min and at least 15 min of data were recorded before the start of exercise. Three half-hour exercise periods at 25 %, 50 %, and 75 % of each individual's maximal oxygen uptake were used. Each exercise period was followed by 30 min of rest. Oxygen uptake was recorded continuously for 5 min before, during, and 10 min after each exercise run. One complete run was performed on all three subjects at 30° C. On *subjects PM* and *BS* complete observations were made at 20° C; and on *subject PM* and *BC* at 10°C.

CALCULATIONS

For each minute of the experiment a heat partition was made using the following heat balance equation

$$S = M - E - W - h(T_s - T_a) \qquad (1)$$

where

S = the rate of body heat storage W/m² (+ for heating; − for cooling)
M = metabolic rate W/m²
W = rate of work W/m²
h = combined heat transfer coefficient W/m²·°C

The loss E (in W/m²) is evaluated from the rate of weight loss ($\dot{W}$) observed on the scale by the relation ($\dot{W} \times 60 \times 0.7 \div A_D$) where 0.7 is the latent heat of water (in W·hr/g). A_D of the DuBois area (8). The evaporative heat loss, E, consists of two parts, E_{res} the heat of vaporization of the expired water vapor and E_s the heat loss by evaporation from the skin surface itself.

The heat conductance of the skin (K) is

$$K = [E_s + h(T_s - T_a)]/(T_r - T_s) \quad W/m^2 \cdot {}^\circ C \qquad (2)$$

or if there is thermal equilibrium

$$K = (M - W - E_{res})/(T_r - \bar{T}_s) \qquad (2')$$

E_{res} may be evaluated by the following relation (1, 9, 19):

$$E_{res} = 0.0023M(44.0 - \phi_a P_a), \quad W/m^2 \qquad (3)$$

where ϕ_a is the humidity of the ambient air as a fraction, and P_a is the saturated vapor pressure at temperature T_a (in mm Hg).

The maximum rate of evaporative heat loss, E_{max}, from the body surface is:

$$E_{max} = 2.2h_c(P_s - \phi P_a) \quad W/m^2 \qquad (4)$$

where

2.2 = the modified Lewis relation in mm Hg/°C for the ratio of the mass and convected heat transfer coefficient from the skin surface to the ambient air (4, 18, 23)
h_c = the convective heat transfer coefficient which varied in our experiments from 1.75 for rest to 4.65 W/(m²·°C) for exercise at 50 rpm
P_s = saturated pressure of water vapor at skin temperature (T_s) in mm Hg
P_a = saturated pressure of water vapor at ambient air (T_a) in mm Hg.

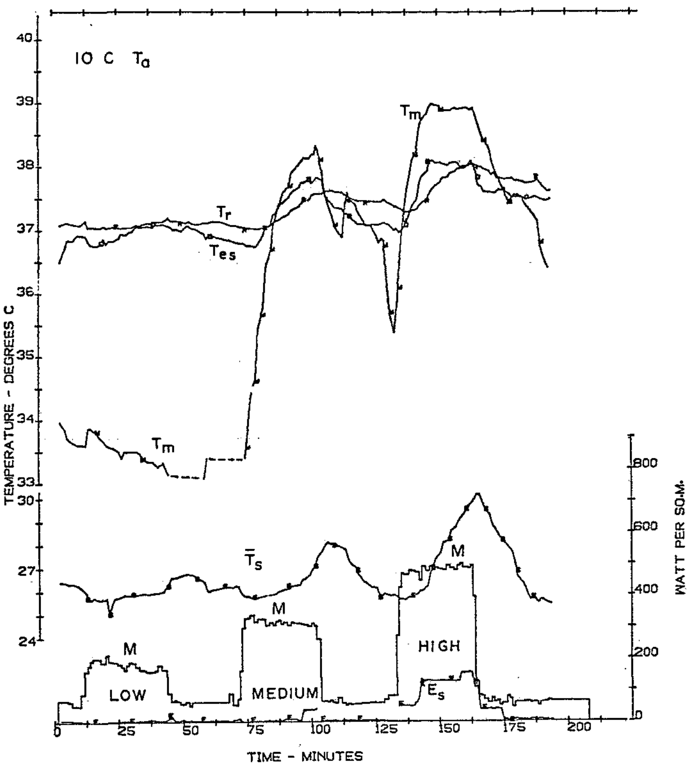

FIG. 2. Computer plot of the basic physiological variables T_r, T_{es}, T_m, $\bar{T}_s$, E_s, and M during experiment at 10° C with *subject PM*.

Whenever the observed value E_s exceeds of $E - E_{res}$ or E_{max}, the latter value is the true heat loss for use in the heat balance Eq. (11) instead of E_s.

The change in mean body temperature $\bar{T}_b$ (in °C/min) may be calculated by the equation

$$\Delta \bar{T}_b = S \times A_D/(m \times 0.965 \times 60) \qquad (5)$$

where A_D is the Dubois area in square meters, m is the body mass in kilograms, 0.965 is the body specific heat in (W·hr)/(kg·°C), and 60 is minutes per hour.

By summarizing $\Delta \bar{T}_b$ over each minute of the experiment from zero time, a value of $\bar{T}_b$ for any time of the experiment follows. At time zero the value of $\bar{T}_b$ is assumed to be:

$$(T_s + 4T_r)/5 \quad \text{at } 30^\circ C \quad \text{(refs. 14, 29)}$$

or

$$(T_s + 2T_r)/3 \quad \text{at } 20^\circ \text{ and } 10^\circ C \quad \text{(refs. 6, 7)}$$

RESULTS

The time course of the various basic physiological observations is indicated in Figs. 2, 3, and 4 for the 10°, 20°, and 30° C environments, respectively. At 30° C while at rest the subject is close to his thermal neutrality and the regulation of body temperature during exercise is primarily accomplished by sweating. At 20° C during rest there is always some body cooling and only at the two higher exercise levels was internal body temperature raised enough to cause regulatory sweating. At 10° C considerable cold stress occurred during rest and at the two lower exercise levels; significant sweating finally occurred at the heaviest exercise level.

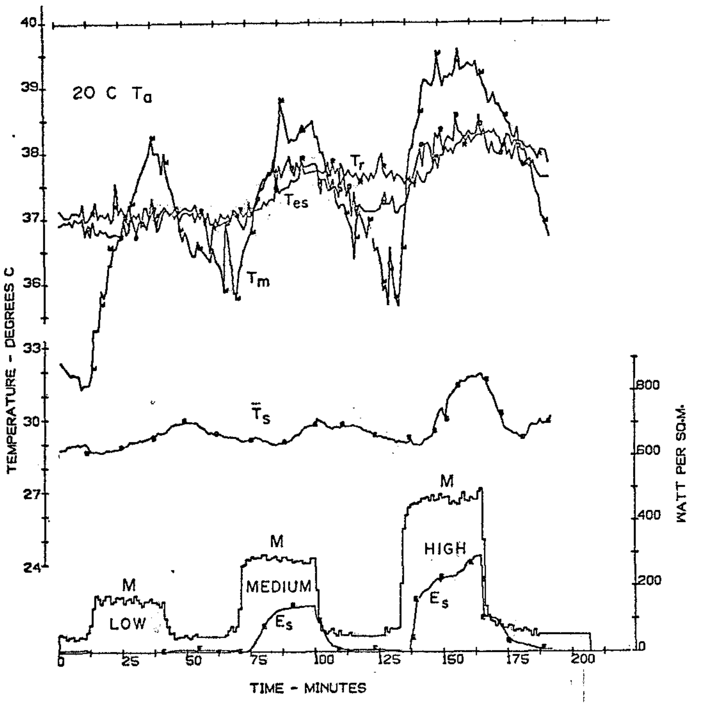

FIG. 3. Computer plot of the basic physiological variables T_r, T_{es}, T_m, $\bar{T}_s$, E_s, and M during experiment at 20° C with *subject PM.*

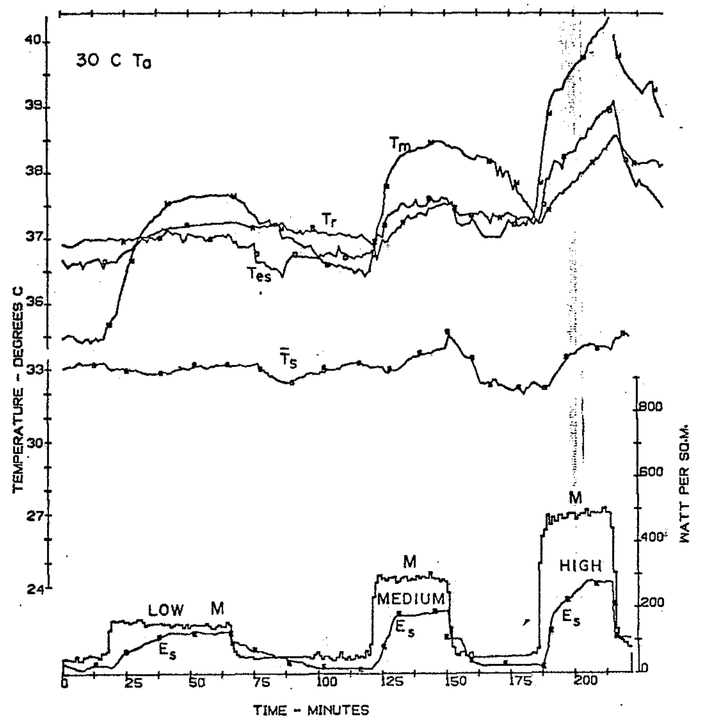

FIG. 4. Computer plot of the basic physiological variables T_r, T_{es}, T_m, $\bar{T}_s$, E_s, and M during experiment at 30° C with *subject PM.*

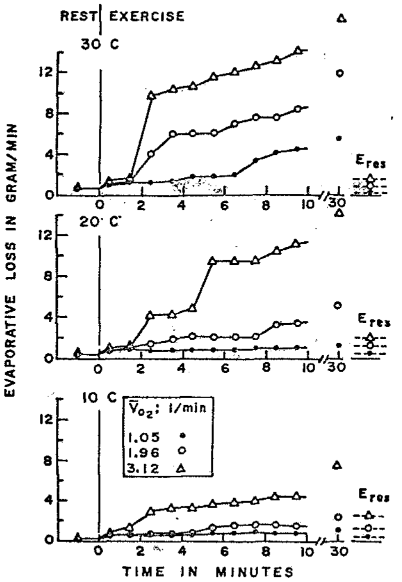

FIG. 5. Averaged data for rate of weight loss by three subjects before and during first 10 min after start of exercise at three submaximal exercise levels indicated in Table 2 and at 10°, 20°, and 30° C. Start of exercise is set at zero time on *abscissa*. Rate of weight loss at end of 30 min of exercise and rate losses attributable to vaporization from lungs are indicated at the right.

At the lower and medium levels of exercise, mean skin temperature ($\bar{T}_s$) is dependent primarily on the ambien temperature (T_a) and is independent of the exercise level. During the heaviest work load the variation in skin temperature with exercise was significant in all ambient temperatures and was the widest for the 10° C case.

At all ambient temperatures and at all three exercise levels muscle temperature was generally very responsive to exercise. The exception occurred at 10° C for the 25% maximal level. A needle probe at the end of this exercise did indicate that some other part of the working muscles had risen to 37.8° C. For the case illustrated, the muscle in Fig. 2, in which the probe was located, was apparently inactive at the 25% level but became very active at the 50% and 75% levels. As pointed out in our earlier paper, the temperature by the indwelling thermocouple must be cross-checked with a needle probe, especially for the lower levels of submaximal exercise, to be sure the section of the muscle being observed is fully active.

At all three ambient temperatures, rectal (T_r) and esophageal (T_{es}) temperatures closely paralleled each other throughout the experiment, but T_{es} was more responsive to exercise and had wider variations and a smaller time lag.

As may be seen in the original record, illustrated in Fig. 1, a few minutes may have elapsed before there was a significant change in the slope and thus in the rate of weight loss observed. The nature of this time delay in sweating at the onset of work has been analyzed in more detail in Fig. 5, where data for the rate of weight loss for our three submaximal exercise levels have been averaged for three subjects at 30°, 20°, and 10° C. In Fig. 5 the start of exercise occurred at zero minutes on the time scales indicated. In all

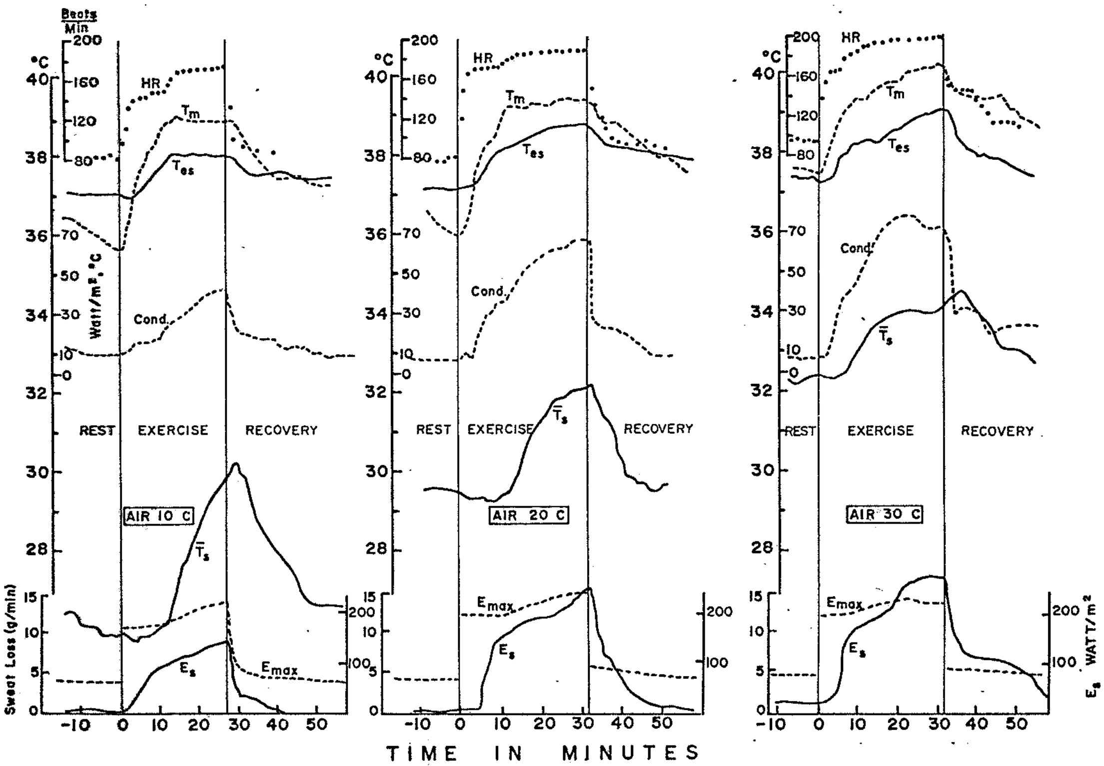

FIG. 6. Variations in time of various body and skin temperatures, of rate of weight loss from skin surface, of heart rate, and of skin conductance are shown for 10°, 20°, and 30° C during exercise at 75% maximal oxygen consumption and during recovery for *subject PM.*

nine cases there was no significant increase in the rate of weight loss during at least the first 1.5 min of exercise. On the right side of the chart there are indicated the equilibrium values for the respired rate of weight loss in grams per minute (E_{res}) as calculated from *equation 4* by the relation $(E_{res} \cdot A_D)/(0.7 \times 60)$ where 0.7 is the latent heat of water (in W·hr/g); and 60 is minutes per hour. In this example the average value of A_D is 2.10 m² for the three subjects. Thus it is possible to account for some of the initial weight loss by the respired water vapor. Weight loss caused by the difference between expired CO_2 and inspired O_2 can account for additional losses up to 1 g/min. Regulatory sweating would occur then only after these loss levels had been reached or exceeded. Also on the right side of the chart a single point has been drawn for the average loss rate observed at 30 min after the start of exercise. Only for the lowest work load was the final rate of weight loss reached within the first 10 min of exercise. For the two heavier work levels the 10-min value was 65–80 % of the weight loss found after 30 min of exercise. For each of the averages during the first minutes of exercise in Fig. 5 the standard deviation is about ±2 g/min, which fact means the time lag and the trends indicated are significant.

Since regulatory sweating occurred for the highest work rate at all three temperature levels, we can compare in greater detail how the sweat loss E_s[1] (in g/min), the average skin temperature ($\bar{T}_s$), the esophageal (T_{es}) and muscle temperatures (T_m), skin conductance and heart rate vary just before, during and after this 30 min period of exercise. The results for 10°, 20°, and 30° C are illustrated in Fig. 6 for *subject PM.* In this figure dotted lines have been drawn for E_{max}[1] (in g/min) expected for the observed $\bar{T}_s$, T_a, and relative humidity. These values have been found from *equation 4* and by the relation $E_{max} \times 2.09/(60 \times 0.7)$, where 2.09 m² is the Dubois area for the subject illustrated. This dotted line thus represents the maximum rate of evaporation that may be expected from the total body surface itself. An observed value for E_s well above the E_{max} indicates that evaporation of sweat may be taking place on surfaces (likely the platform of the scale and the bicycle) other than on the skin surface itself.

Of all the physiological variables illustrated in Fig. 6 only muscle temperature and heart rate increased immediately at the beginning of exercise. After its initial rapid rise, the muscle temperature reached a new relatively steady state within 10–12 min. The evaporation of the regulatory sweat (E_s) was delayed for 2–5 min, and then, in every case, a rapid increase occurred until the 10th min of exercise. After this critical 10 min, E_s rose continuously to the end of the experiment, but at a slower rate of increase. Esophageal temperature (T_{es}) had approximately the same time lag as E_s before the rapid increase occurred, but it tended to level off after 15–20 min of exercise.

As mentioned earlier, a marked rise in $\bar{T}_s$ was also observed at 75 % work level. The delay in the rise of $\bar{T}_s$ varied from 6 min at 30° C to 10 min at 10° and 20°. At the two latter temperatures the rate of rise in $\bar{T}_s$ was as fast as the

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[1] When E_s and E_{max} are not italicized, they are expressed in g/min and cannot be used in the heat balance equations.

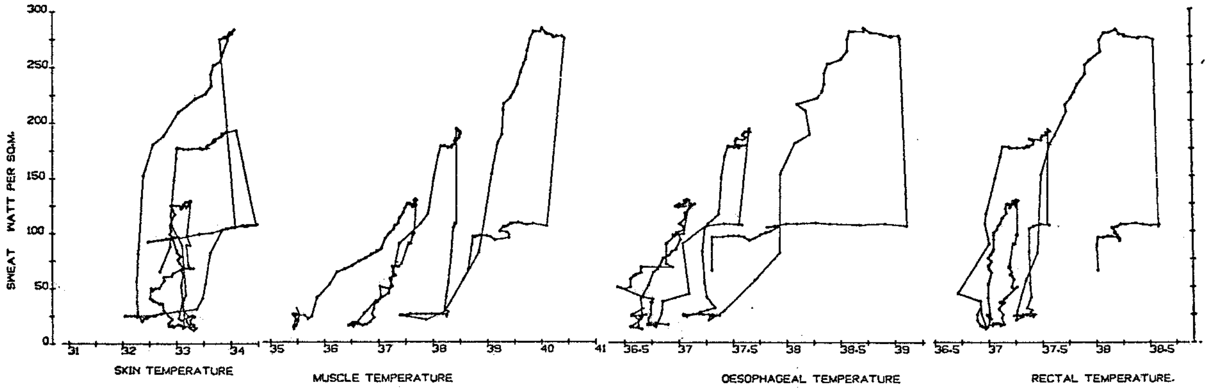

FIG. 7. Sweat losses observed for *subject PM* are simultaneously plotted by computer against $\bar{T}_s$, T_m, T_{es}, and T_r for three levels of exercise during a 3-hr experimental run at 30° C. Each successive point in time has been joined by a straight line.

temperature rise in T_m at the onset of exercise. At 10° the equilibrium level for $\bar{T}_s$ was not reached at the end of the exercise period, at which time both E_s and skin conductance were still both rising. Since E_s was always below the predicted E_{max}, the rise in $\bar{T}_s$ at 10° C and 75% work level thus represents an increasing heat flow by circulation to the skin surface.

At 30° C the skin temperature tended to parallel the rise of the esophageal temperature throughout the exercise period. At this ambient temperature the skin conductance (an index of skin blood flow) ranged from a minimal level of 10 W/(m²·°C) to a maximal level of 60–65 W/(m²·°C) in 10 min after which there was a slow rise to 75 W/m² — °C. Since T_{es} is an index of the temperature of the blood from the heart, and since a high level of vasodilation existed at the skin surface, the parallel relation between $\bar{T}_s$ and T_{es} during heavy exercise at 30° C was expected. During the recovery period after exercise at 30° C, $\bar{T}_s$, T_{es}, and T_m all fell at approximately the same rate after $\bar{T}_s$ had reversed its rise 5 min after the exercise. At the end of exercise the cooling power of the ambient air is markedly reduced since E_{max} is about half of its former level and since the dry heat exchange is relatively insignificant during rest and exercise.

The values of E_{max} (in g/min), derived from *equation 4*, represent the maximum rate of weight loss from the skin surface by evaporation and are based on values for average skin temperature ($\bar{T}_s$) and for an average convective heat transfer coefficient (h_c) for the entire body surface. Regional values of h_c for the legs and thighs are probably higher than the average, and values over the trunk may be lower but their surface temperature may be lower.

The effect of thermal stress caused by exercise at the 75% maximal level can be illustrated by changes in heart rate as the ambient temperature was varied. At the end of exercise at 30° C the heart rate was 194 beats/min; at 20°, 178; and at 10°, 167. Recovery heart rates at 100–90 level occurred within 6 min at 10° and 20° C, but 6 min after exercise at 30° C the rate was still 144 beats/min. This latter fact again shows poor cooling ability of the environment at 30° C after heavy exercise.

How regulatory sweating is directly related to the esophageal, skin and muscle temperature is illustrated by the machine plot in Fig. 7. The same data for 30° C as plotted in Fig. 4 are used. In Fig. 7 the observations for each minute of the experiment are plotted in time sequence, and a straight line joins each successive point. The loops for the three successive levels of exercise at 25%, 50% and 75% max $\dot{V}O_2$ are readily recognized. The exercise loops seem to reach an upper limit, which indicates that an increase of 1° C in T_{es} would result in an overall increase of E_s of approximately 200 W/m² (or 10 g/min sweat loss rate). In contrast, a 1° C change in muscle temperature is associated with a change in E_s of approximately 63 W/m² (or a 3 g/min sweat loss). For T_r the loops at the low and medium levels of exercise tend to coincide; the greatest change occurs at the highest exercise level. For $\bar{T}_s$ the three loops are apparent but tend to repeat about the same 33° C $\bar{T}_s$ level. For each successive level of exercise after a 30-min rest period, the threshold for sweating appears to increase for both esophageal and muscle temperature but less so for the rectal. The physical explanation may be again the poor environmental cooling during rest at 30° C and the body's inability to restore equilibrium during the recovery periods. Except for the shifting threshold, the hysteresis curves in Fig. 7 are somewhat reminiscent of similar curves observed for resting subjects (15) when exposed to thermal transients caused by varying the ambient temperature rather than by exercise. At 20° and 10° C a somewhat similar picture would have occurred for the two higher levels of exercise, except that the $\bar{T}_s$ loops would have repeated themselves about lower temperature levels.

TABLE 3. *Best prediction of sweat by a single body temperature*

Subj.	Data Selection	Regression, W/m^2	$R(t)$
PM, BS, BC	Ex—30° C (all)	$E_s = 156.9\ (T_r - 36.5)$	0.85 (21)
PM, BS	Ex—20° C (all)	$E_s = 155.2\ (T_{es} - 37.0)$	0.89 (25)
PM, BC	Ex—10° C (75%)	$E_s = 32.5\ (T_m - 35.0)$	0.76 (12)
PM, BC	Recovery—30° C (all)	$E_s = 59.9\ (T_r - 36.8)$	0.74 (15)
PM, BS	Recovery—20° C (all)	$E_s = 69.2\ (T_r - 37.1)$	0.87 (12)
PM, BC	Recovery—10° C (75%)	$E_s = 101.8\ (T_r - 37.6)$	0.93 (15)

TABLE 4. *Prediction of sweat loss* (W/m^2) *at 10°, 20°, and 30° C*

Data Selection	Linear Regression	Ratio Coeff.	R	t
All	$E_s = 11.8\ (T_s - 27.7) + 93.0\ (T_{es} - 37.0)^*$	1:8	0.81	17,26
Exercise	$E_s = 14.3\ (T_s - 29.7) + 109.8\ (T_{es} - 37.0)^*$	1:7.5	0.93	18,29
Exercise	$E_s = 15.2\ (T_s - 27.7) + 159.9\ (T_r - 37.0)^*$	1:10	0.92	18,25
Exercise	$E_s = 8.31\ (T_s - 28.7)^* + 32.5\ (T_m - 34.4)$	1:4	0.87	6,18

* Threshold temperatures arbitrarily selected for factoring intercept from regression equation.

CORRELATION ANALYSIS OF DATA

For the present limited analysis the combined data for all three subjects have been considered, and approximately 500 different sets of observations were used. In each analysis at least 100 different sets of data were included.

Table 3 presents linear regression equations predicting sweating E_s for each temperature from either rectal (T_r), esophageal (T_{es}), or muscle (T_m). They represent the best single correlations for the present data under the conditions specified on the left two columns. At 30° C T_r is predominant and its regression equation is able to account for 75% of the variation of the data (i.e., r^2). At 20° C the regression for the esophageal T_{es} is able to account for 80% of the variation in the data. At 10° C the muscle temperature provides the best fit of the three, but the regression equation is able to account for only 58% of the data. During the recovery phase the regression coefficients for T_r are less than half those for the exercise phase. Since sweating after the heaviest work load at both 20° and 30° C during recovery was sometimes above E_{max}, these two regressions may have little physical significance. At 10° C where the sweating observed during the recovery phase was real, the regression between sweating and T_r was able to account for 86% of the variation in the data observed.

In Table 4 all data for 10°, 20°, and 30° C were used for the multiple regression equations presented. Sweating (E_s) during both exercise and recovery was best predicted by the pair T_s and T_{es}; however, this regression was only able to account for 65% of the variability in the data used. The regressions for the exercise phase alone showed that skin temperature has a significance in the control of regulatory sweating.

If one had measured average body temperature $\bar{T}_b$ by weighing $\bar{T}_s$ and T_{es} in the ratio of 1:8 or $\bar{T}_s$ and T_r in the ratio of 1:10, for example, one could have concluded that sweating during the exercise transient might be a simple function of mean body temperature. On the other hand, when $\bar{T}_b$ is measured by integrating the accumulation of heat storage during the entire course of the experiment, we were unable to arrive at any significant and consistent relationship between the calculated body temperature $\bar{T}_b$ based on calorimetric considerations, and any combination of observed body temperature. This difficulty has been already pointed out (29) for the steady state at rest and would be expected to be even greater during exercise.

There are two other interesting regression equations based on all data between T_a of 10° and 30° C. For the Nielsen relation during both rest and exercise we find

$$T_r = 0.00408M + 35.9 \qquad (r = 0.83,\ t = 24)$$

where (M is in 2 watts per square meter). For the relation between mean skin and air temperature,

$$\bar{T}_s = 0.391T_a + 22.2 \qquad (r = 0.96;\ t = 78)$$

These two general relationships, previously observed for the steady-state, also appear to be valid during transients.

DISCUSSION

There are few continuous observations in the literature of the rate of weight loss due to the evaporation of sweating during exercise. Nielsen (22) and Nielsen and Nielsen (21) used a Krogh balance for their records which showed that significant observations were possible over 5-min periods. Nielsen in his classic study demonstrated that during the first 5 min of exercise the rate of weight loss was proportional to the work load. At the end of the first 5 min of work at 1,260 kpm/min (22.5° C; 50%RH), he reported a weight loss as high as 30 g. After 15 min of exercise the rate of weight loss for each 5-min period had risen to 60–70 g. Further support for his concept that there is a very fast onset of sweating at the start of exercise was given by van Beaumont and Bullard (2). They used cups (7 cm^2 area), placed on the forearm and calf; the change in humidity of dry air flowing through the cups at constant flow was their continuous index of sweating. They found in a "warm" environment (37.5° C) that increased sweating occurred within 1.5 sec after the start of exercise at 1,000 kpm/min and that it tripled after 1 min of exercise. If these data for the cups were representative of the sweating over the entire area, they showed that approximately 7 g of sweat had been produced during this first minute of exercise. At 30° C, which they described as "cool" rather than "neutral," van Beaumont and Bullard observed a time lag in sweating over the first minute of exercise (1,000 kpm/min), and during the second minute only a small increase was observed by the calf cup. Since none of their body temperatures (skin, tympanic, and rectal) had changed before sweating started, they concluded that sweating during exercise was partially regulated by a nonthermal reflex mechanism or by the exercising muscle temperature or both.

During our present study we were unable to demonstrate any significant increase in the rate of weight loss by sweating during the first 1.5 min of exercise for a wide range of work rates (300–1,650 kpm/min) and ambient temperatures (10°, 20°, and 30° C). After 5 min of exercise our observations are comparable to those of Nielsen. However, at the onset of exercise the temperature of the exercising muscle does rise both earlier and faster than does the regulatory sweating as judged by the rate of weight loss. Would this fact indicate that there is no direct relation between T_m and E_s?

In our reasoning so far we have associated the observed rate of weight loss ($\dot{W}$), corrected for the rate of respired vapor loss ($\dot{W}_{res}$), with the rate of secretion ($\dot{S}$) and its subsequent rate of heat loss by vaporization (E_s). When the initial secretion of the sweat glands appears on the skin surface, two avenues occur simultaneously: *1*) accumulation of sweat as a thin film on the skin surface and *2*) its evaporation. When the accumulation is constant (i.e., constant wetness, which is measured by the ratio E_s/E_{max} (10, 11), then $\dot{S} \simeq \dot{W}_s$. Brebner and Kerslake (3) have recently shown that the rate of secretion ($\dot{S}$) is the sum of the rate of weight loss ($\dot{W}$) and a second derivative, $\ddot{W}$, whose coefficient, α is the time constant for the accumulation of sweat on the skin surface. For the present case,[2] α is the ratio of the wetness (g/m^2) of the evaporating film on the skin surface to the evaporative power (i.e., E_{max}) of the ambient environment expressed in grams per minute · square meter. The initial time delay of approximately 2 min observed in our studies may be partially explained by the delay in $\dot{W}_s$ due to the initial accumulation of sweat. As may be seen in Fig. 5, $\ddot{W}_s$ becomes insignificant after 3–4 min. The respired vapor loss (E_{res}) also has a time delay in its buildup to the values shown at the right in Fig. 5. Our present measurements of $\dot{W}$ during the initial period of exercise are insufficiently refined to distinguish between $\dot{W}_s$, $\ddot{W}_s$, E_{res} and $\dot{E}_{res}$ or to conclude that there is no secretion of sweat at the start of exercise as our observation would at first imply. One fact is apparent: there must be a significant delay in the evaporative heat loss E_s at the skin surface after the start of exercise, even if $\dot{S}$ should occur immediately at the level required for body temperature regulation. Under these circumstances the rapid rise in muscle temperature seen at the start of exercise could still be responsible for a sudden increase in the rate of secretion $\dot{S}$; this secretion must precede the evaporative heat loss (E_s) which is derived from the observed $\dot{W}$.

Our statistical analysis above tends to show that the internal body temperatures, T_{es} and T_r, are more significant as a single index of sweating than muscle temperature, T_m; the same is true when all three temperatures are used in a linear multiple regression with the skin temperatures $\bar{T}_s$ during the exercise phase. For our steady-state studies on exercise (27, 31) skin temperature alone showed no significant relationship to sweating but in a multiple regression with T_r its significance greatly improved (to $r = 0.9$). Our present study shows that this same multiple relationship between sweating and ($\bar{T}_s$, T_{es}) or ($\bar{T}_s$, T_r) again holds but only during the exercise transients. The lower significance for muscle temperature (T_m) as indicated by linear regressions in the regulation of sweating during exercise may be explained by the fact that this temperature increases before the evaporative loss (E_s) starts, it levels off before E_s reaches its final equilibrium and does not have the same time delay as E_s, T_{es}, and T_r in relation to the start of exercise. This latter fact may account for the better correlations observed between the last three factors.

At all ambient temperatures a significant change (see Fig. 6) in average skin temperature $\bar{T}_s$ was observed during the heaviest work load. The equilibrium heart rate was progressively higher as the ambient temperature varied from 10° to 20° and 30° C. The increase in $\bar{T}_s$ probably indicates increased skin vasodilation, reduced peripheral resistance and a drop in the stroke volume, which is compensated by an increase in heart rate as the cardiac output is constant. This statement agrees with recent studies on the circulation and the effect of heat (16, 25, 32).

During the recovery phase, especially after the heavy exercise at 20° and 30° C ambient, the exact nature of regulatory sweating is more difficult to interpret from the observed rate of weight loss, as recorded by the Potter scale. Part of this loss may be due to sweat secreted and accumulated during the last minutes of exercise and part may have occurred during the recovery period itself. There is no assurance, except by visual inspection, that evaporation of sweat is occurring only on the skin surface and not on the bicycle or platform.

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[2] The rate of weight loss ($\dot{W}_s$) in g/min, caused by evaporation from a thin film of water on the skin surface, is given by

$$\dot{W}_s = A \cdot E_{max}$$

where A is the surface area of the accumulated film of sweat in square meters and E_{max} is in g/(m^2·min). The rate of secretion ($\dot{S}$) in g/min is given by

$$\dot{S} = m_s \cdot \dot{A} + \dot{W}_s$$

where m_s is the specific wetness (in g/m^2) of the evaporating film itself. Eliminating A from two above equations

$$\dot{S} = \dot{W}_s + (m_s/E_{max}) \cdot \ddot{W}_s$$

The time constant for sweat accumulation α is

$$\alpha = m_s/E_{max}\,.$$

For the example illustrated in Fig. 8 at the start of exercise the value for α is about (11) g/m^2 ÷ (14/2.19) g/(m^2·min) or 1.7 min, when an observed value for m_s from the cold spray experiment is used.

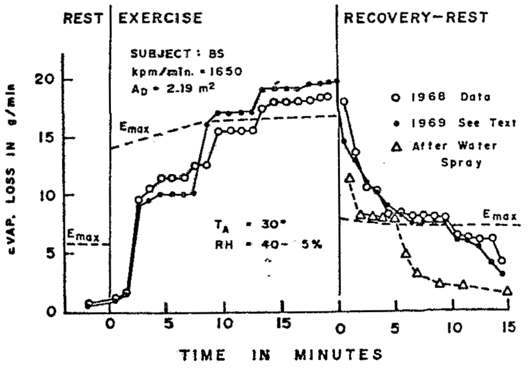

FIG. 8. Rate of weight loss during 20–30 min of exercise at 75% max $\dot{V}_{O_2}$ and 15 min of recovery have been compared for data taken in summer 1968 and for repeat data in 1969, both for *subject BS*. Ambient temperature was 30° C (40–45% RH). At the end of exercise for 1969 data subject was wiped off with dry towels during first 15 sec of rest and recovery. A third curve (triangles) shows how rate of weight loss changes after subject has been covered with a thin layer of water from a spray gun to simulate sweating. Zero time in latter case represents end of spraying.

Two special experiments were done to test the physical nature of the rate of weight loss which occurred during the recovery phase after exercise. *Subject BS* was used and his rate of total weight loss ($\dot{W}$) over the first 20 min of exercise for the 1968 data is presented in Fig. 8. The rise and fall of sweating paralleled the curve indicated for *subject PM* illustrated in Fig. 6 during the heaviest exercise at 30° C. The same experiment was now repeated (1969) for *subject BS* except at the end of exercise all sweat on the body surface and the platform was wiped off with a dry towel before the rate of weight loss measurements were resumed. The first point in the recovery period is a backward projection of the rate of weight loss and represents the time the weight record was started. Surprisingly, the rate of evaporation was almost as great as the case when the body was not wiped off (1968 series). This indicates the sweating drive is still continuing at a high rate into the recovery period and the body surface becomes immediately over 100% wet again after wiping. Integrating the weight loss over the first 5 min of recovery indicates that approximately 60 g of water were lost. During the following 5- to 10-min recovery period the rate of loss remained steady at approximately 8 g/min. After 10 min the rate of loss is lower than the expected E_{max}.

In a second experiment, while sitting without prior exercise on the bicycle at 30° C, the entire body surface of the subject was covered with 25° C water from a spray gun to the point where the skin surface appeared shining wet with beads of water. A towel on the platform (later removed) collected any excess. The point of this experiment was to find out what mass of water (i.e., wetness) be accumulated on the skin surface without perceptible excess and then to follow the rate of weight-loss curve during the following minutes, as was done at the end of exercise above. Under these conditions the chill of the spray caused great cold discomfort and must have inhibited all sweating. At the end of spraying the weight record indicated that 72 g of water had been accumulated on the skin surface. The rate of weight loss after spraying is indicated by triangles on Fig. 8. Only during the first 2 min was the rate of evaporation greater than E_{max} and for the next 3-min period the evaporative rate equaled the theoretical maximum. After 5 min the rate of weight loss started to drop towards the insensible level. After 15 min drying the skin surface still had a damp sheen. Integration of the weight loss after spraying indicates that during the first 2 min approximately 21 g were lost. From 2 to 5 min 24 g were evaporated at a constant rate. During the following 10 min another 25 g were evaporated. In all approximately 70 g of water were evaporated and thus most of the initial accumulation has been accounted for. During the 2- to 5-minute period the wetted surface area for evaporation was constant but the accumulated surface water was being constantly evaporated. During this period the surface wetness dropped from 22 to 11 g/m². Integration of the sweat loss curves indicates that approximately 125 g were lost after the end of exercise. A comparison of the physical evaporative loss curve with the sweat loss curves gives an index how much longer after exercise the regulatory drive may continue. Sweating, after heavy exercise at 30° C, may have continued at least 5 min into the recovery period.

The two above experiments agree roughly with data reported by Brebner and Kerslake (3) for the situation where secretion is greater than the evaporation (E_{max}) possible to the environment. Their experiments were performed at rest in a saturated atmosphere where $\bar{T}_s = T_a$ and after the skin had been washed with a detergent to reduce accumulation. All three of our recovery curves in Fig. 8 leveled for a short period at E_{max}, during which the evaporating surface area of sweat accumulated on skin surface was constant. This period of constancy was roughly the same for the water spray at the sweat curves.

Finally, our observations as well as the statistical results reported here indicate that no linear combination of average skin temperature, esophageal, rectal, or muscle temperature can completely or uniquely predict the regulatory sweating response both during and after periods of exercise and in different environmental temperatures. Possible conclusions are: thermal signals from these sources may be interacting in a nonlinear manner or may have nonlinear characteristics themselves, or that an important new source of thermal or nonthermal signals, necessary for regulation, may not be represented by the various body temperature measurements made in the present experiments.

Nonlinearity of the thermoreceptive structures in the human skin has been demonstrated by Hensel (17) and was shown to consist of a high sensitivity to the rate of temperature change, of a threshold, and of a nonlinear steady-state temperature characteristic. Nonlinear integration of signals from different body structures has been proposed by Hammel et al. (13) in the form of additive displacement of thresholds, and by Stolwijk and Hardy (15, 30) and by Bullard et al. (5) in the form of parametric changes in the effector response to a given internal temperature displacement.

There is a real possibility that there are thermoreceptive structures which contribute to thermoregulatory responses and which were not foreseen by the measurements we have used. Hammel, in his recent review, (12) anticipated new receptors located somewhere in the core, but outside the hypothalamus. Rawson (24) has recently presented some indirect evidence for the existence of such receptors in the abdomen.

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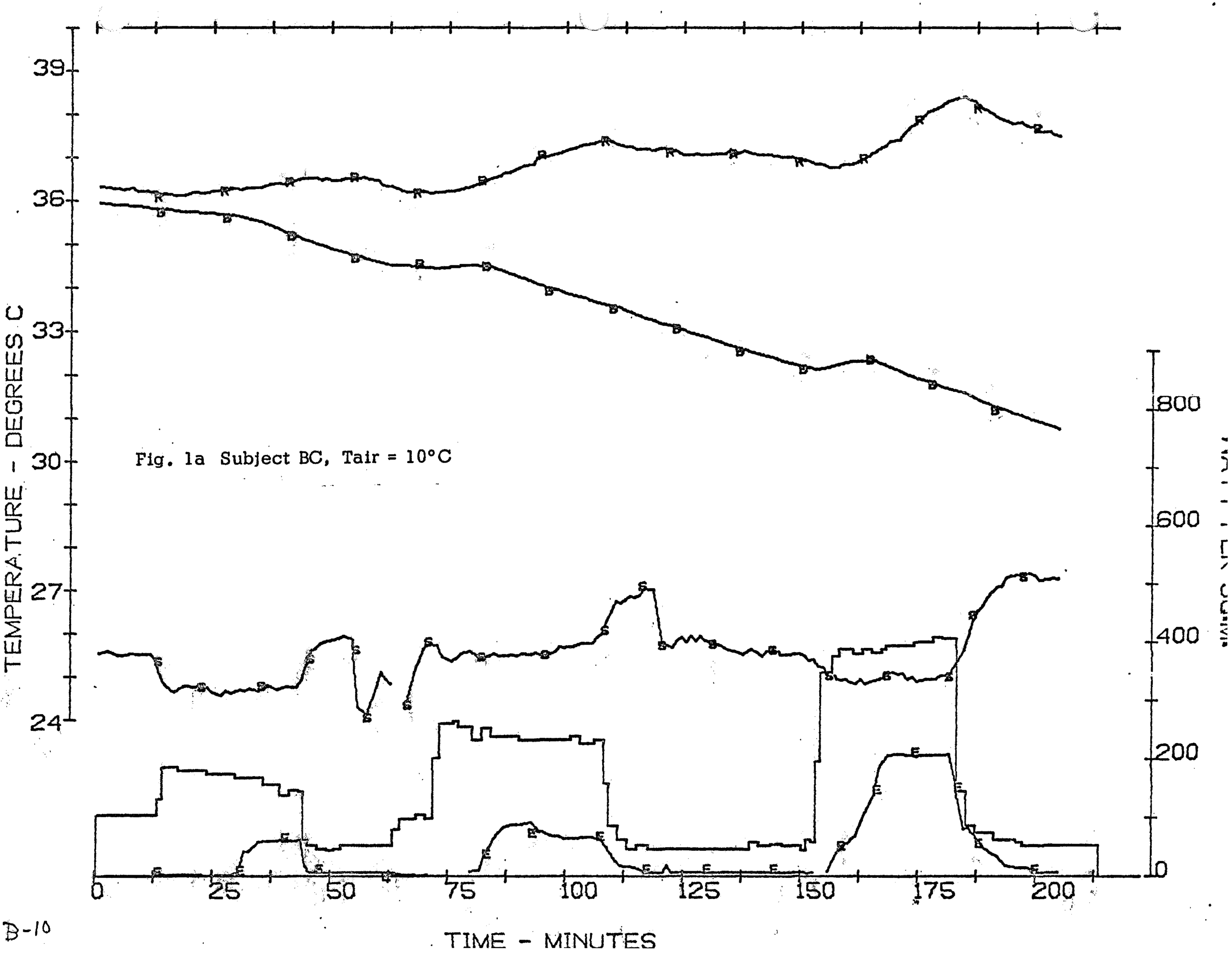
Fig. 1a Subject BC, Tair = 10°C

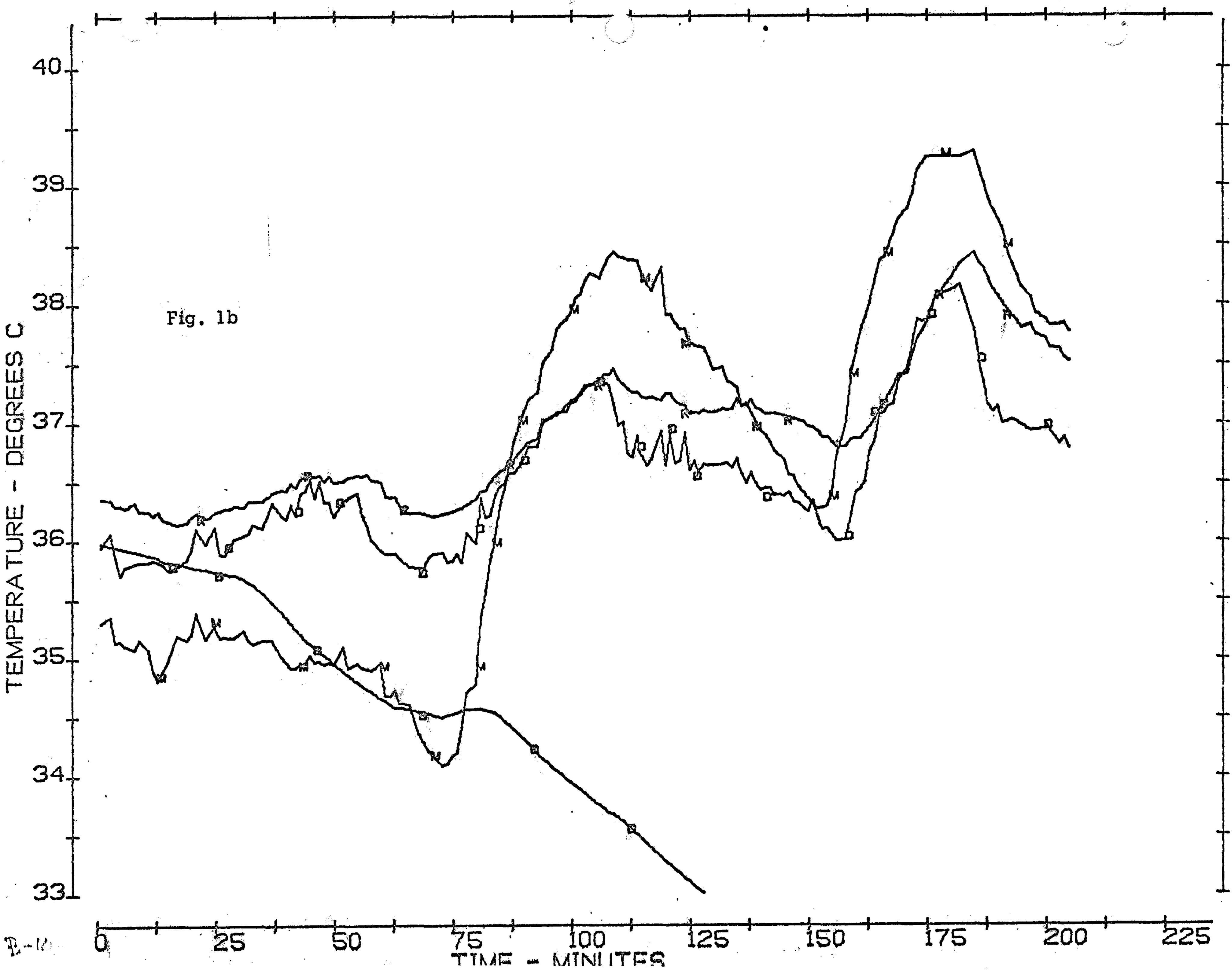

Fig. 1b

TEMPERATURE - DEGREES C
40
39
38
37
36
35
34
33
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25
50
75
100
125
150
175
200
225
TIME - MINUTES
M
R
D

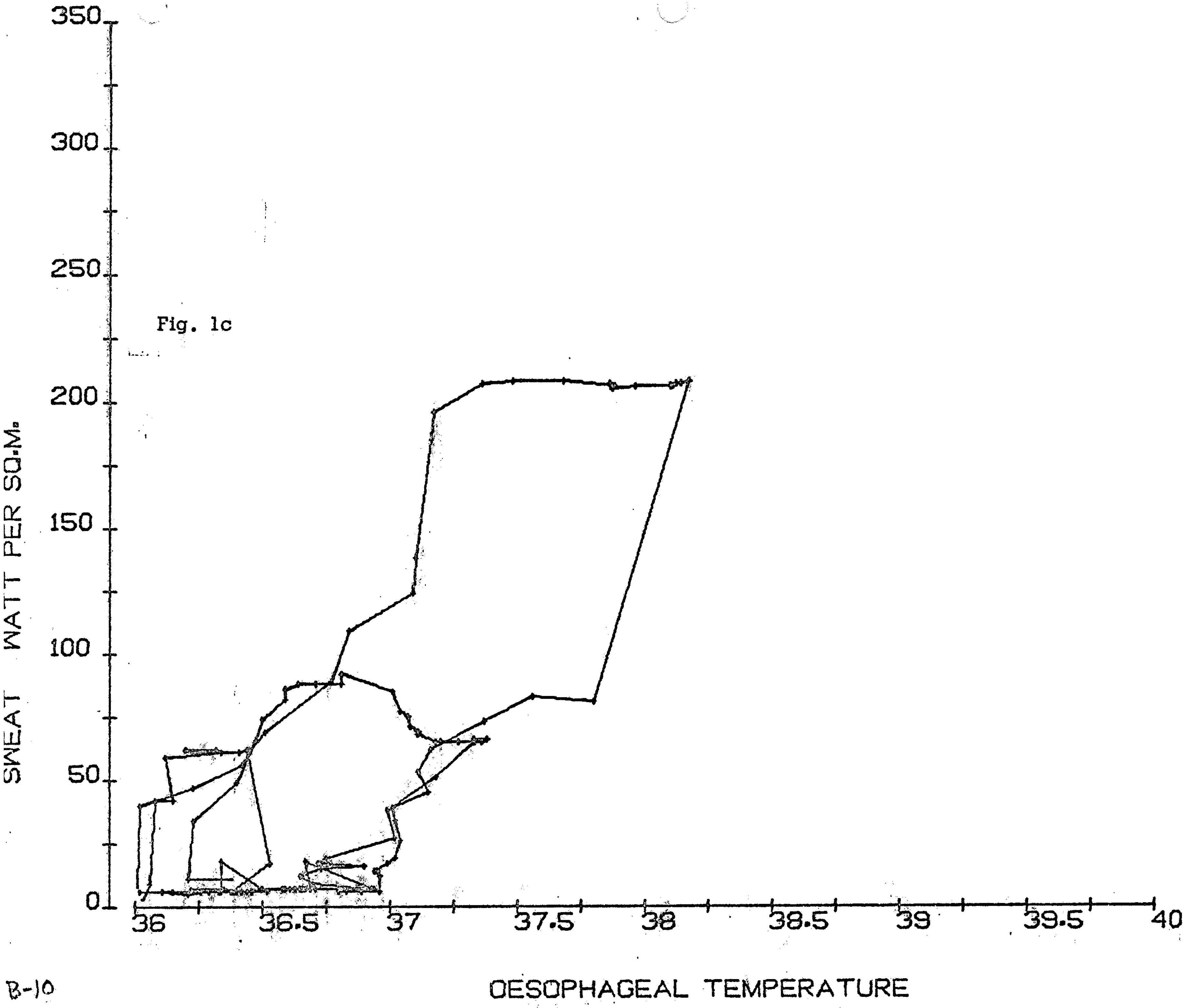
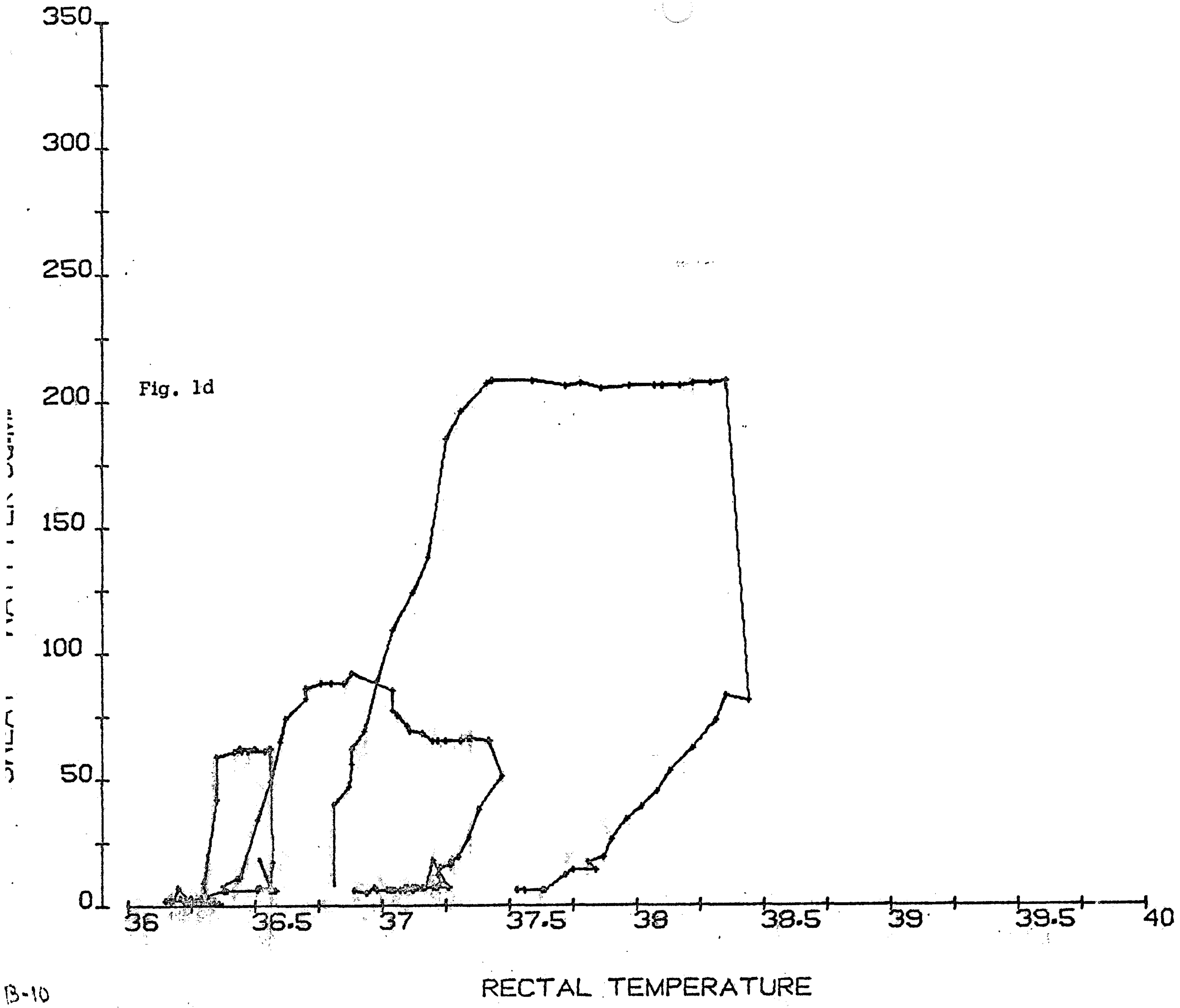

350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
36
36.5
37
37.5
38
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

Fig. 1c

Fig. 1d


350
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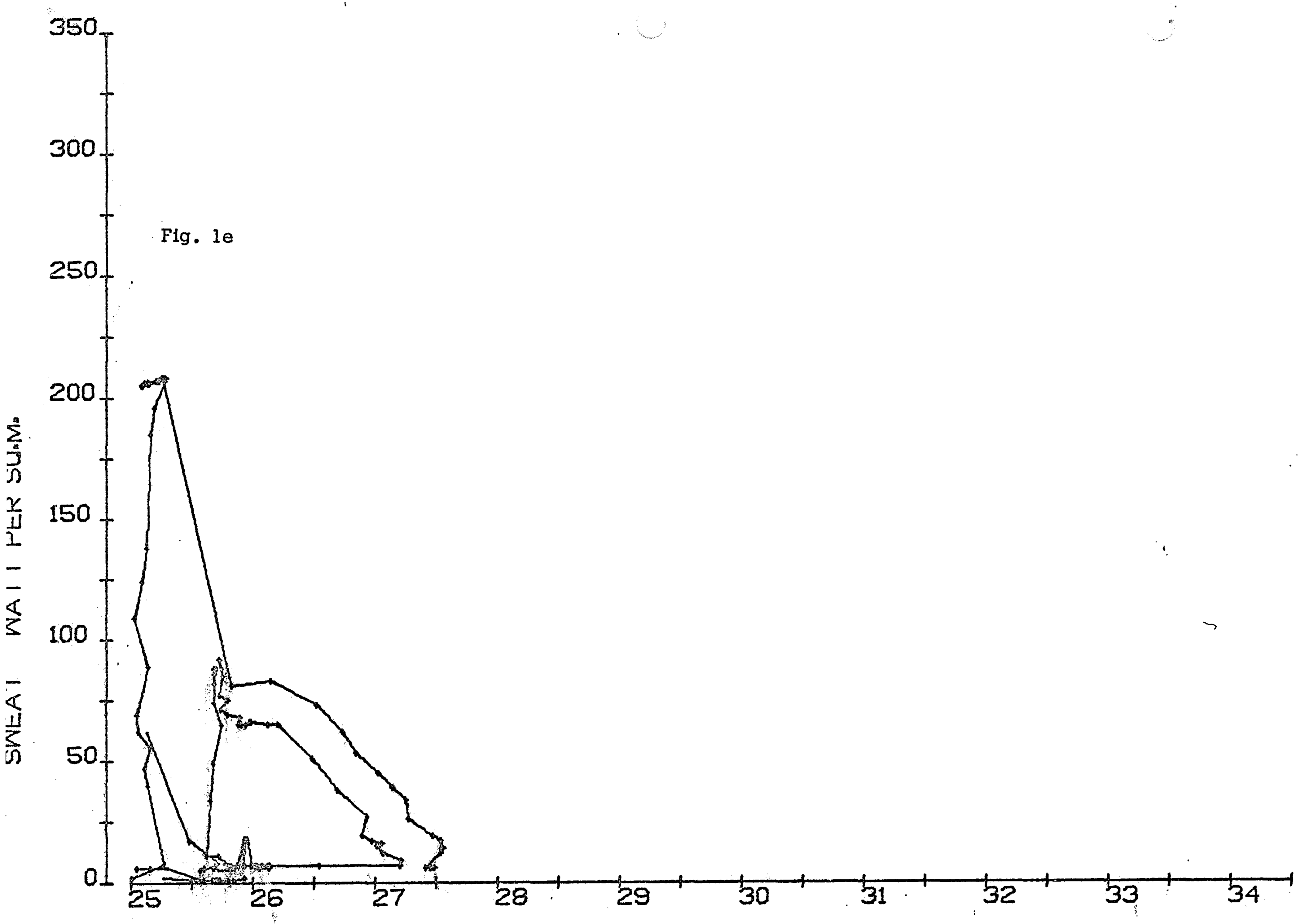
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

Fig. 1e


350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

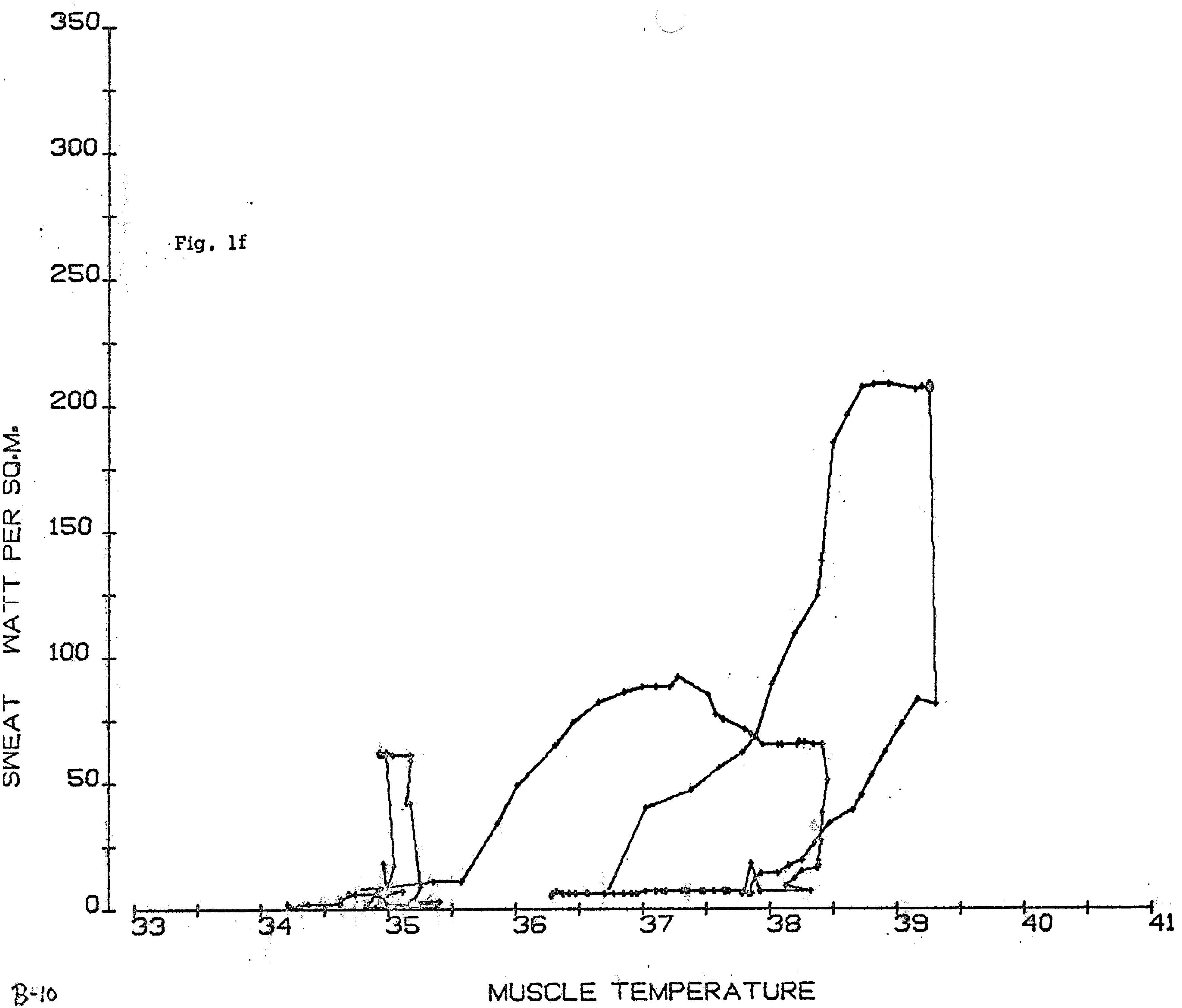


Fig. 1f
SWEAT WATT PER SQ.M.
350
300
250
200
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100
50
0
33
34
35
36
37
38
39
40
41
MUSCLE TEMPERATURE

B-10

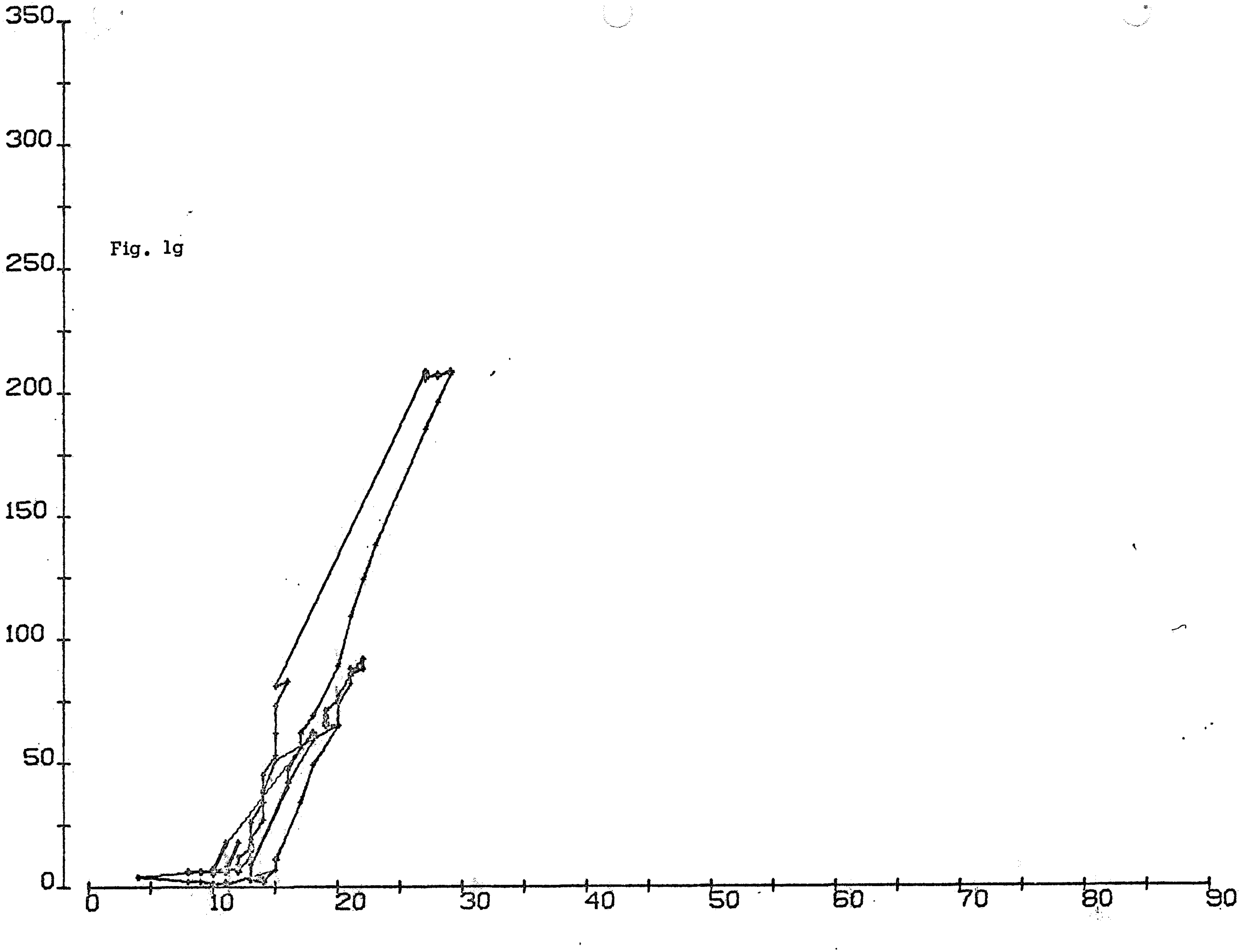
Fig. 1g
350
300
250
200
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100
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30
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50
60
70
80
90
CONDUCTANCE WATT PER SQ.M. - C

B-10

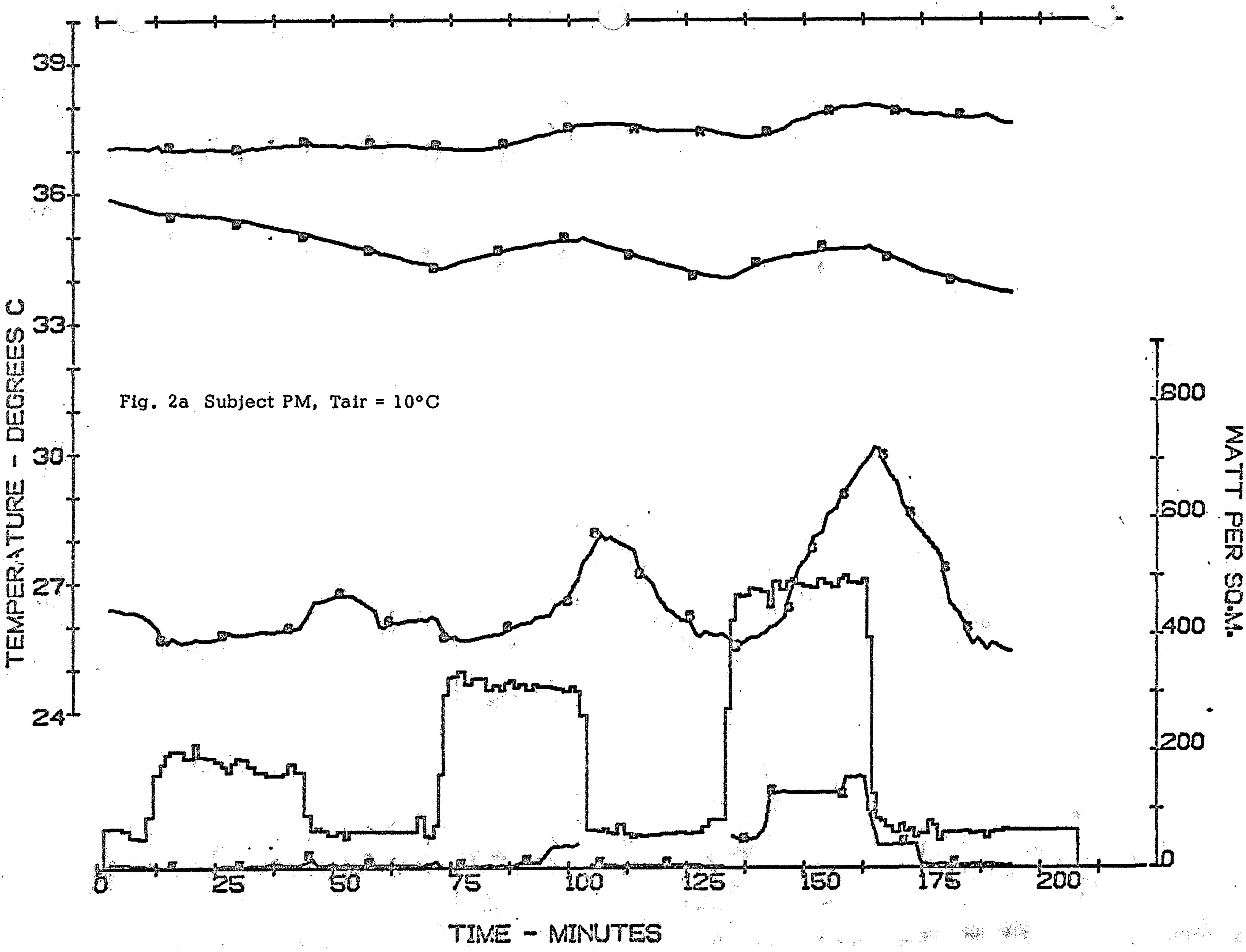
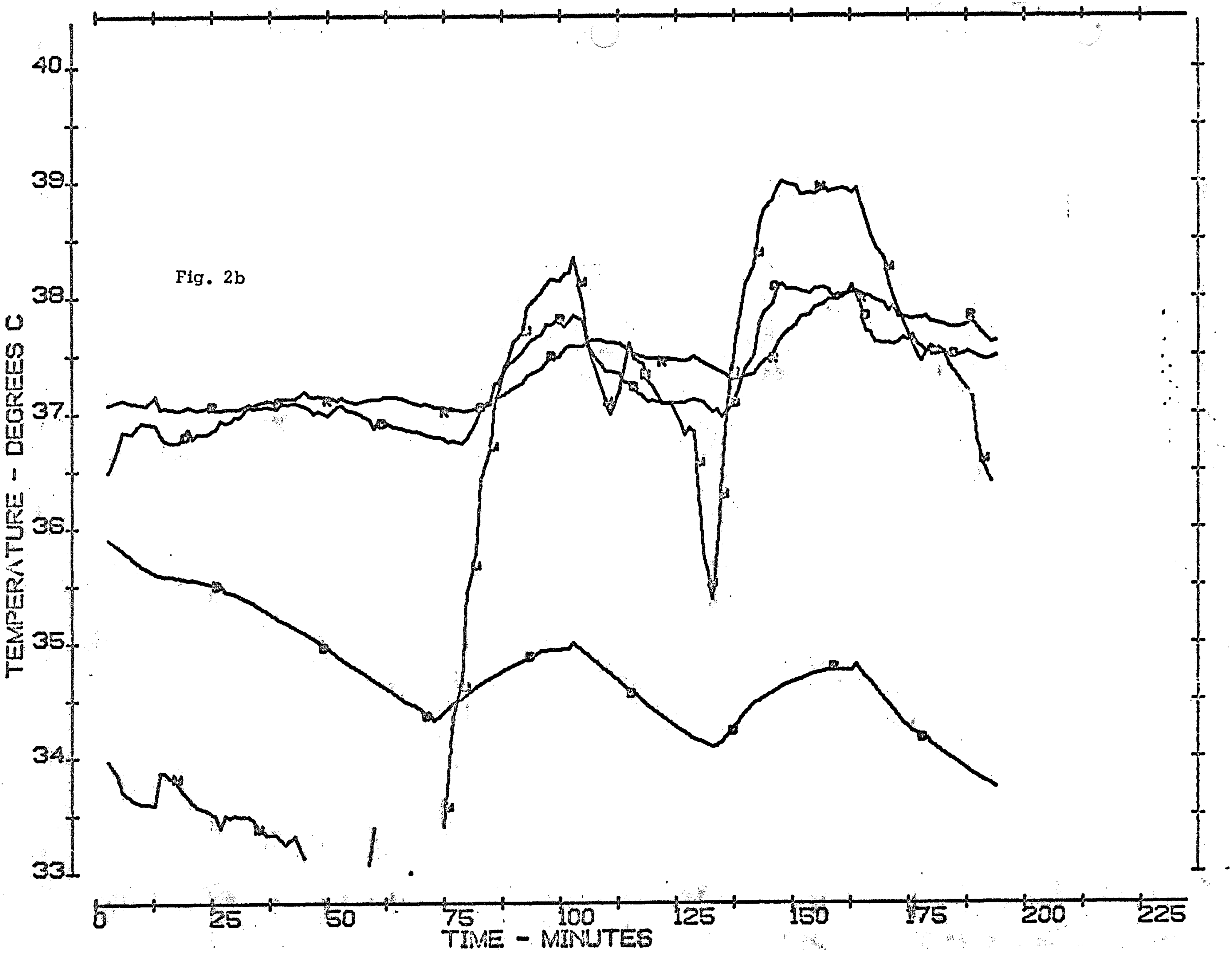


Fig. 2a Subject PM, Tair = 10°C


TEMPERATURE - DEGREES C
40
39
38
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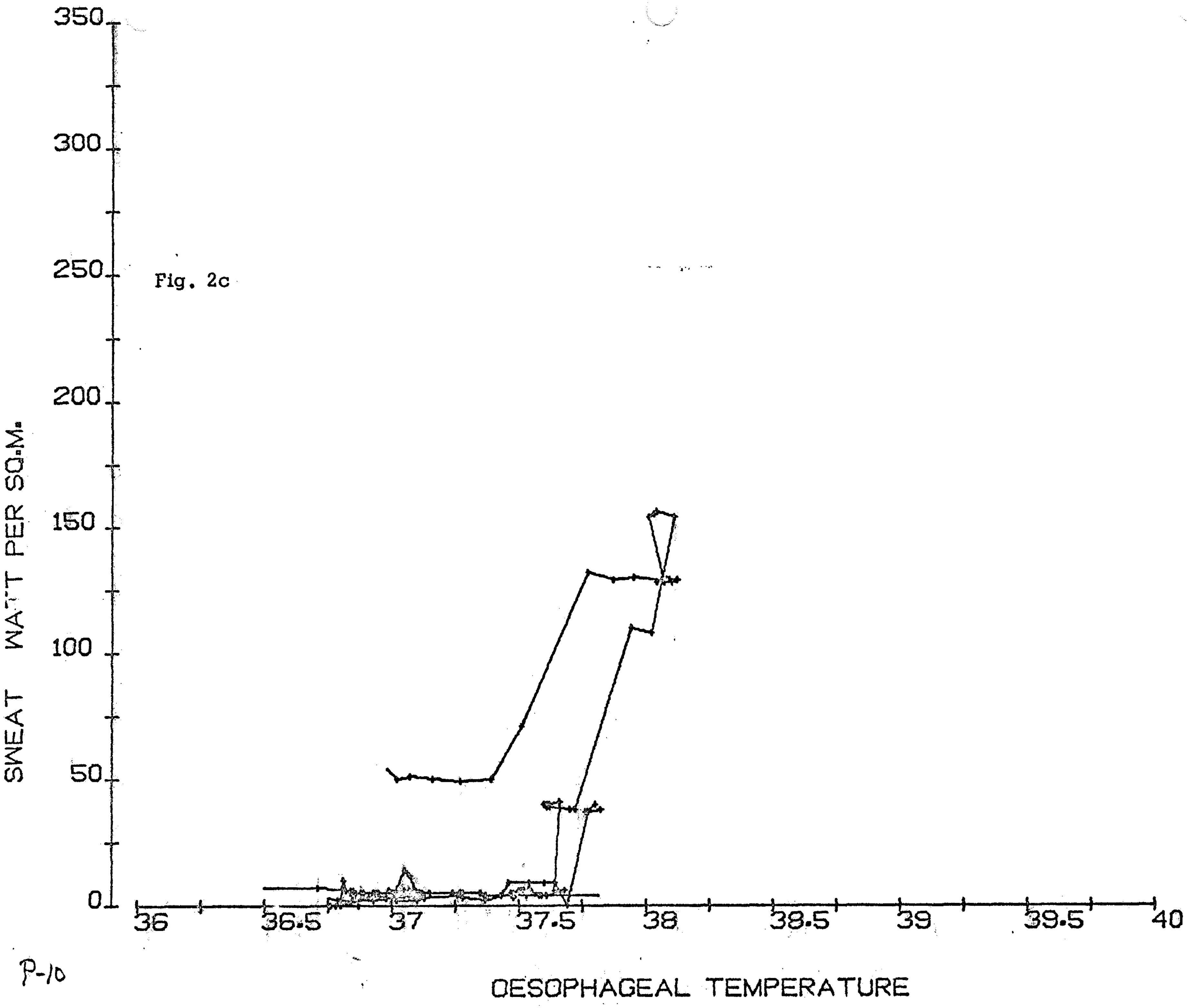
200
225
TIME - MINUTES

Fig. 2b

Fig. 2c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SWEAT WATT PER SQ.M.
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37.5
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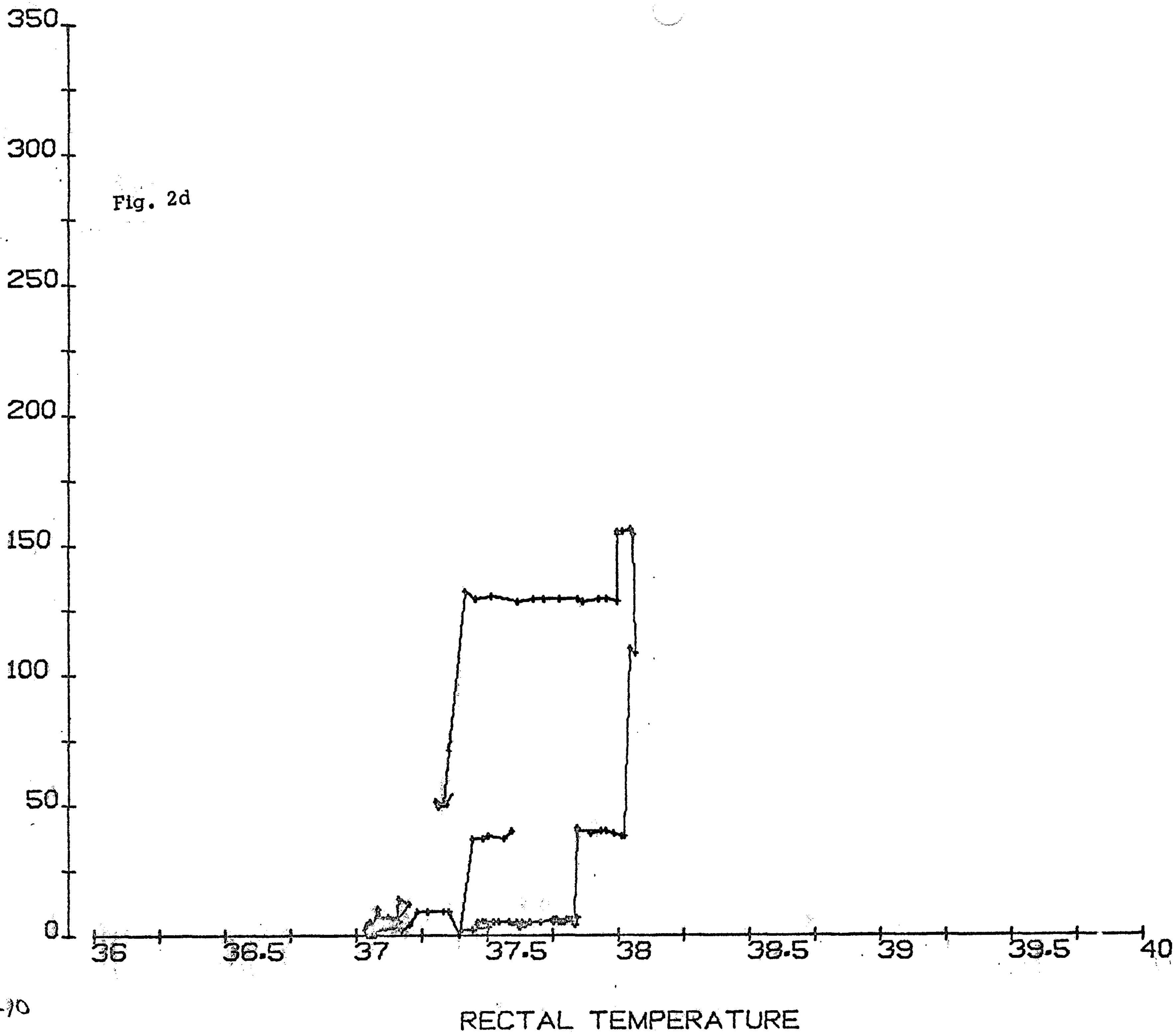
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

P-10

Fig. 2d



350
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36
36.5
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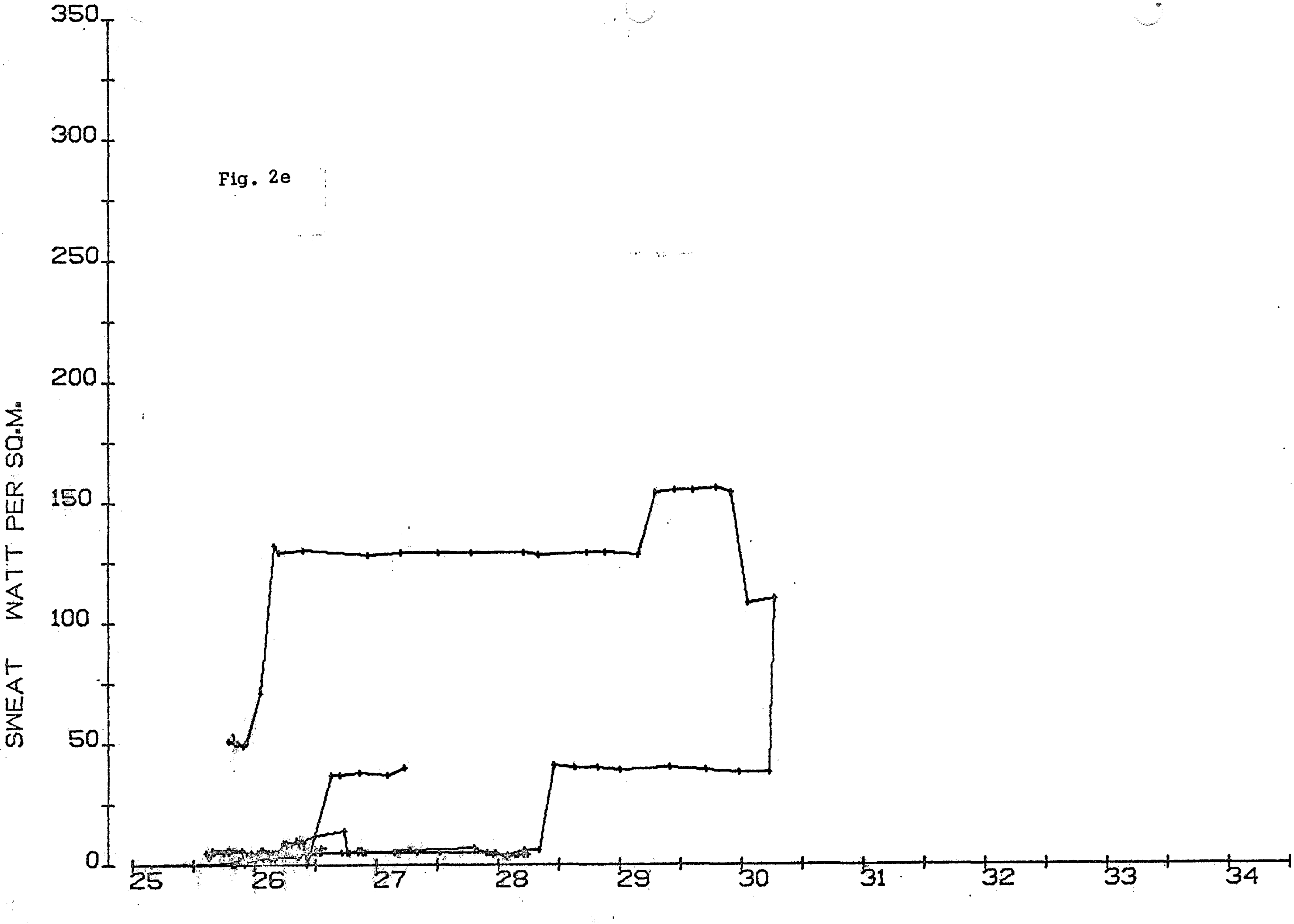
38
38.5
39
39.5
40
RECTAL TEMPERATURE

P-70

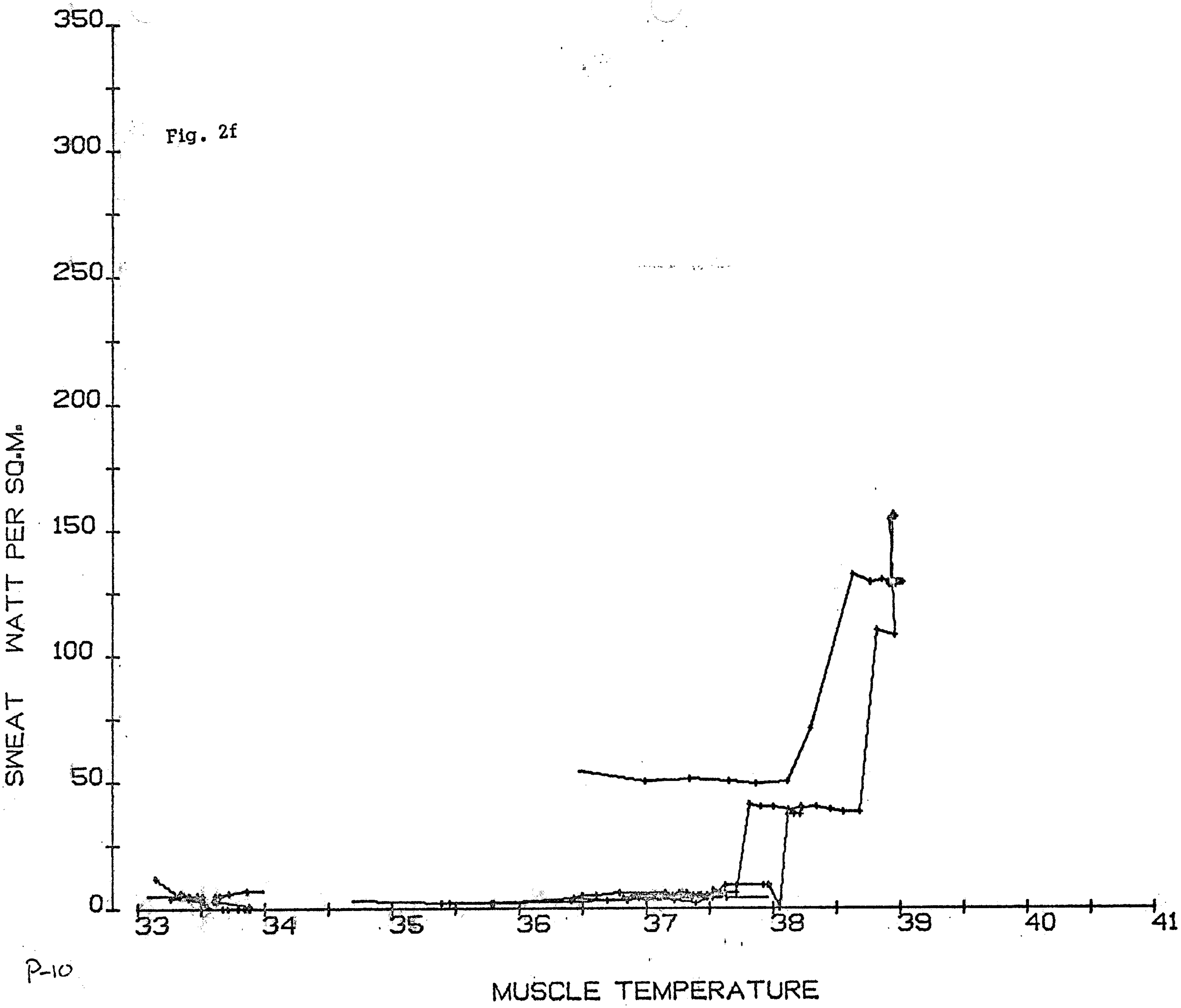


350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

Fig. 2e

P-10

Fig. 2f



350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
33
34
35
36
37
38
39
40
41
MUSCLE TEMPERATURE

P-10

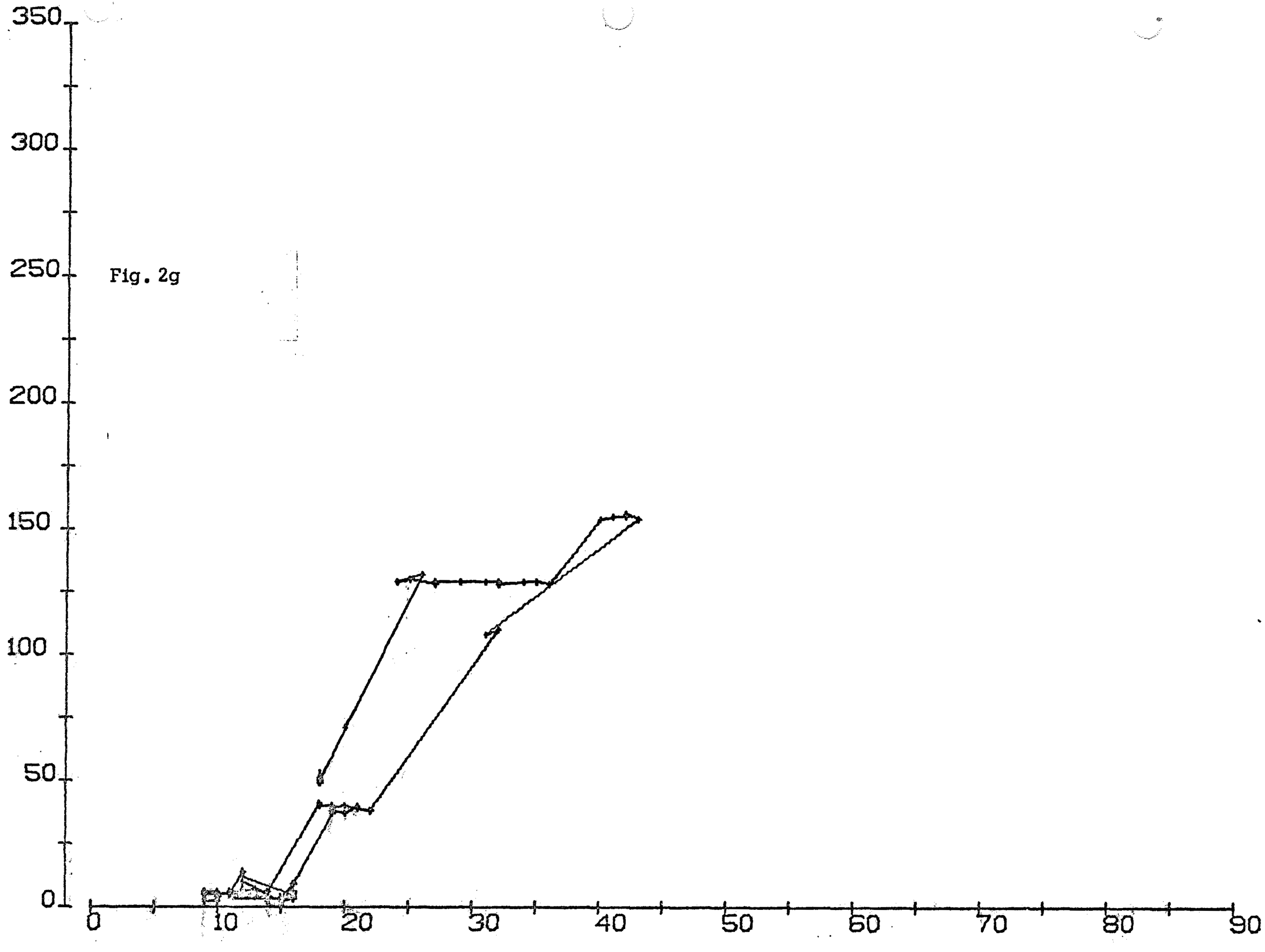


Fig. 2g

CONDUCTANCE WATT PER SQ.M. - C

P-10

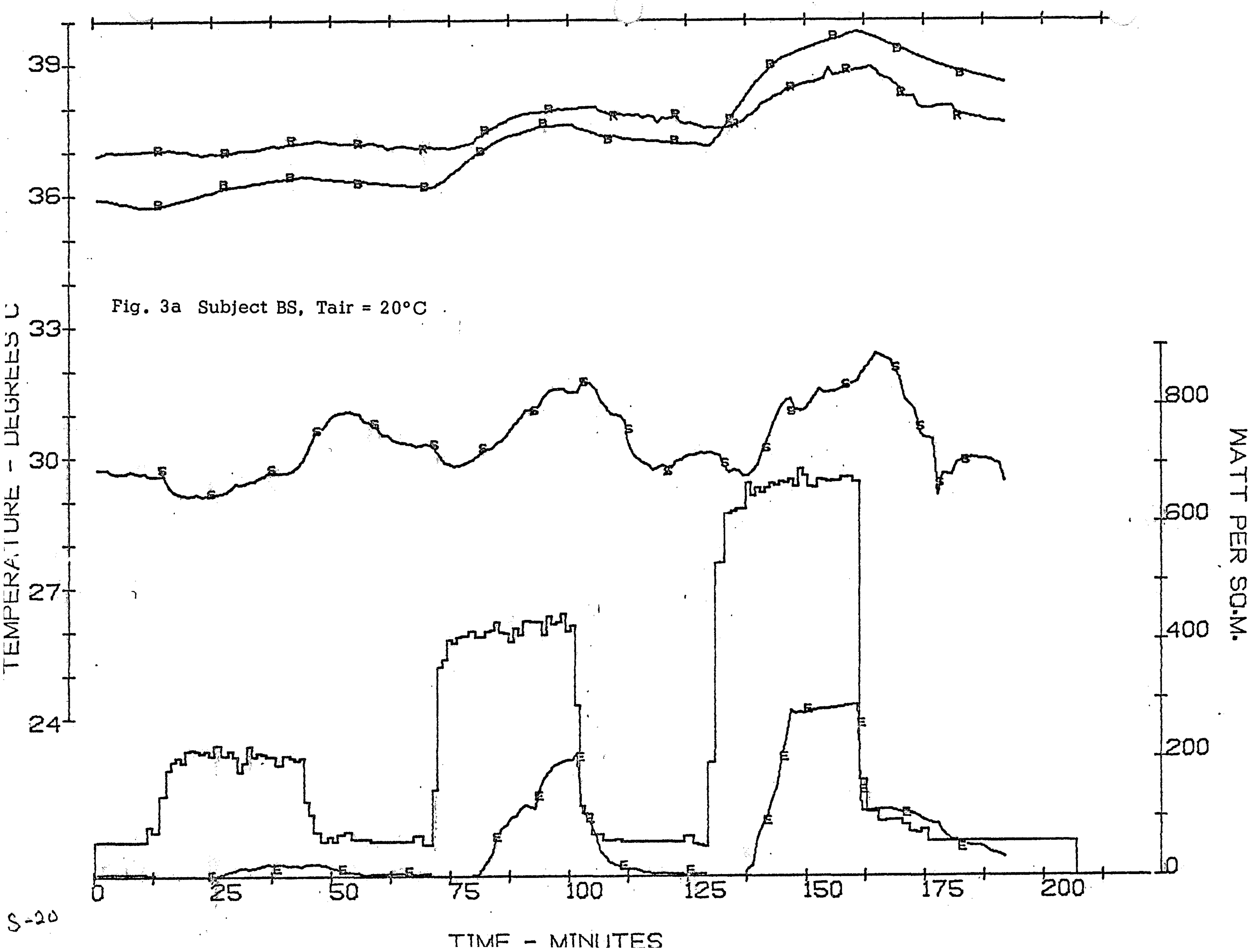


Fig. 3a Subject BS, Tair = 20°C

S-20

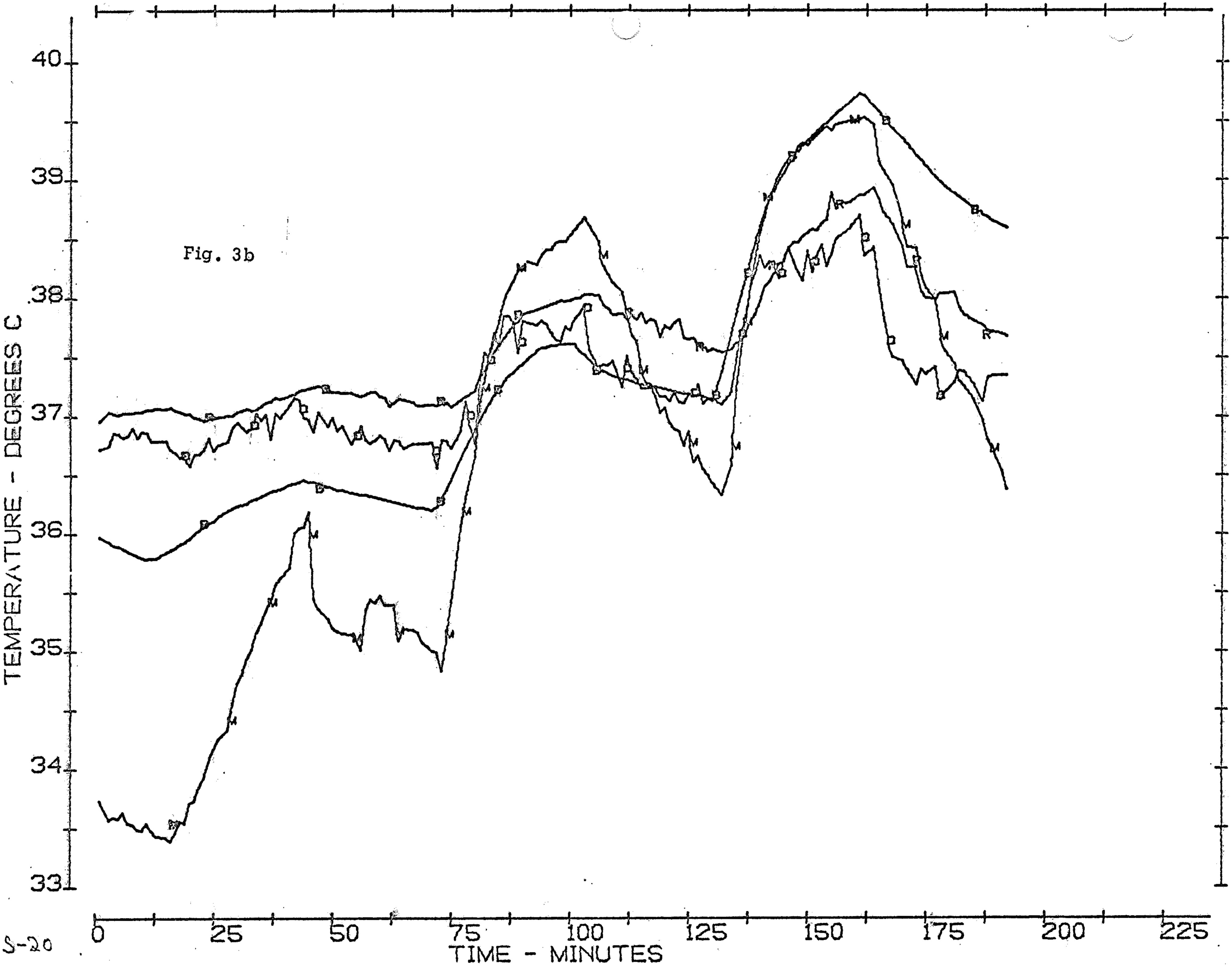


Fig. 3b
TEMPERATURE - DEGREES C
40
39
38
37
36
35
34
33
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES
M
R
D
B

S-20

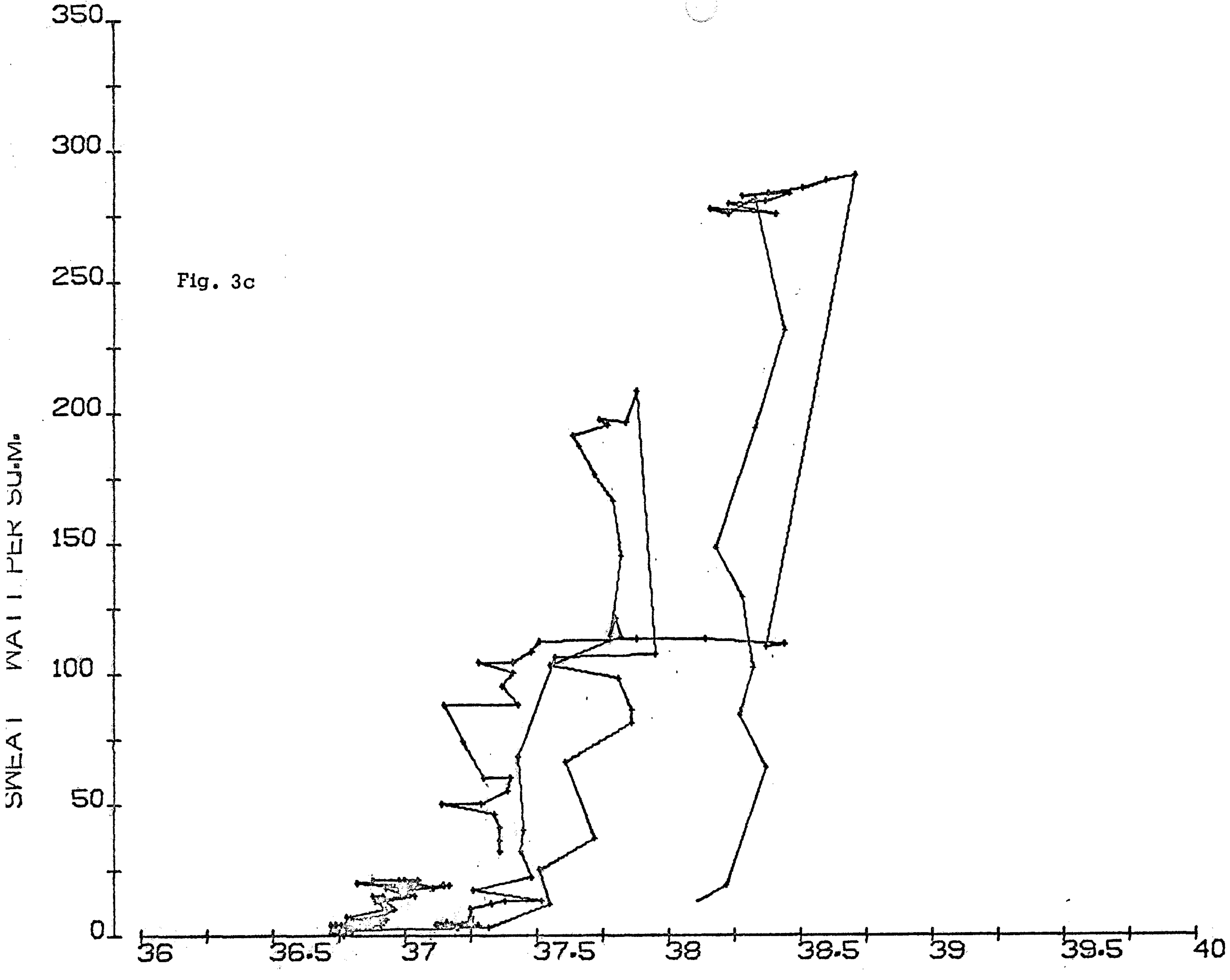
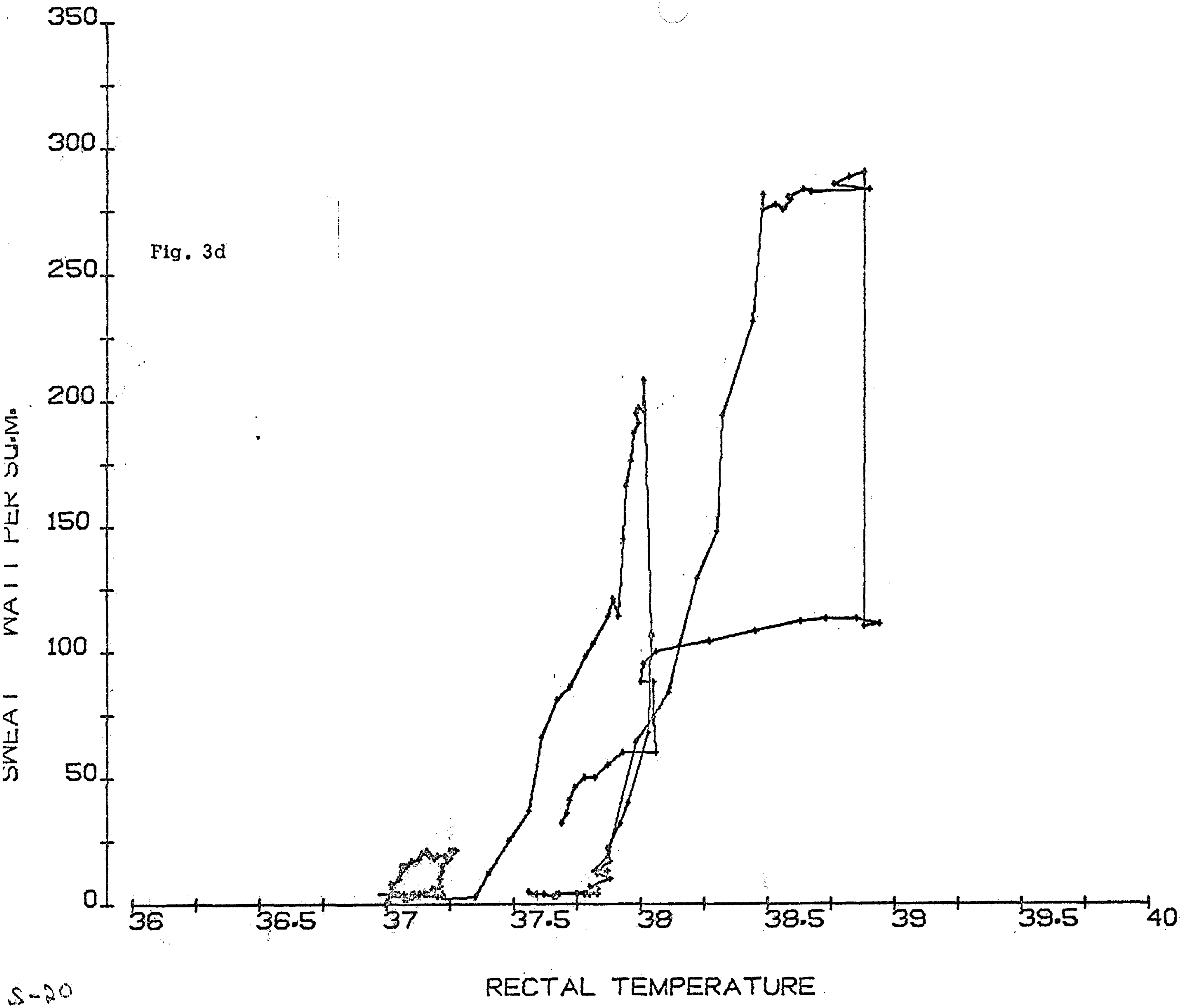


Fig. 3c

OESOPHAGEAL TEMPERATURE

S-20

Fig. 3d


SWEAT WATT PER SQ.M.
350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

S-20

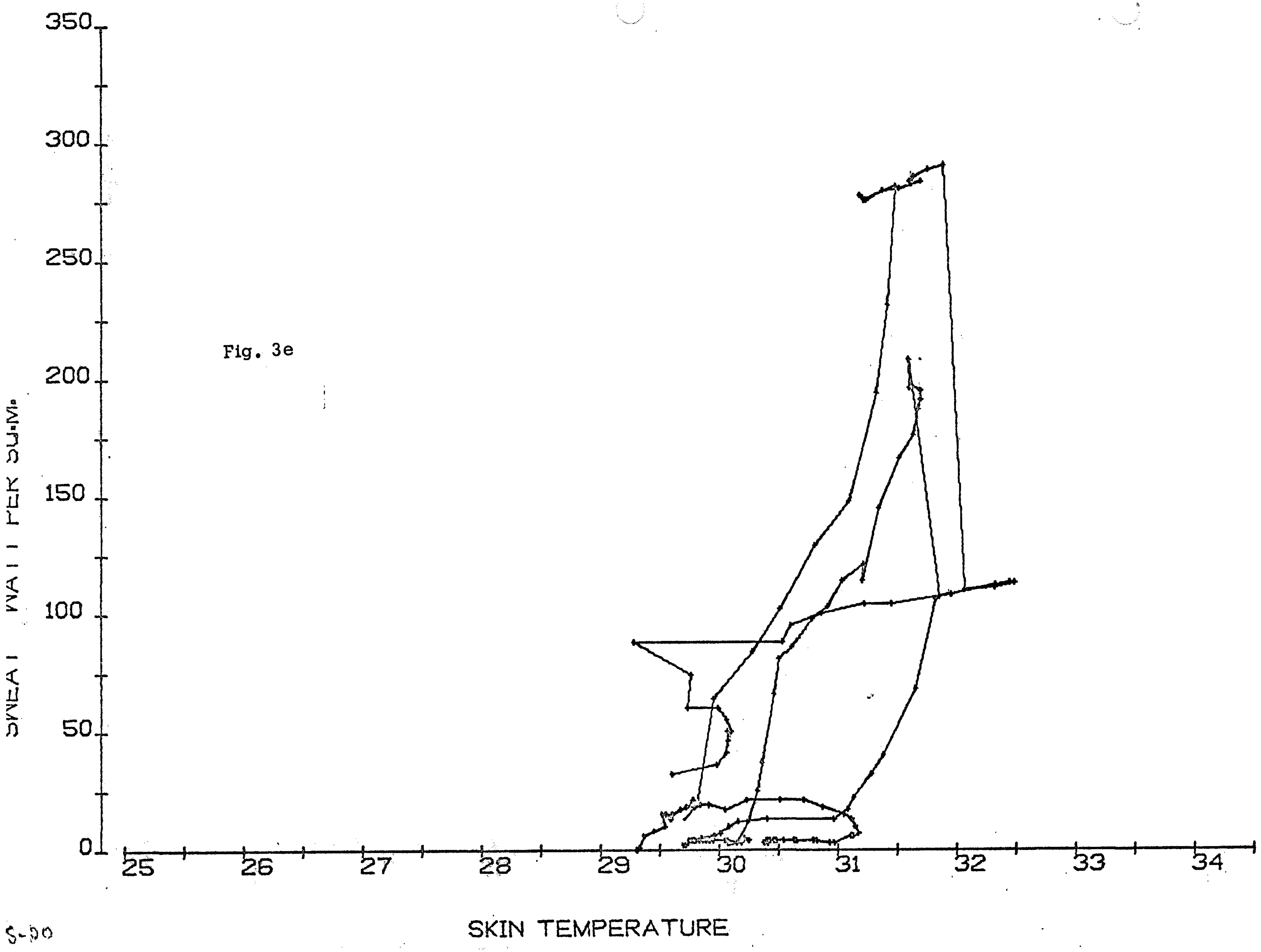

350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

Fig. 3e

S-90

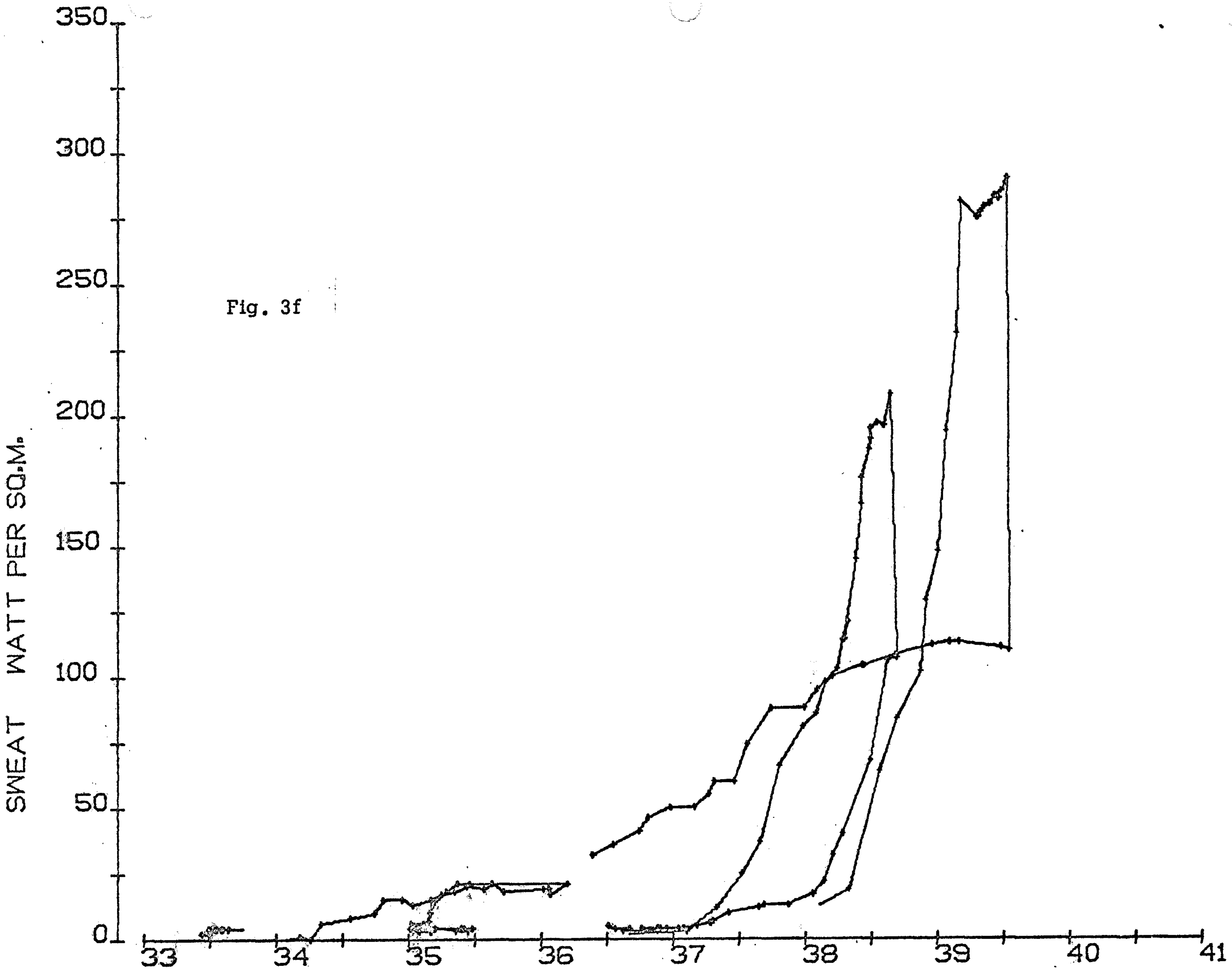


Fig. 3f

MUSCLE TEMPERATURE

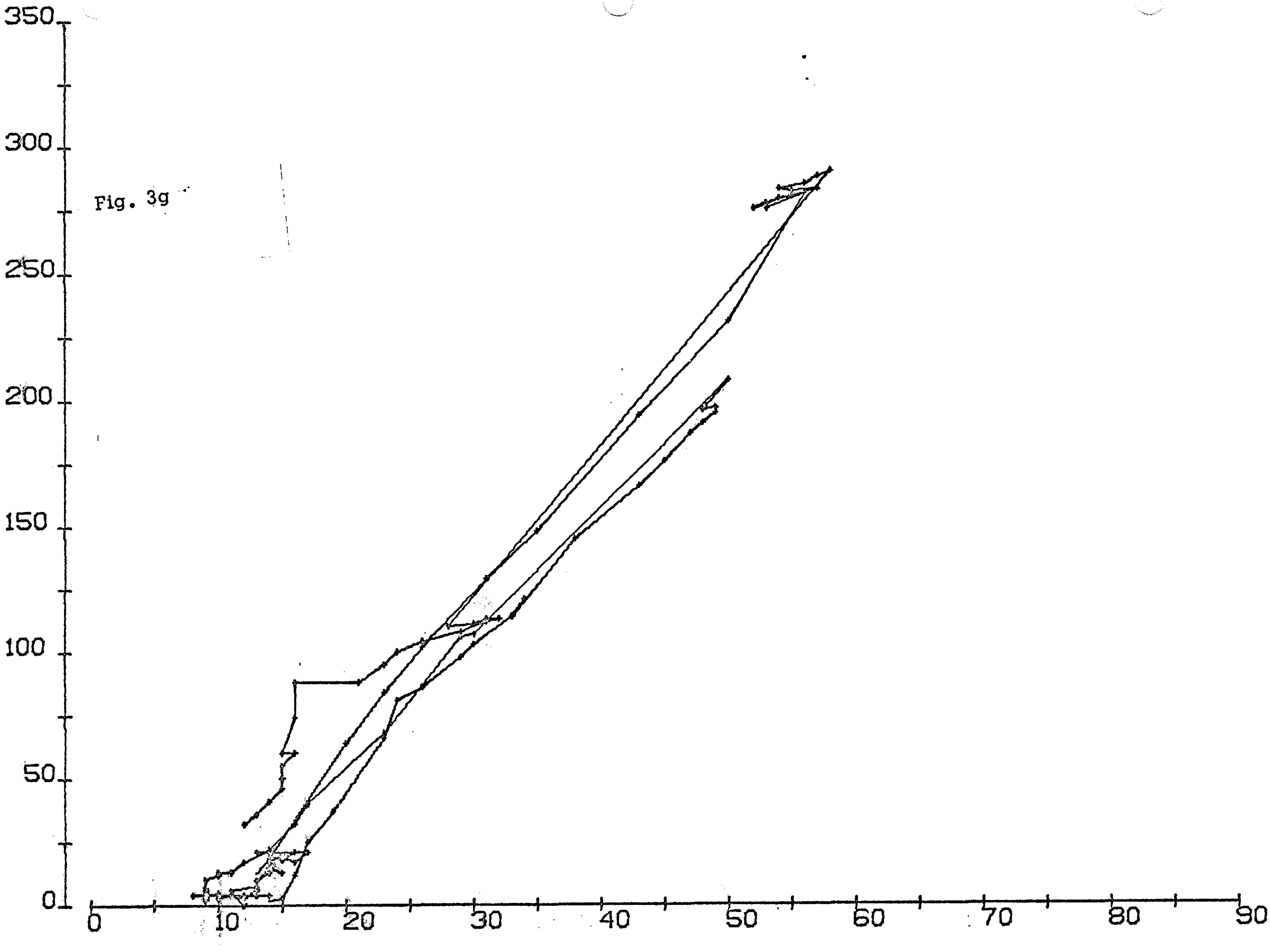


Fig. 3g

CONDUCTANCE WATT PER SQ.M. - C

S-20

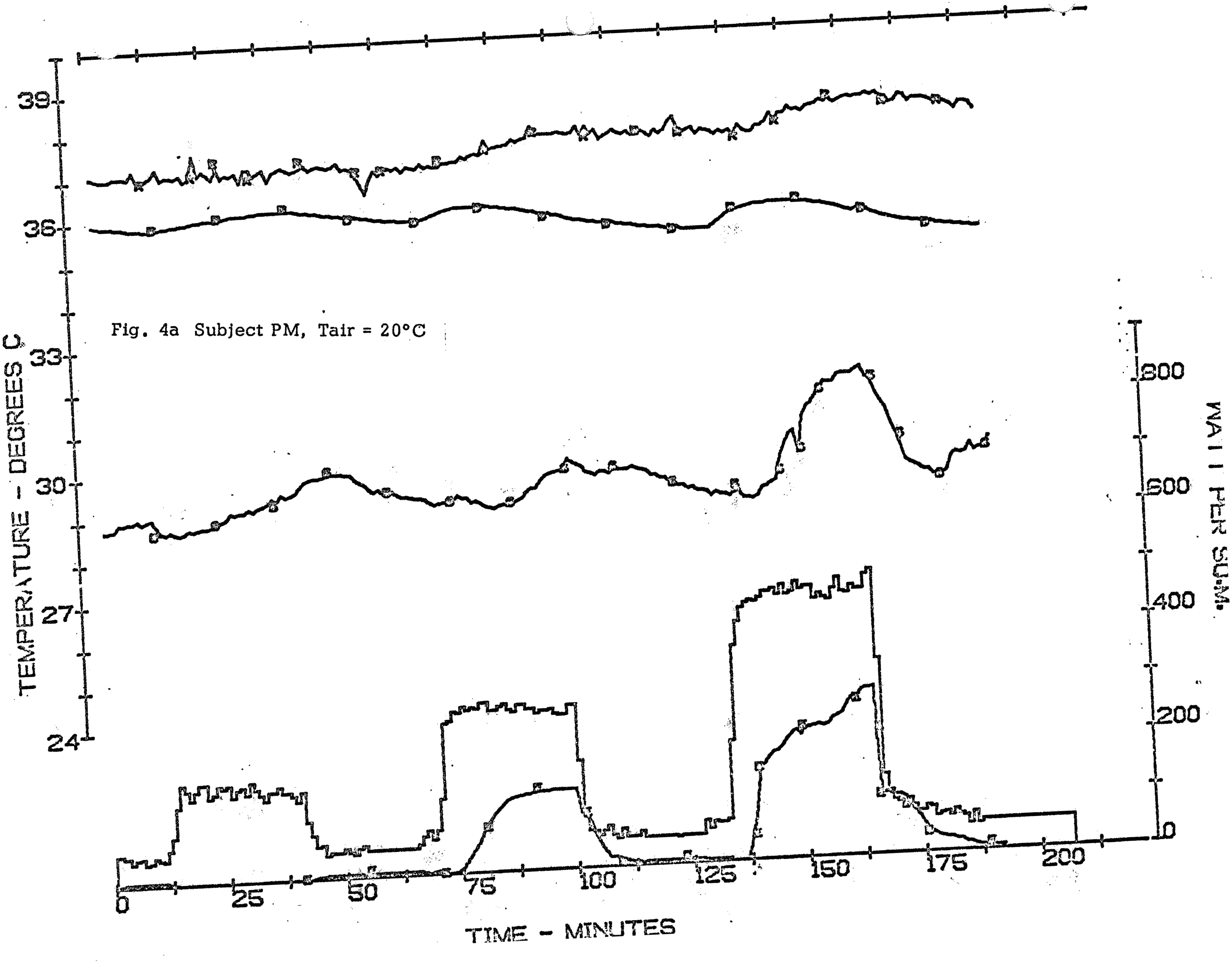
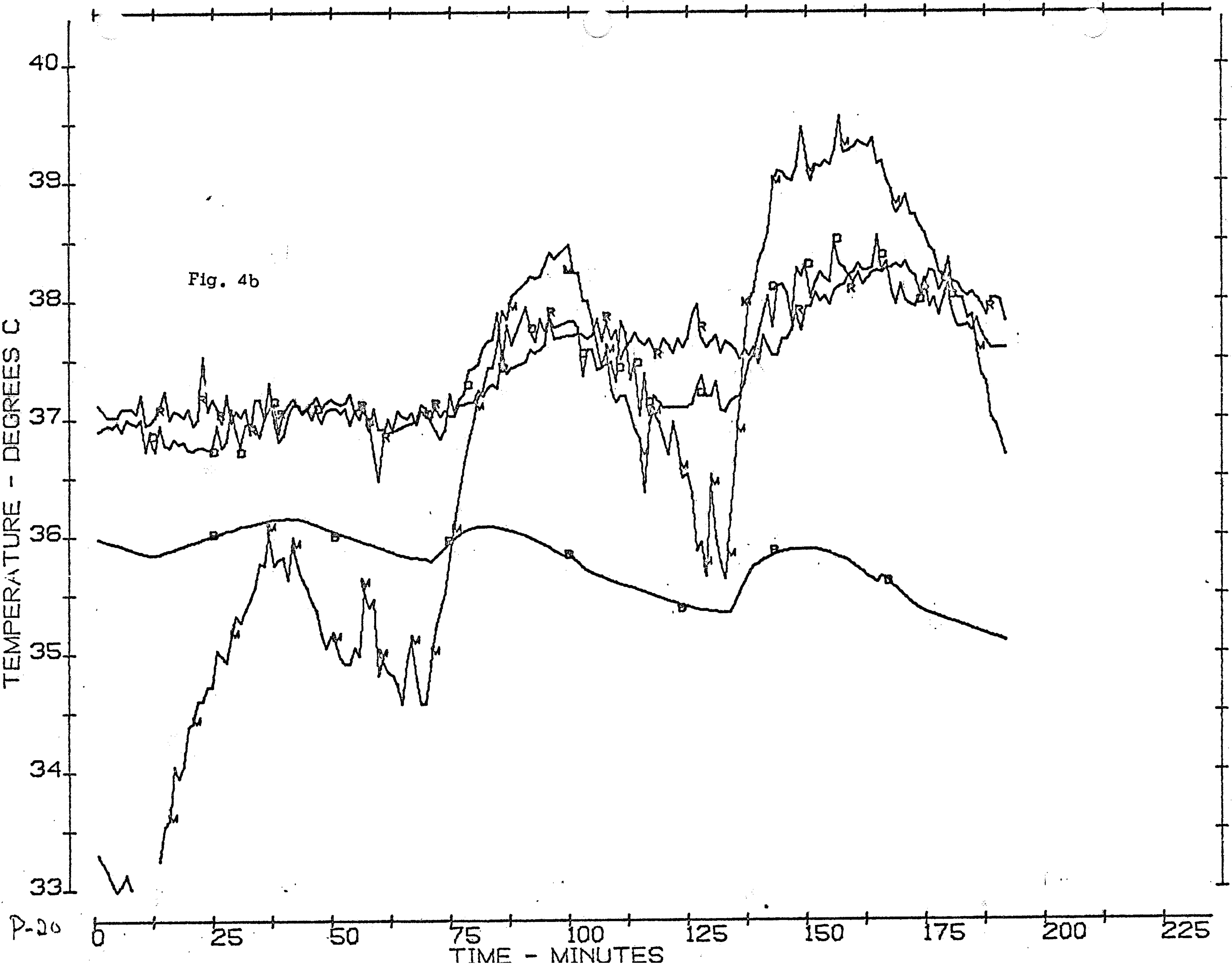


Fig. 4a Subject PM, Tair = 20°C

Fig. 4b



40
39
38
37
36
35
34
33
TEMPERATURE - DEGREES C
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES
M
R
P
D

P-20

Fig. 4c

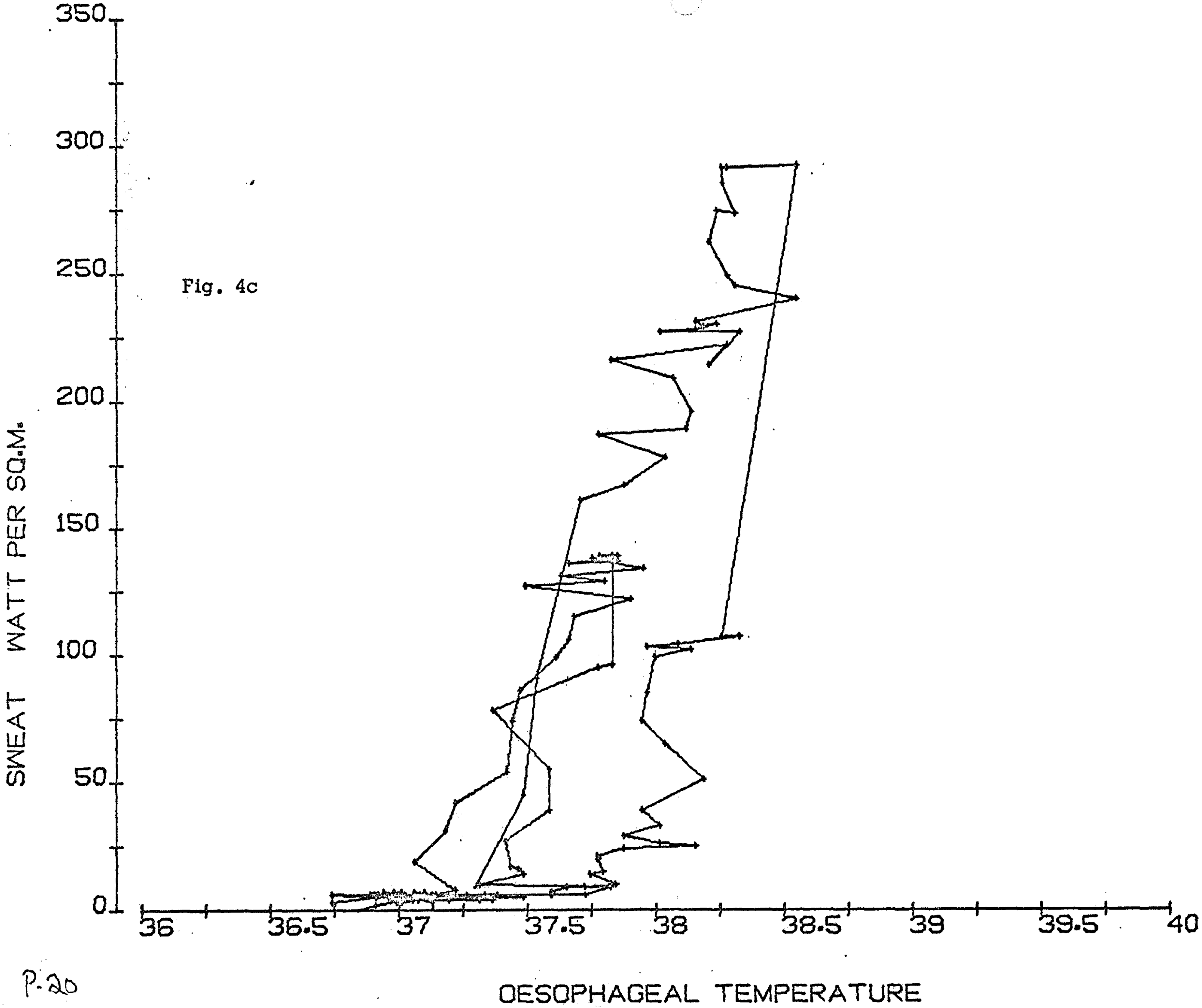
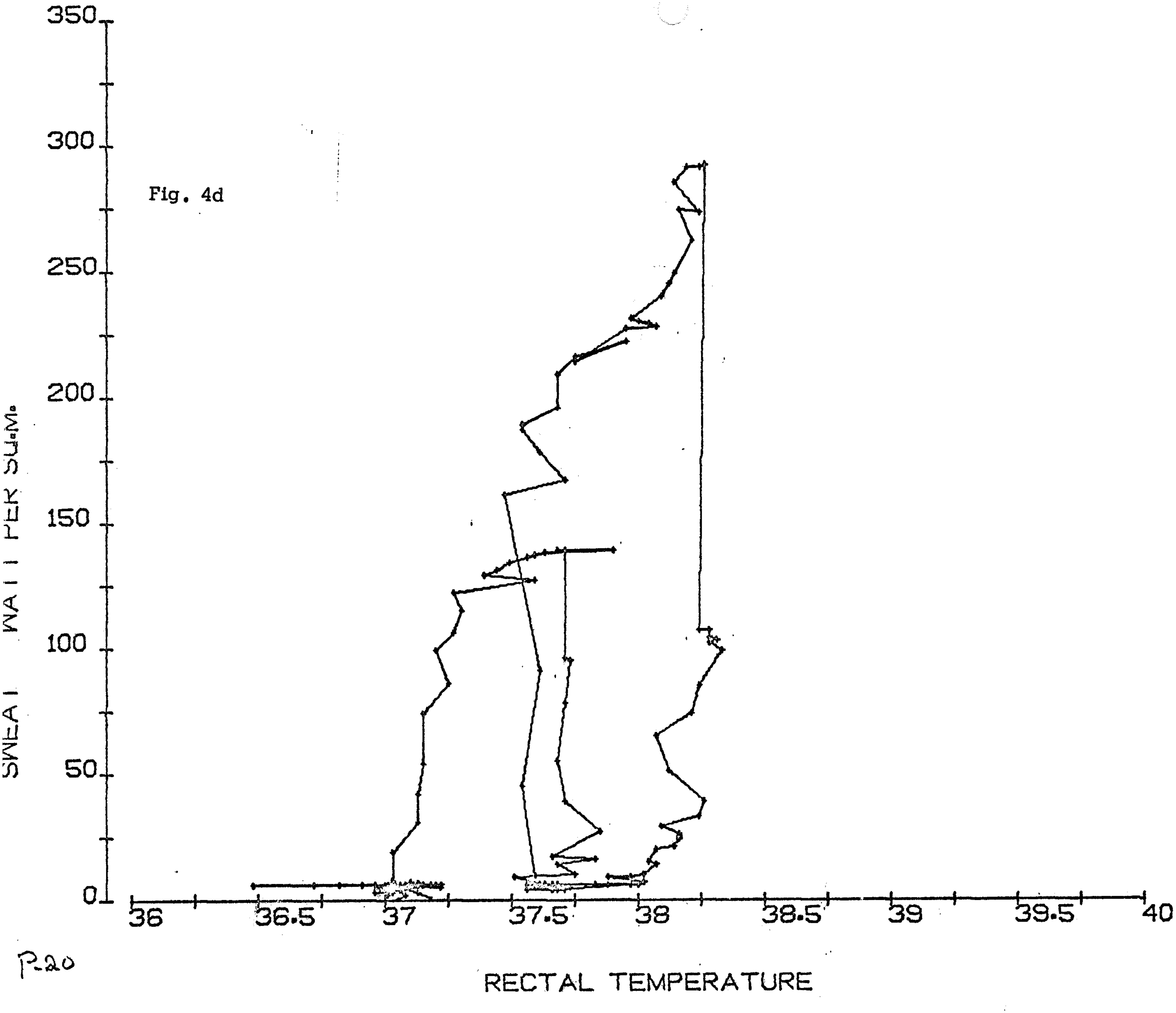
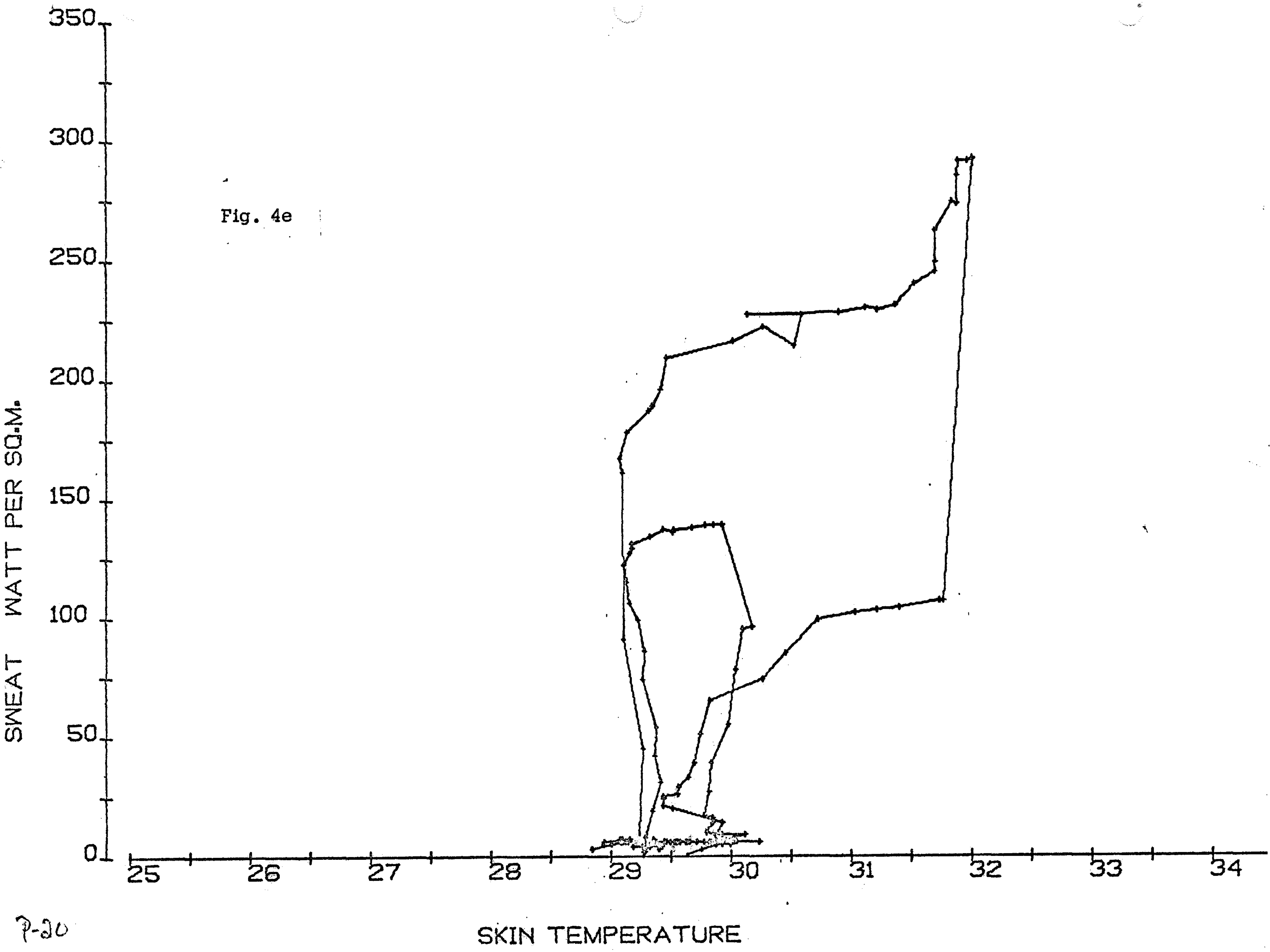

SWEAT WATT PER SQ.M.
350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

Fig. 4d


350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

P-20

Fig. 4e


350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

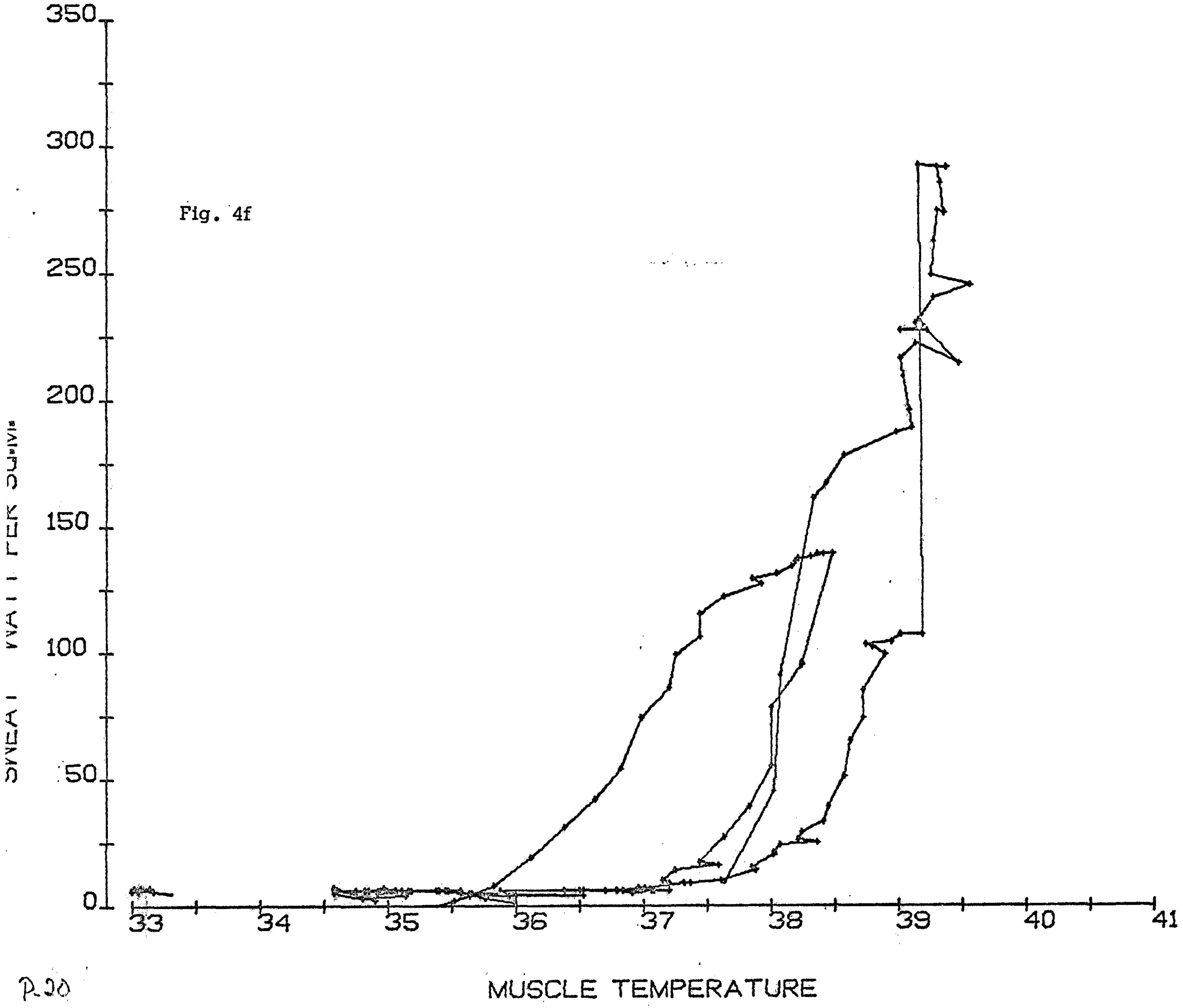

350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
33
34
35
36
37
38
39
40
41
MUSCLE TEMPERATURE

Fig. 4f

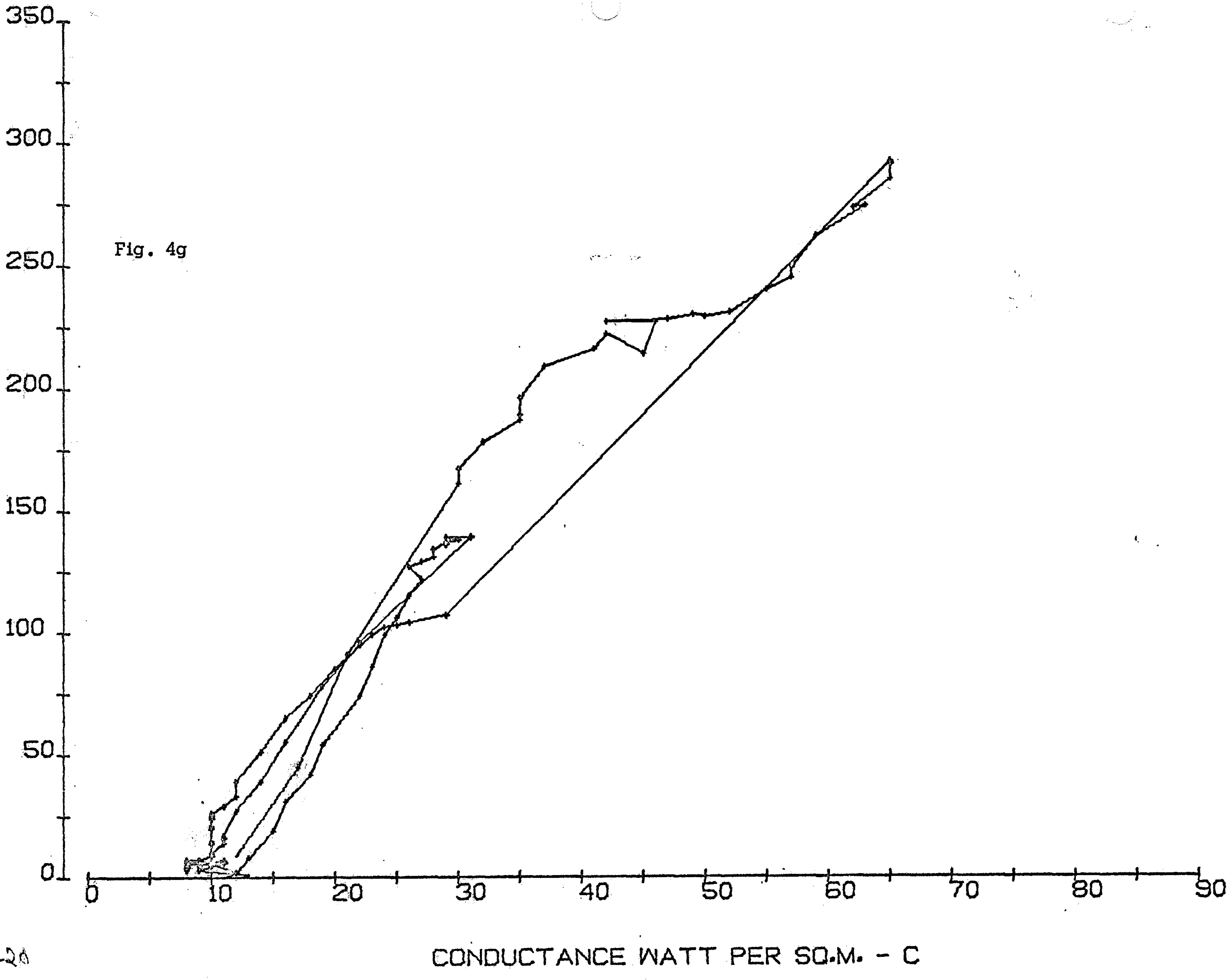

350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
CONDUCTANCE WATT PER SQ.M. - C

Fig. 4g

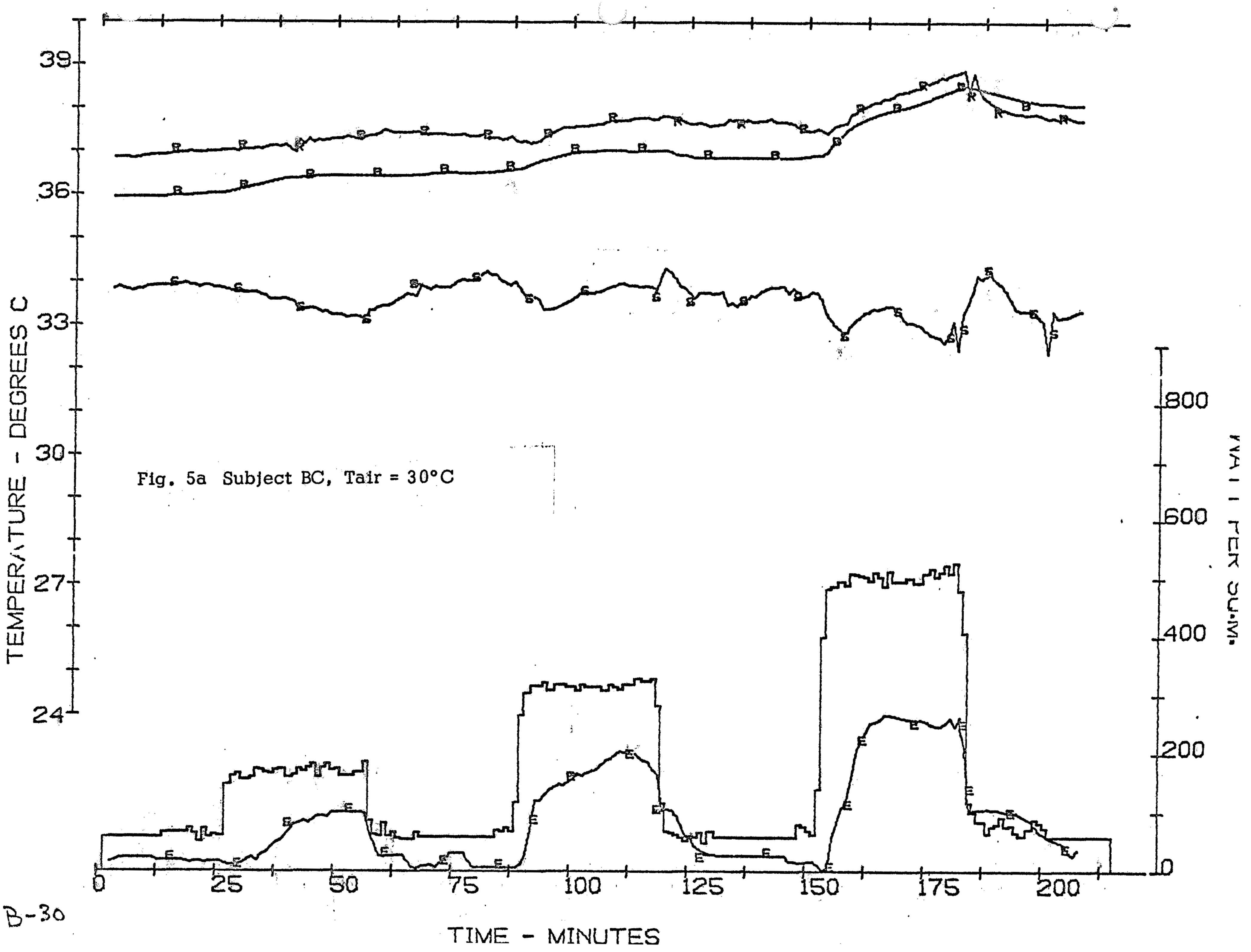


Fig. 5a Subject BC, Tair = 30°C

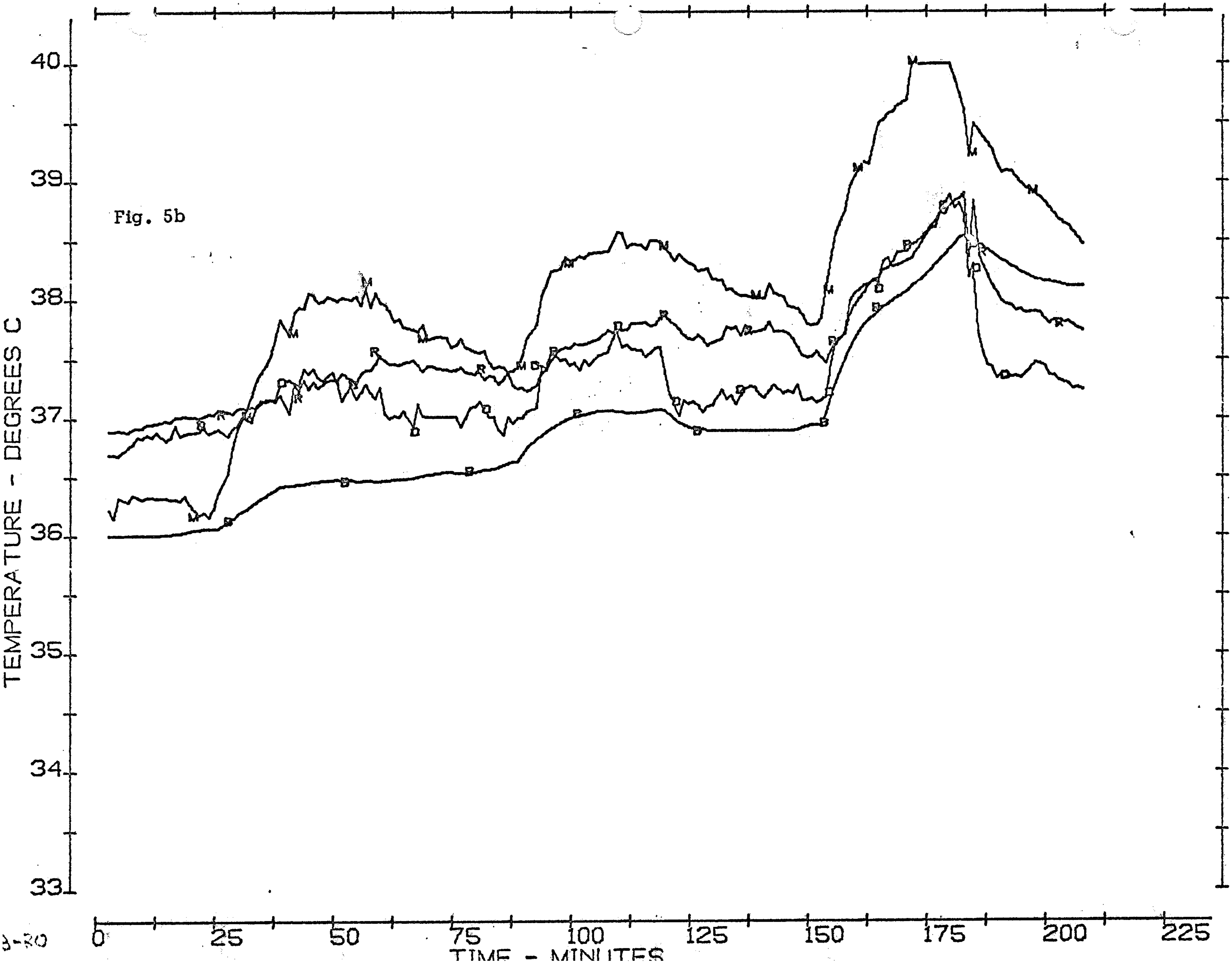
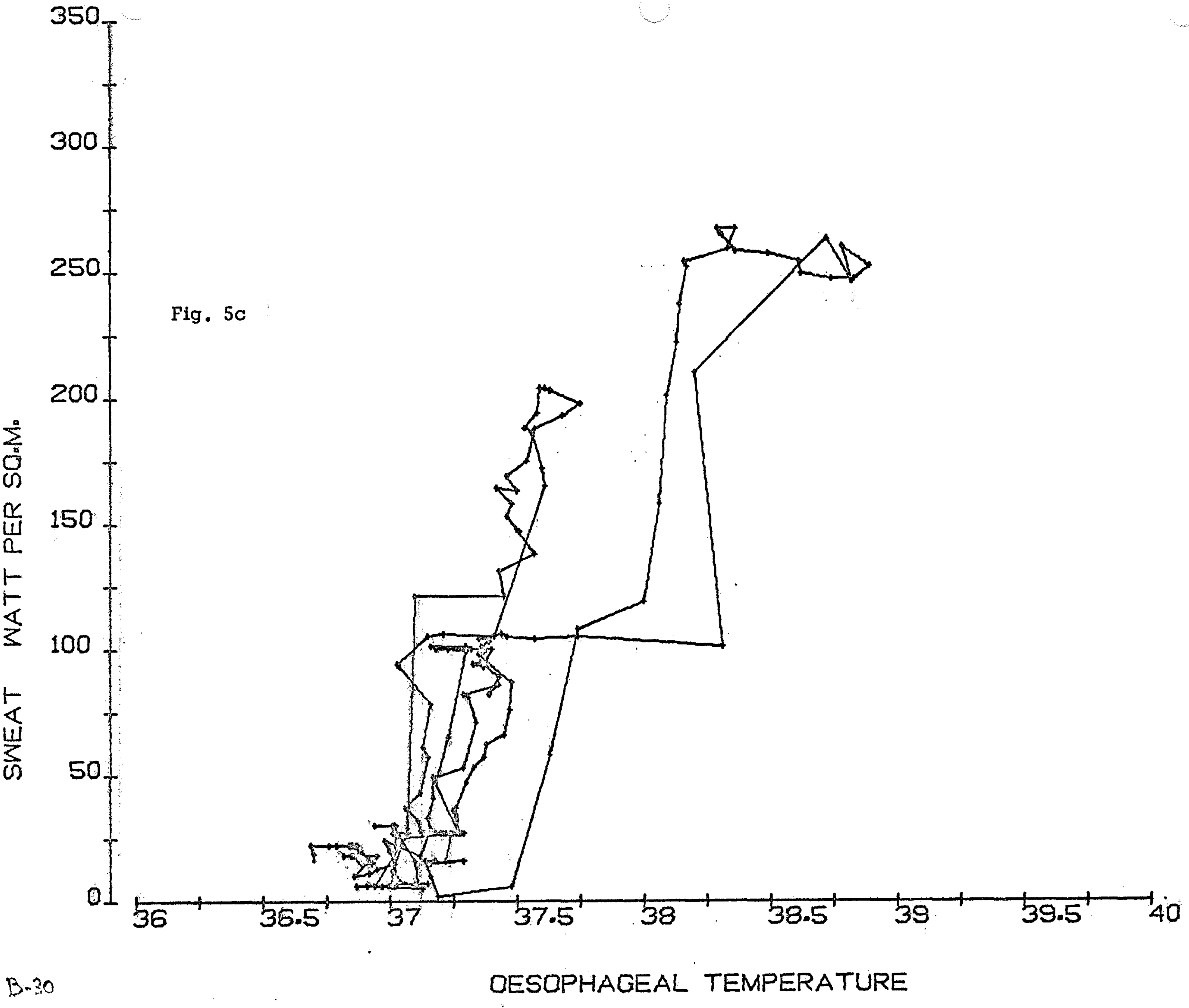


Fig. 5b

TEMPERATURE - DEGREES C
40
39
38
37
36
35
34
33
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES
M
R
D
B

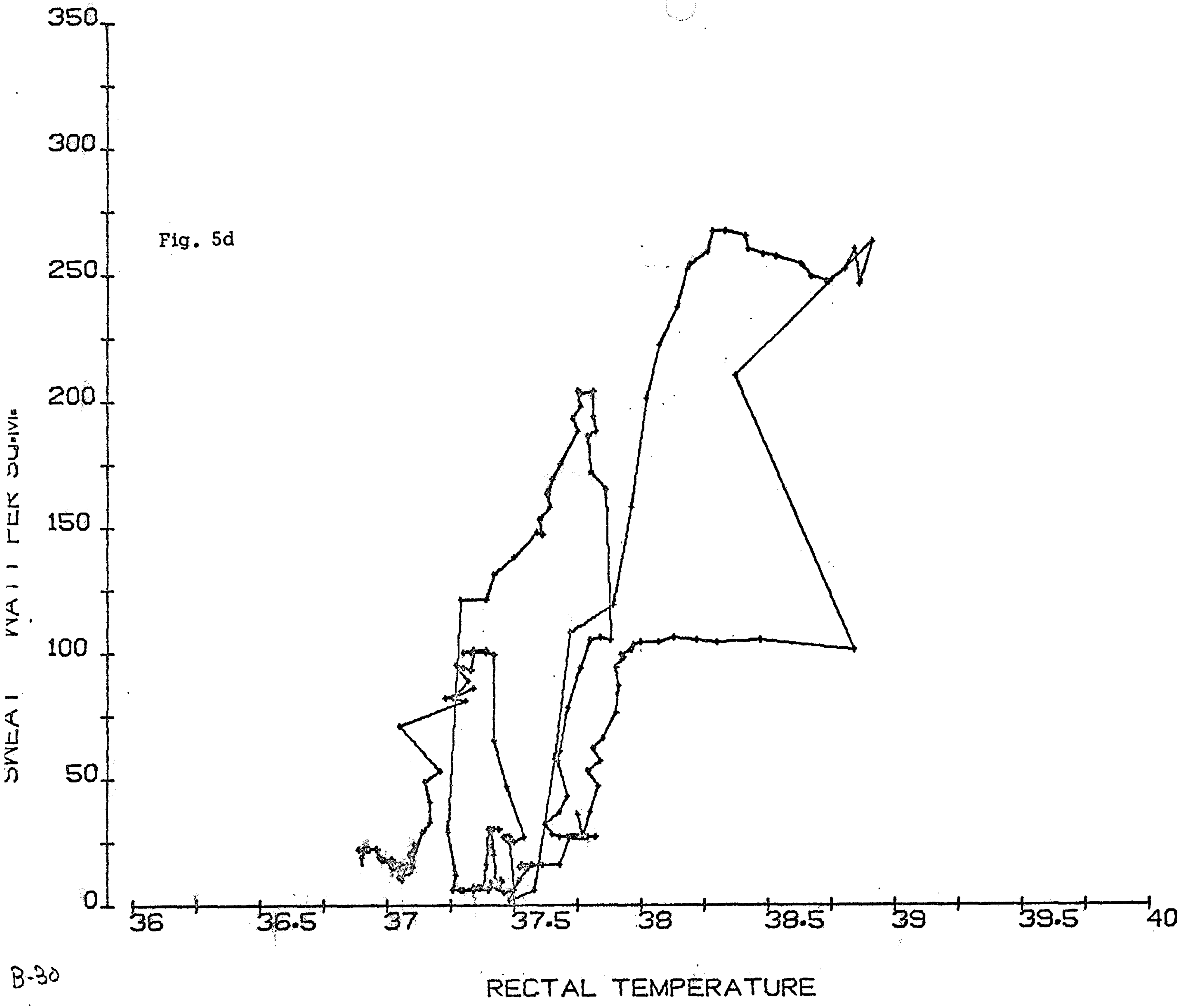
Fig. 5c



350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
36
36.5
37
37.5
38
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

B-30

Fig. 5d


SWEAT WATT PER SQ.M.
350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

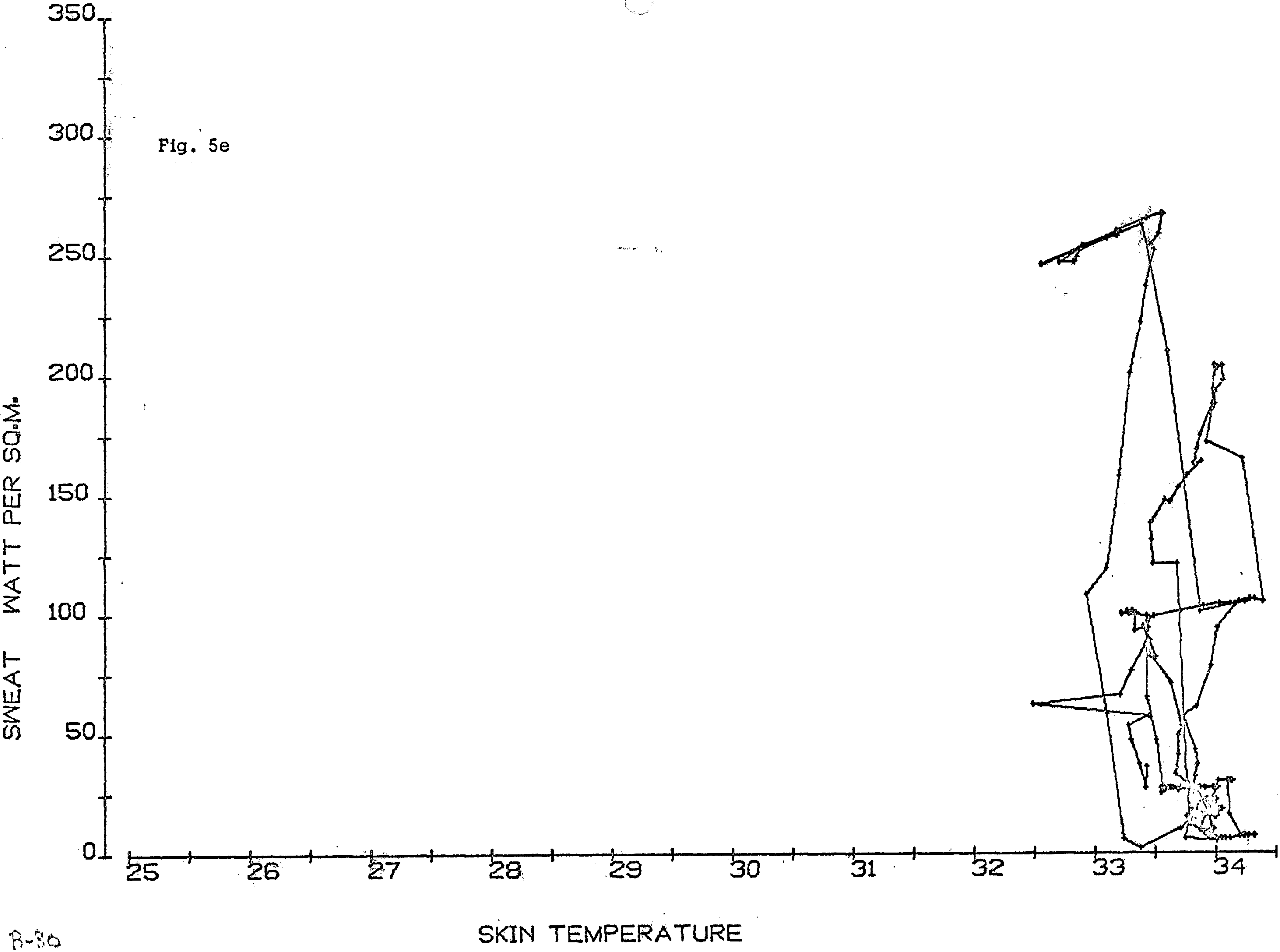


Fig. 5e
350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

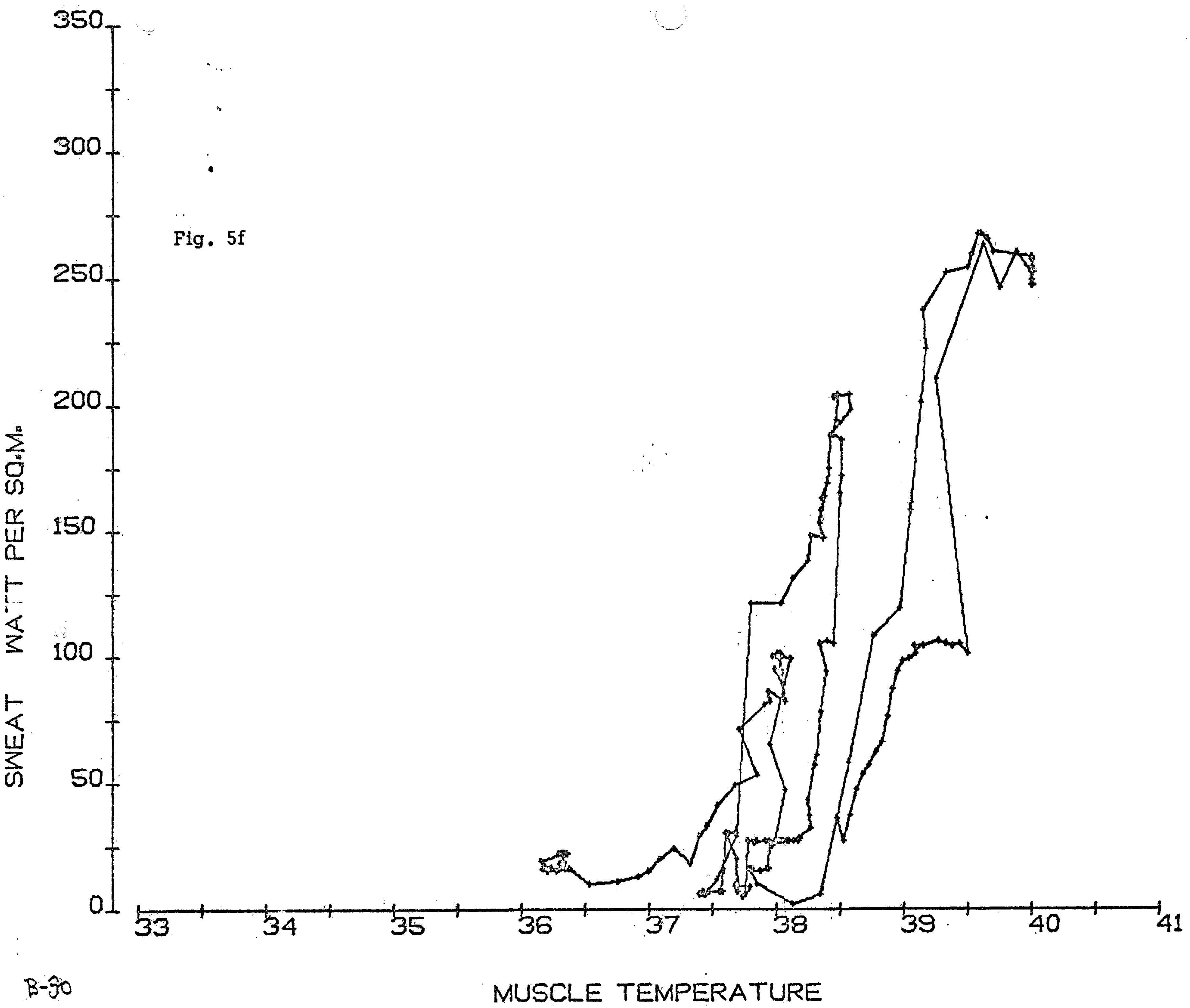


Fig. 5f
350
300
250
200
150
100
50
0
33
34
35
36
37
38
39
40
41
SWEAT WATT PER SQ.M.
MUSCLE TEMPERATURE

B-90

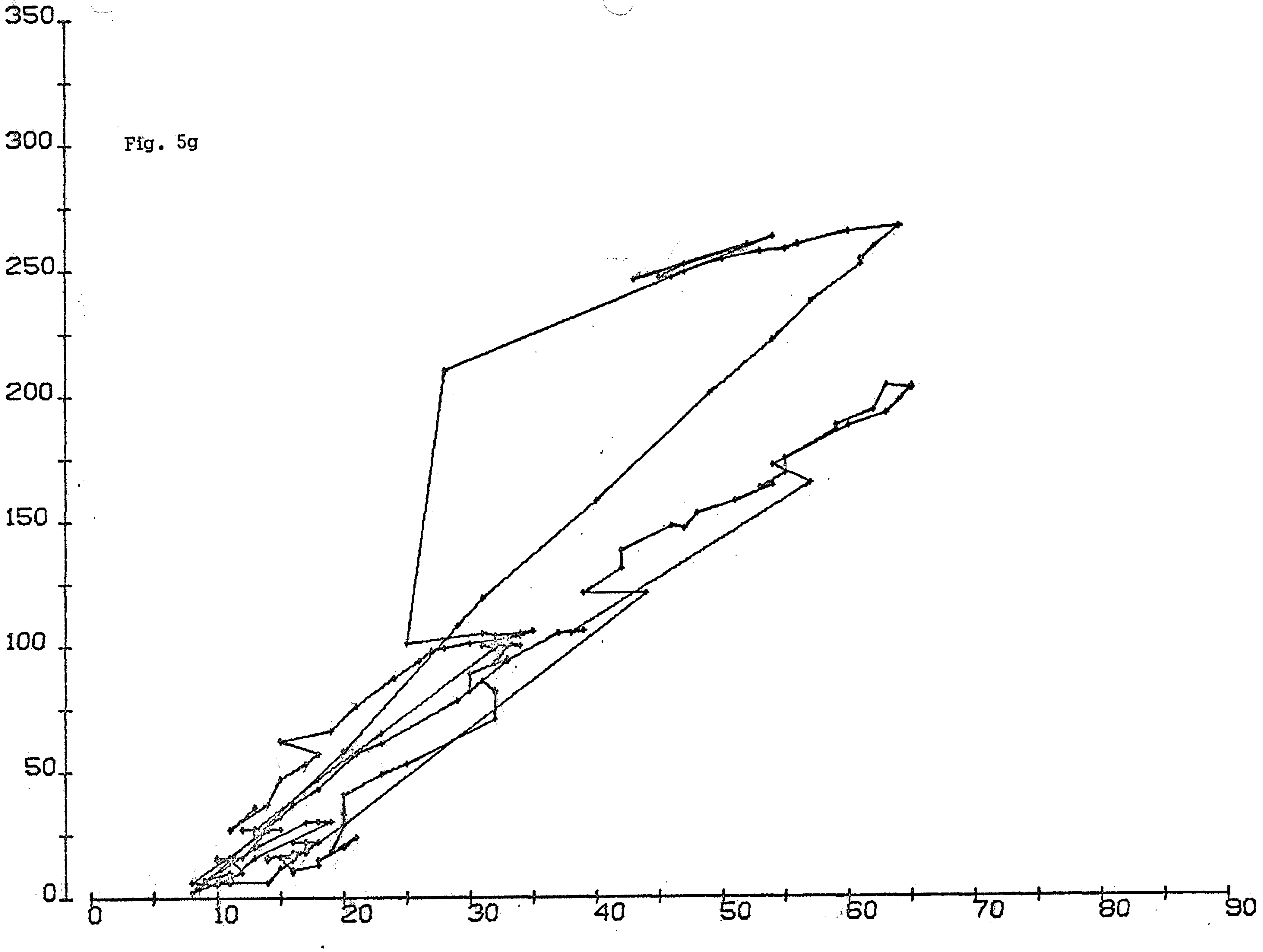


Fig. 5g

CONDUCTANCE WATT PER SQ.M. - C

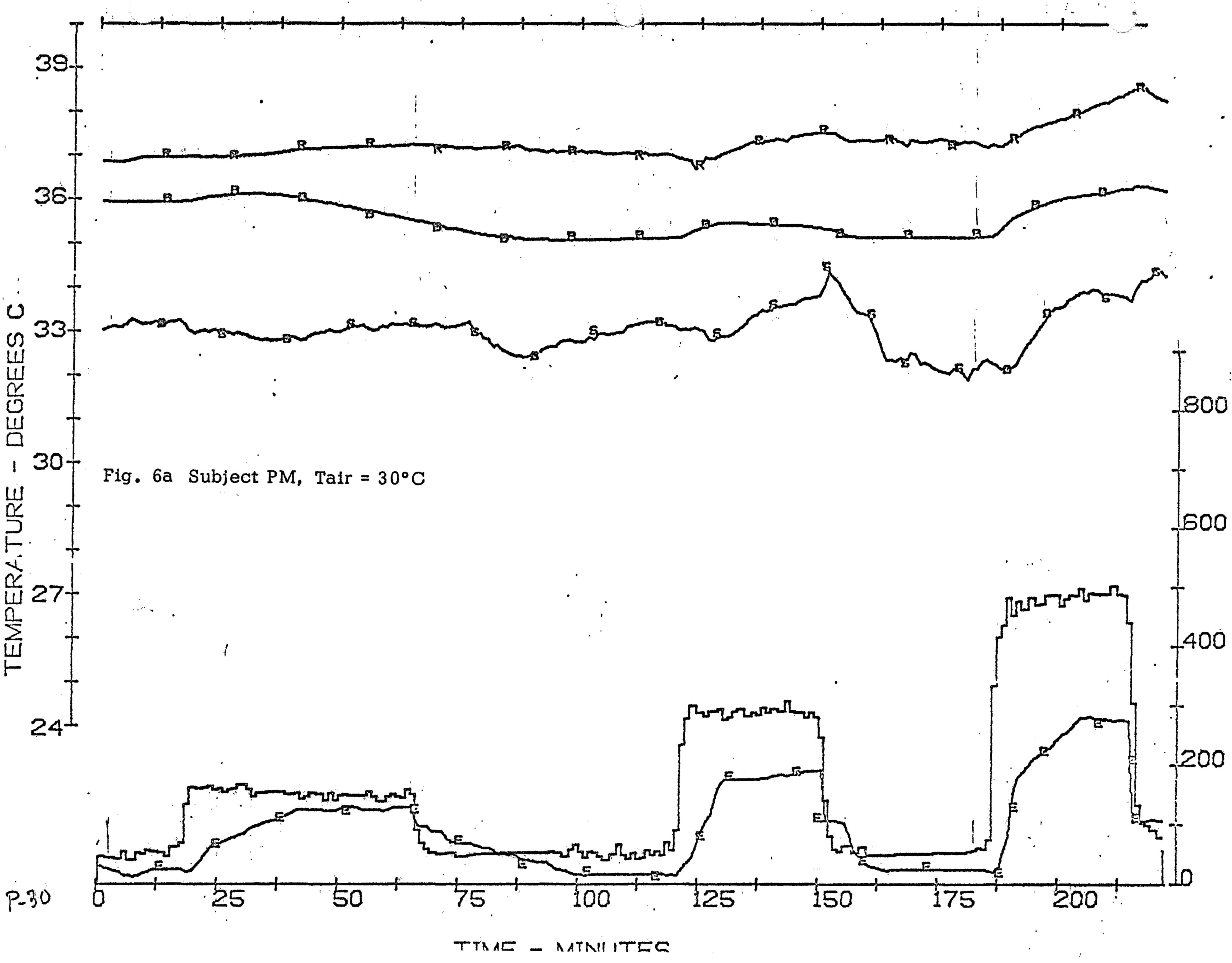


Fig. 6a Subject PM, Tair = 30°C

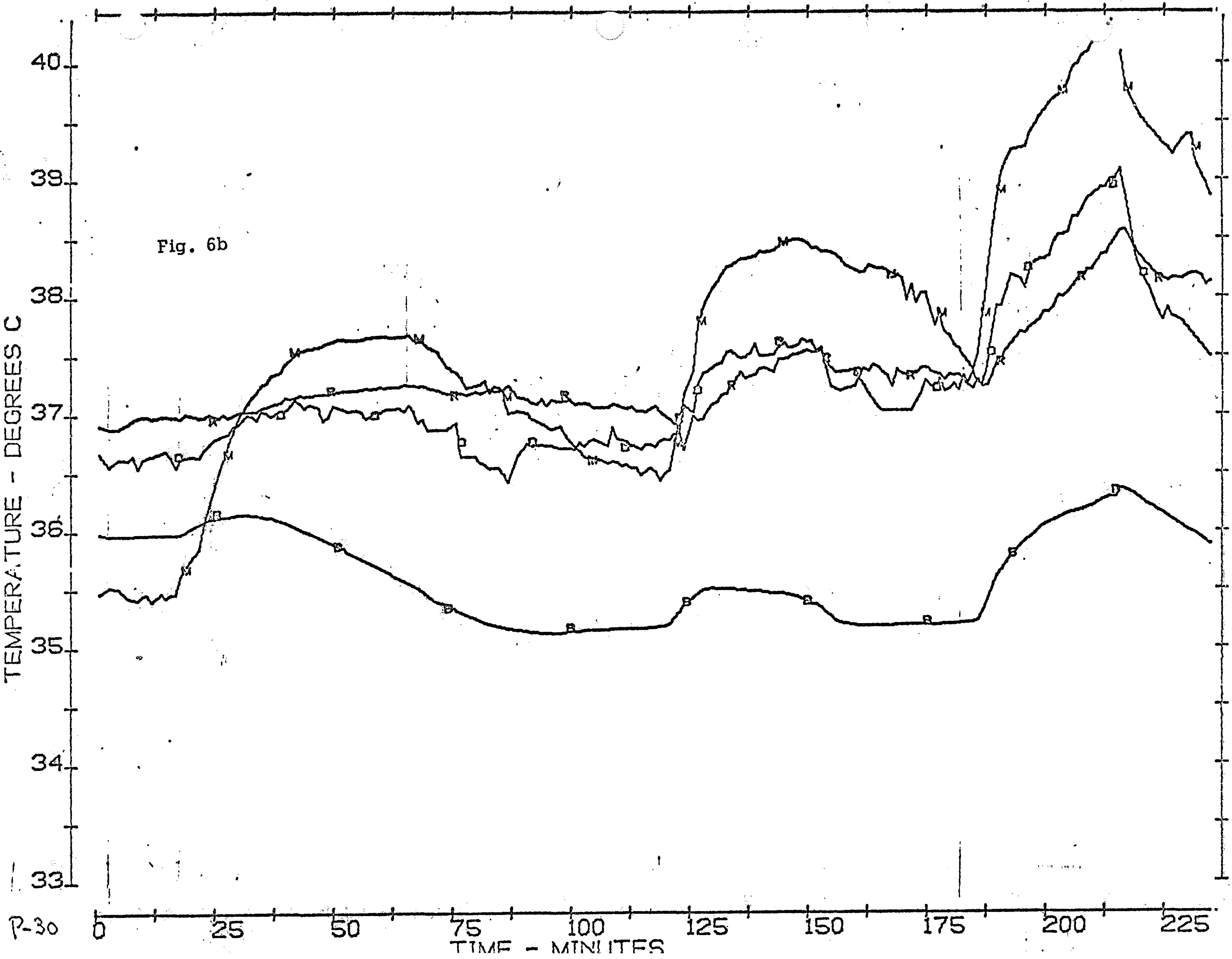
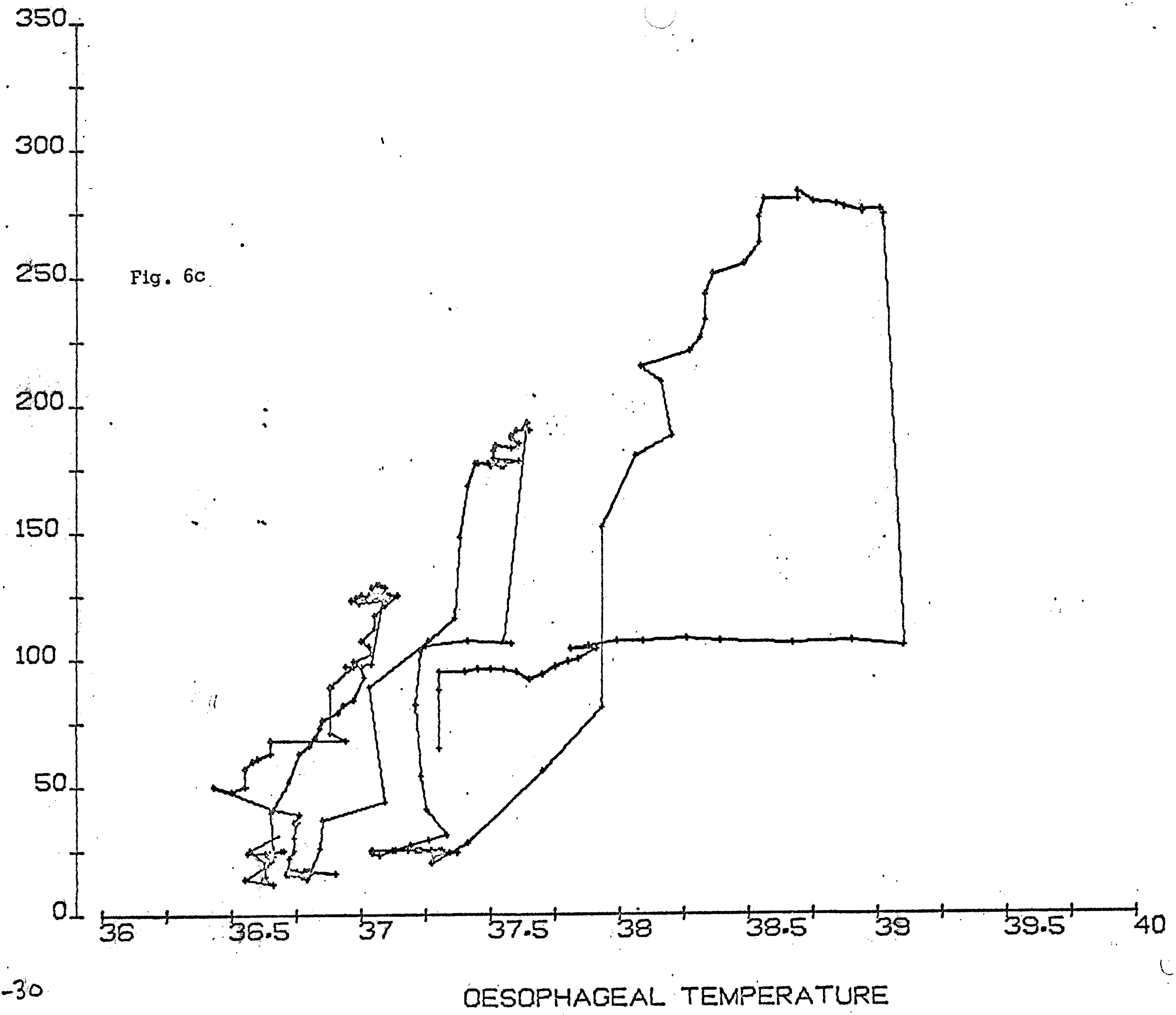


Fig. 6b
TEMPERATURE - DEGREES C
40
39
38
37
36
35
34
33
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES
M
R
D
B

Fig. 6c



350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

P-30

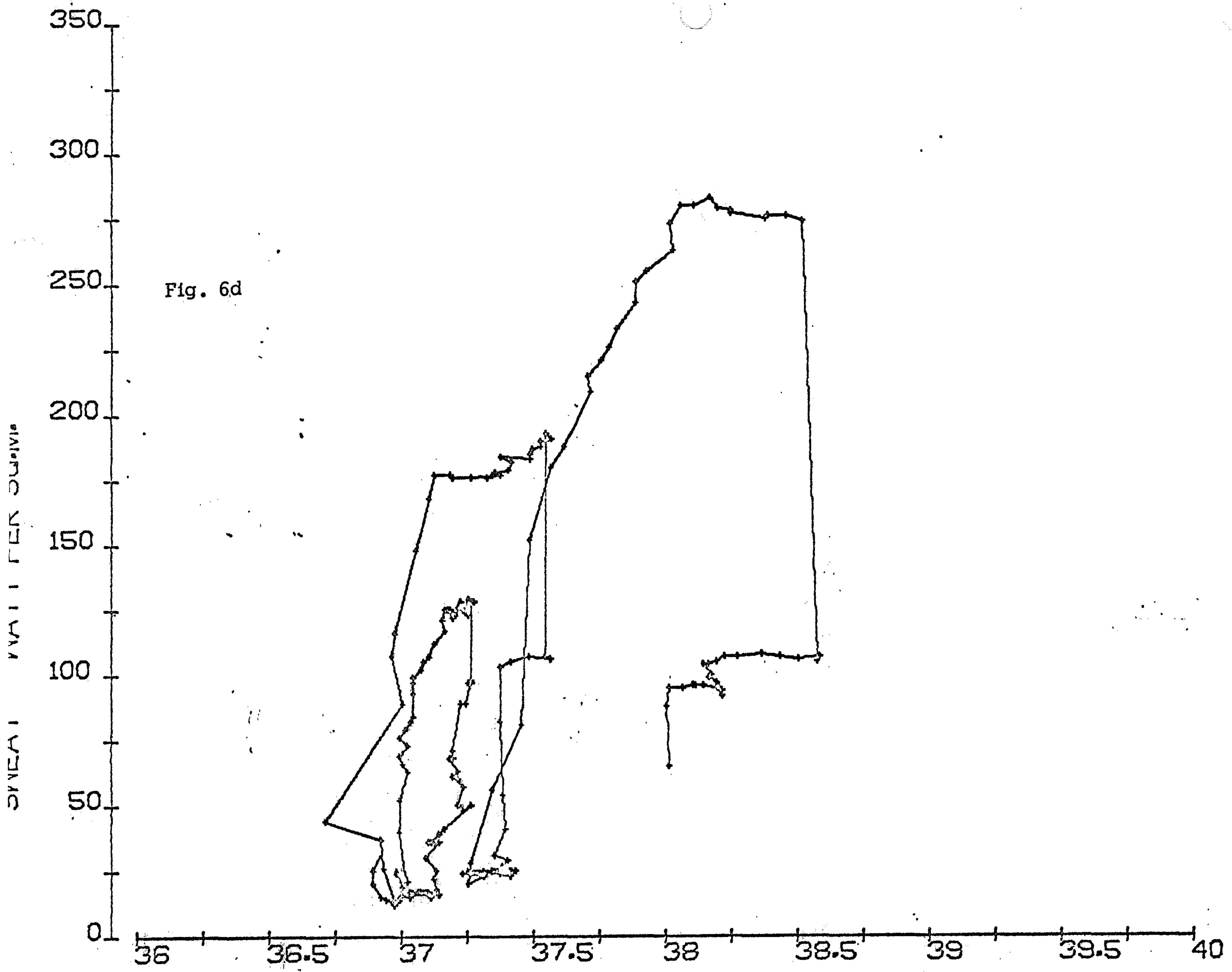


Fig. 6d
350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

R-30

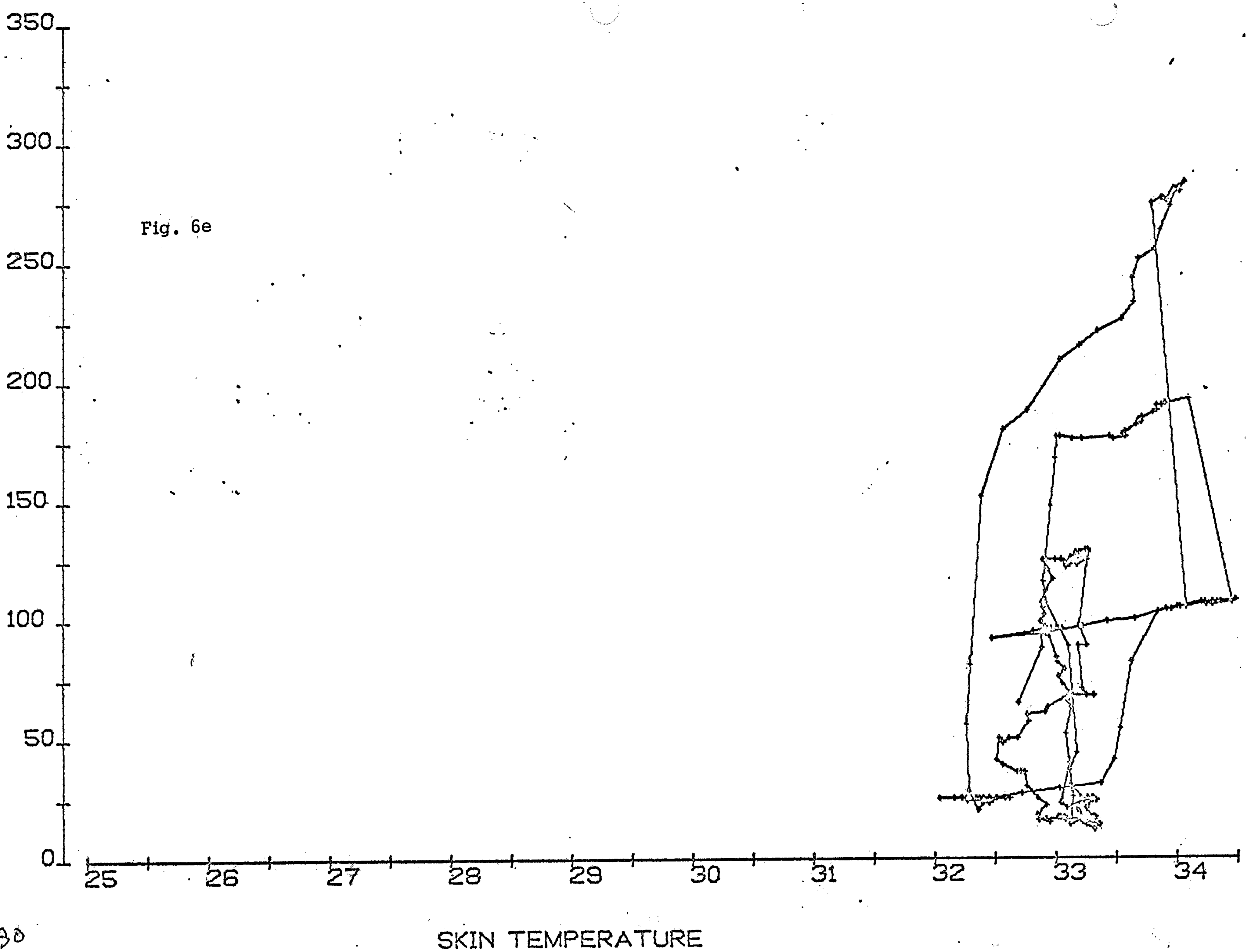

350
300
250
200
150
100
50
0
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

Fig. 6e

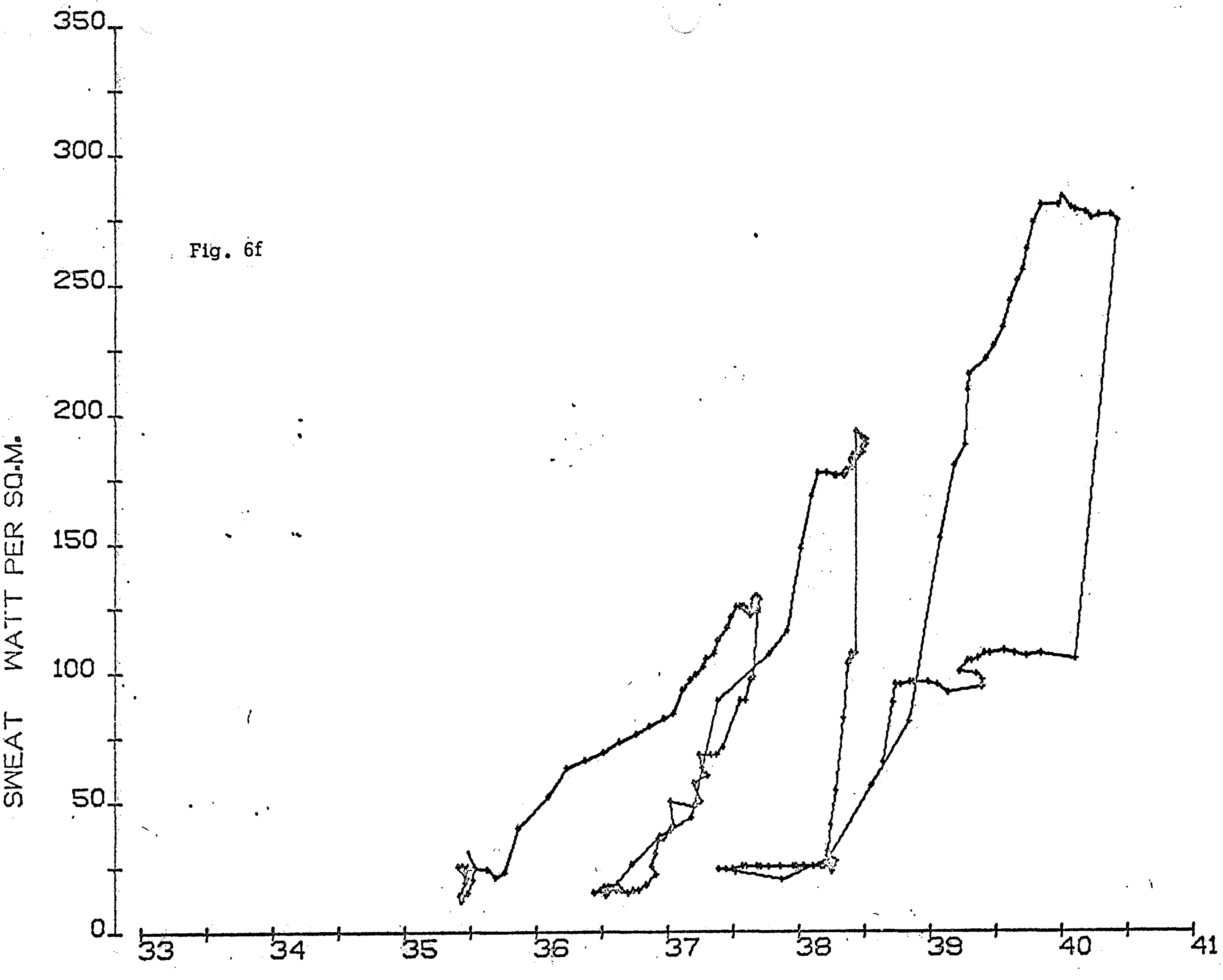


Fig. 6f
350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
33
34
35
36
37
38
39
40
41
MUSCLE TEMPERATURE

P-30

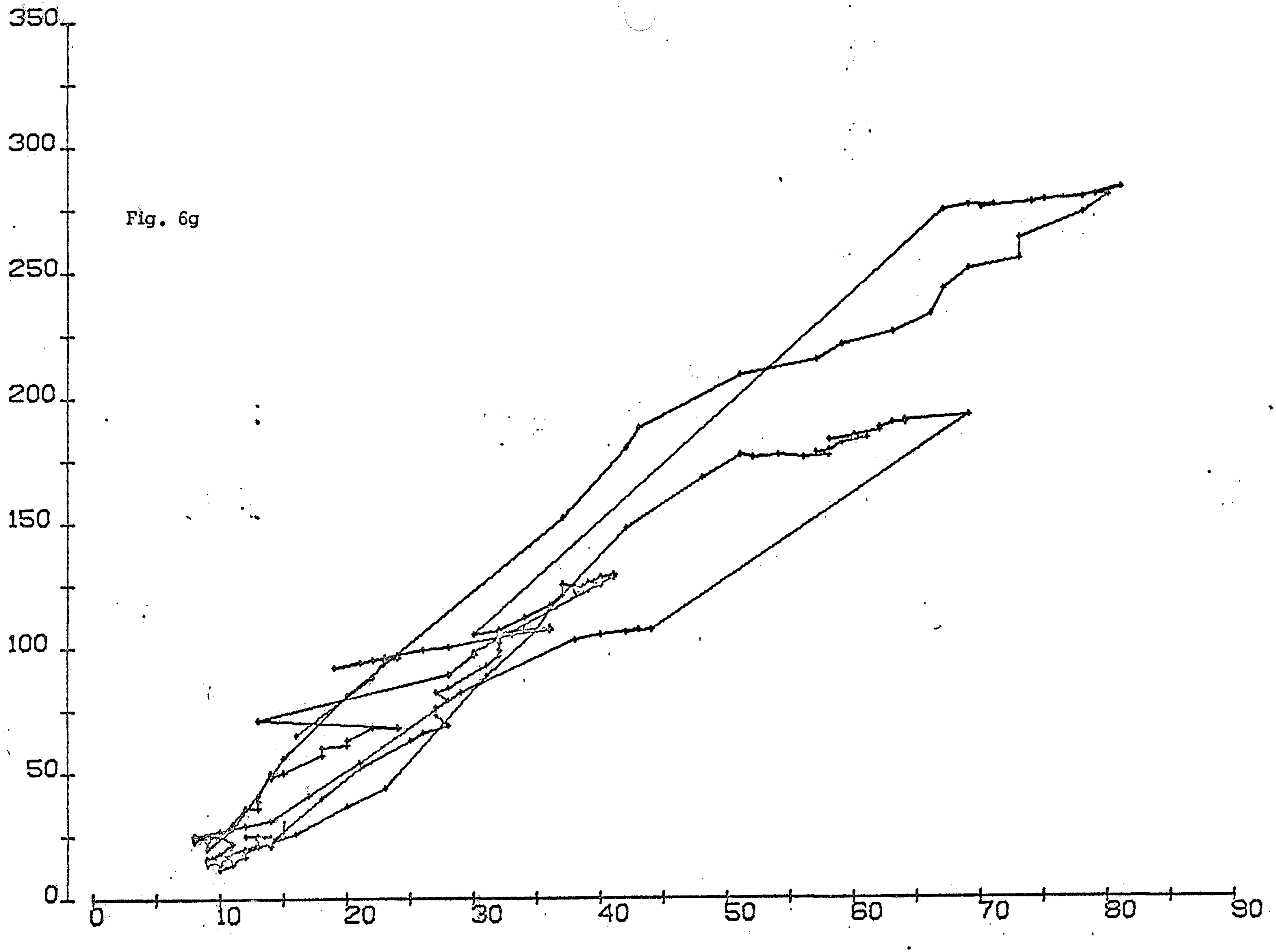

350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90

Fig. 6g

CONDUCTANCE WATT PER SQ.M. - C

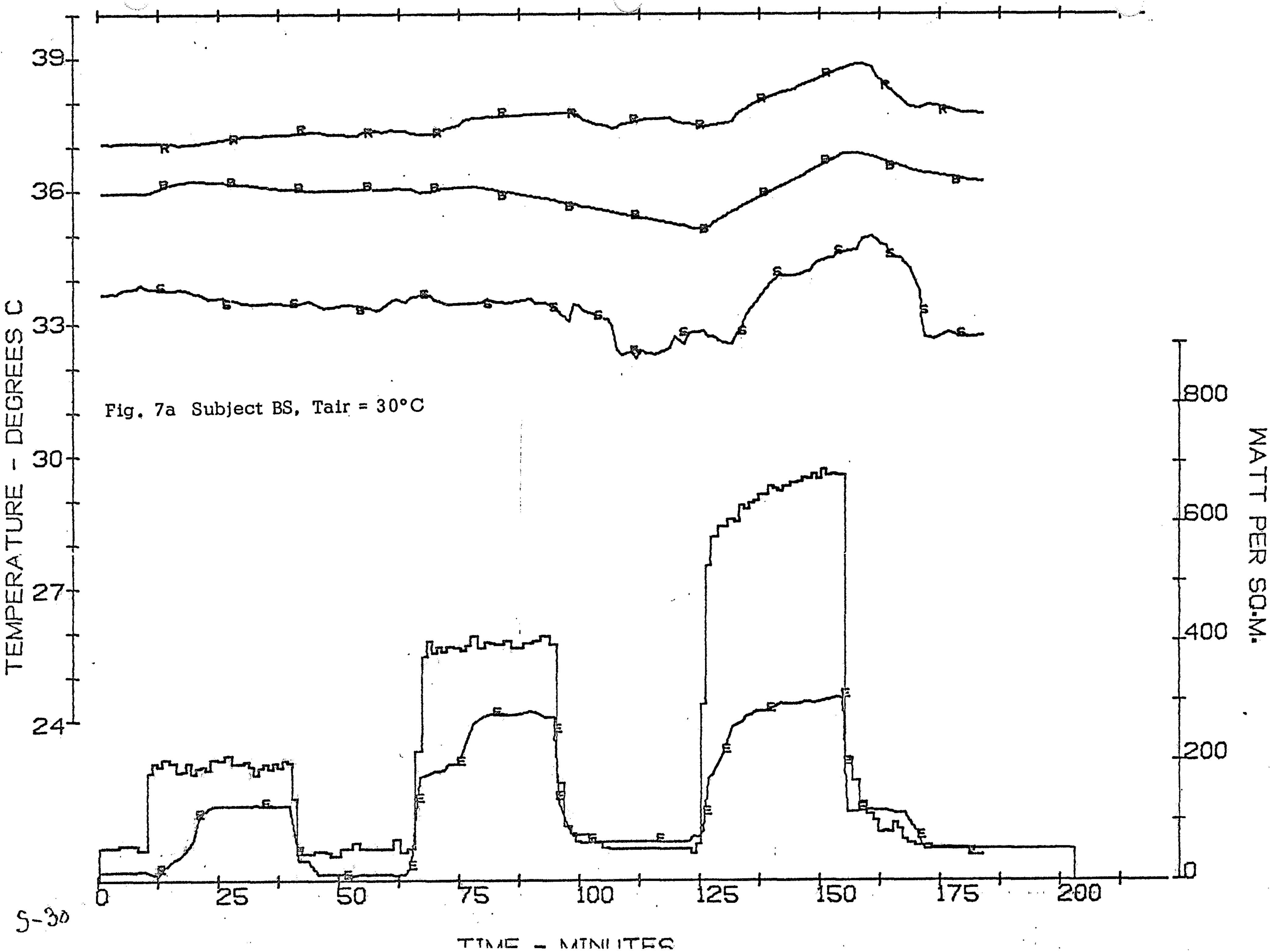


Fig. 7a Subject BS, Tair = 30°C

5-30

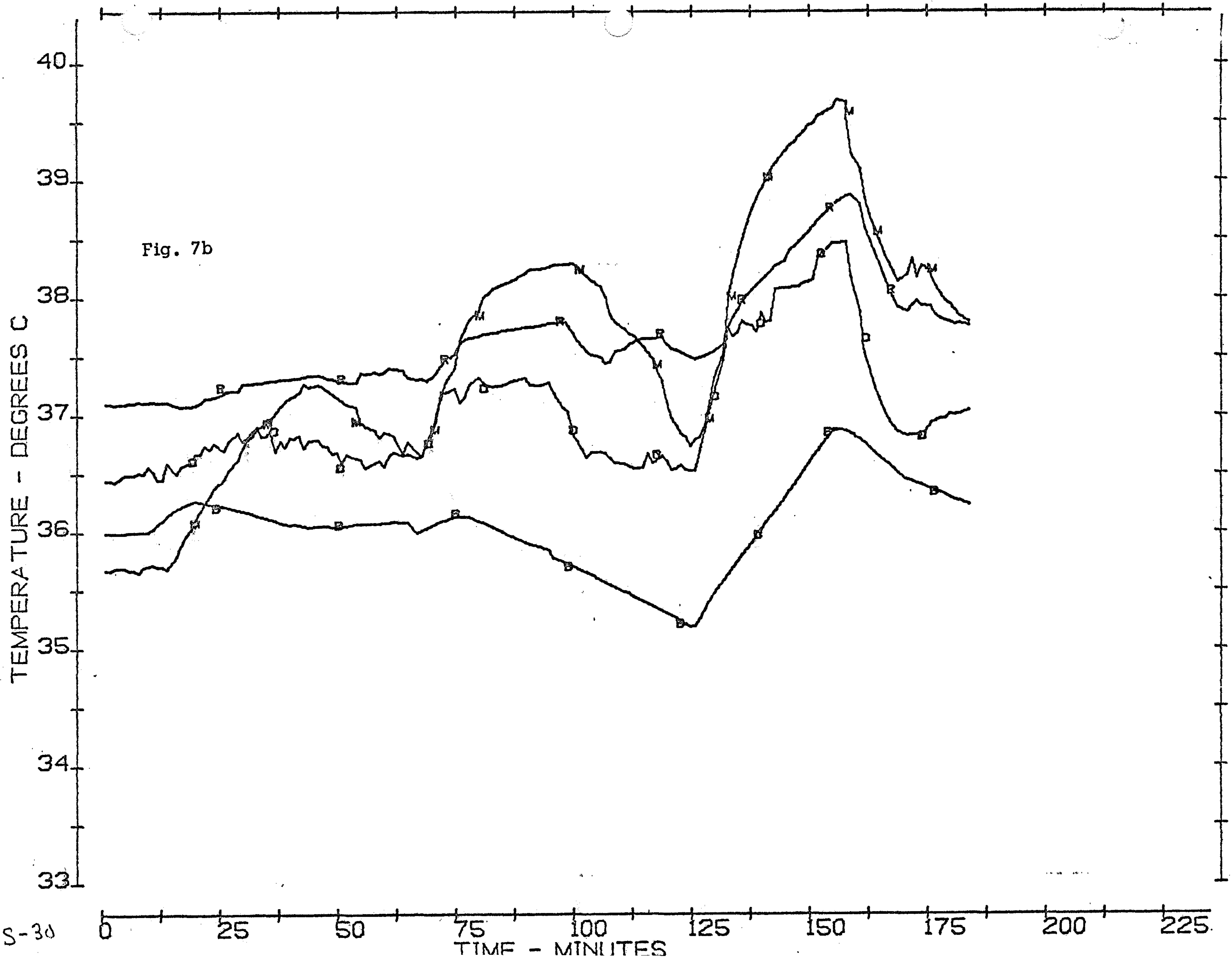


Fig. 7b
TEMPERATURE - DEGREES C
40.
39.
38.
37.
36.
35.
34.
33.
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES
R
M
D
B

S-30

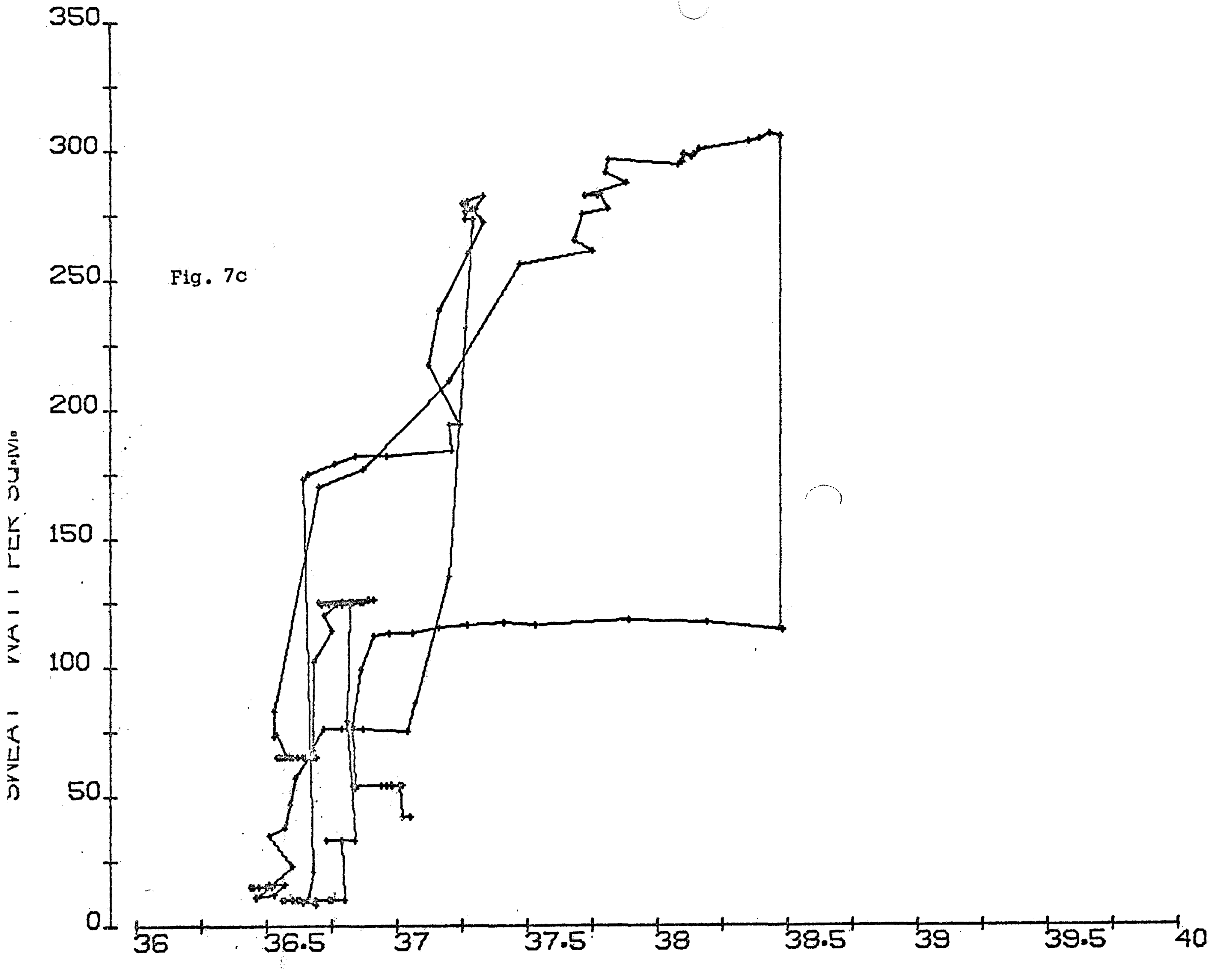


Fig. 7c

350
300
250
200
150
100
50
0
36
36.5
37
37.5
38
38.5
39
39.5
40
OESOPHAGEAL TEMPERATURE

8-30

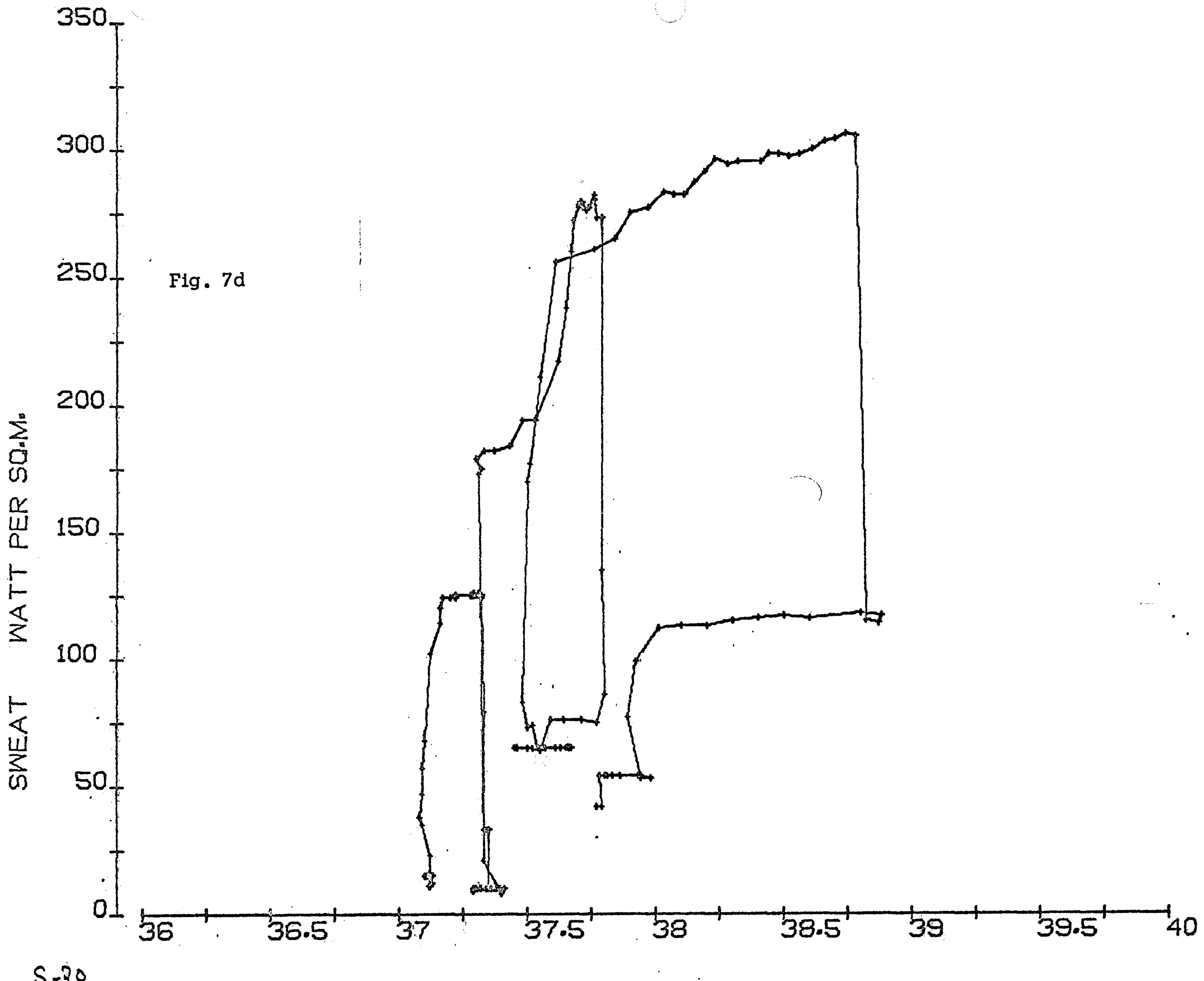


Fig. 7d
350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
36
36.5
37
37.5
38
38.5
39
39.5
40
RECTAL TEMPERATURE

S-30

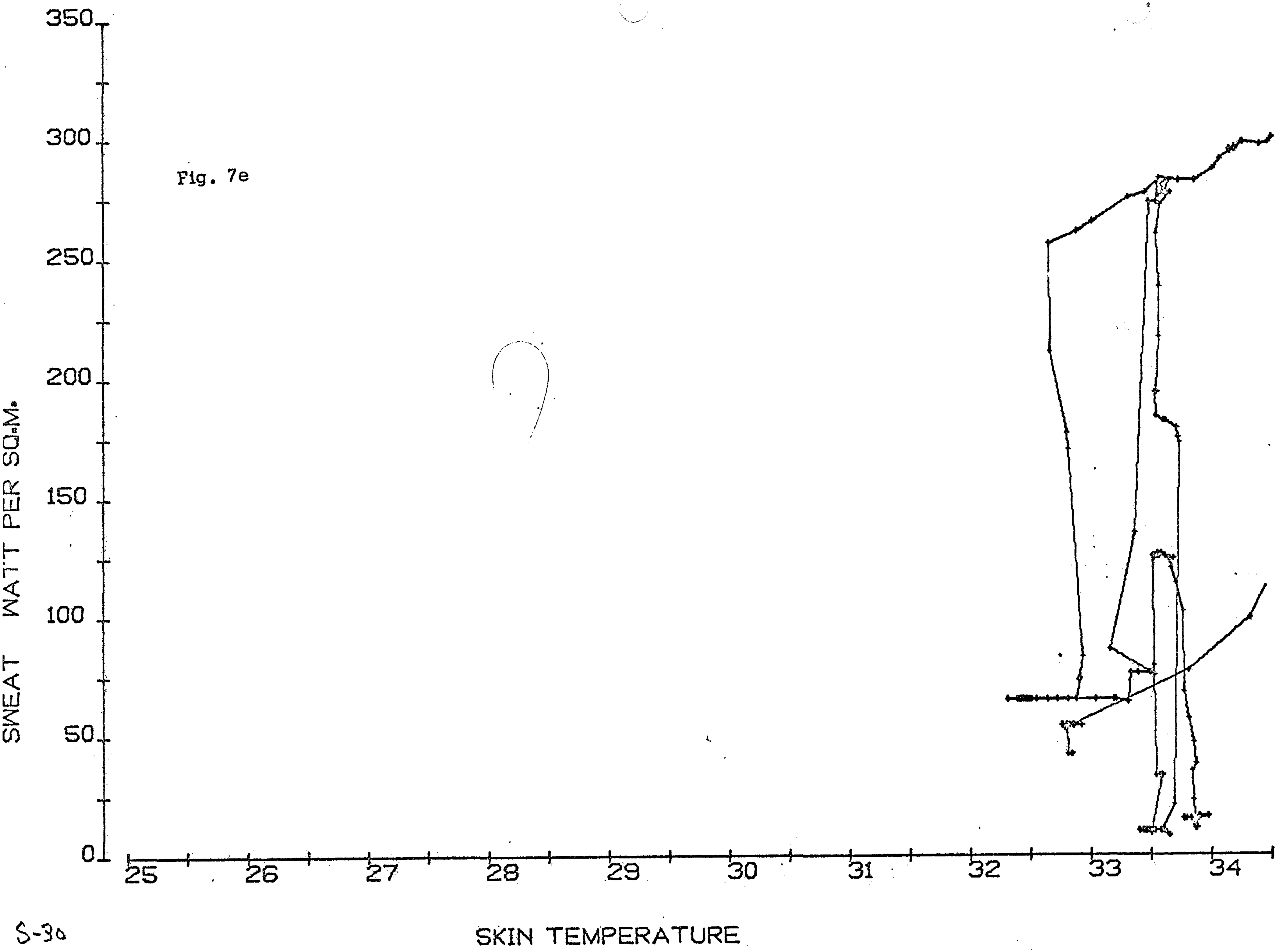
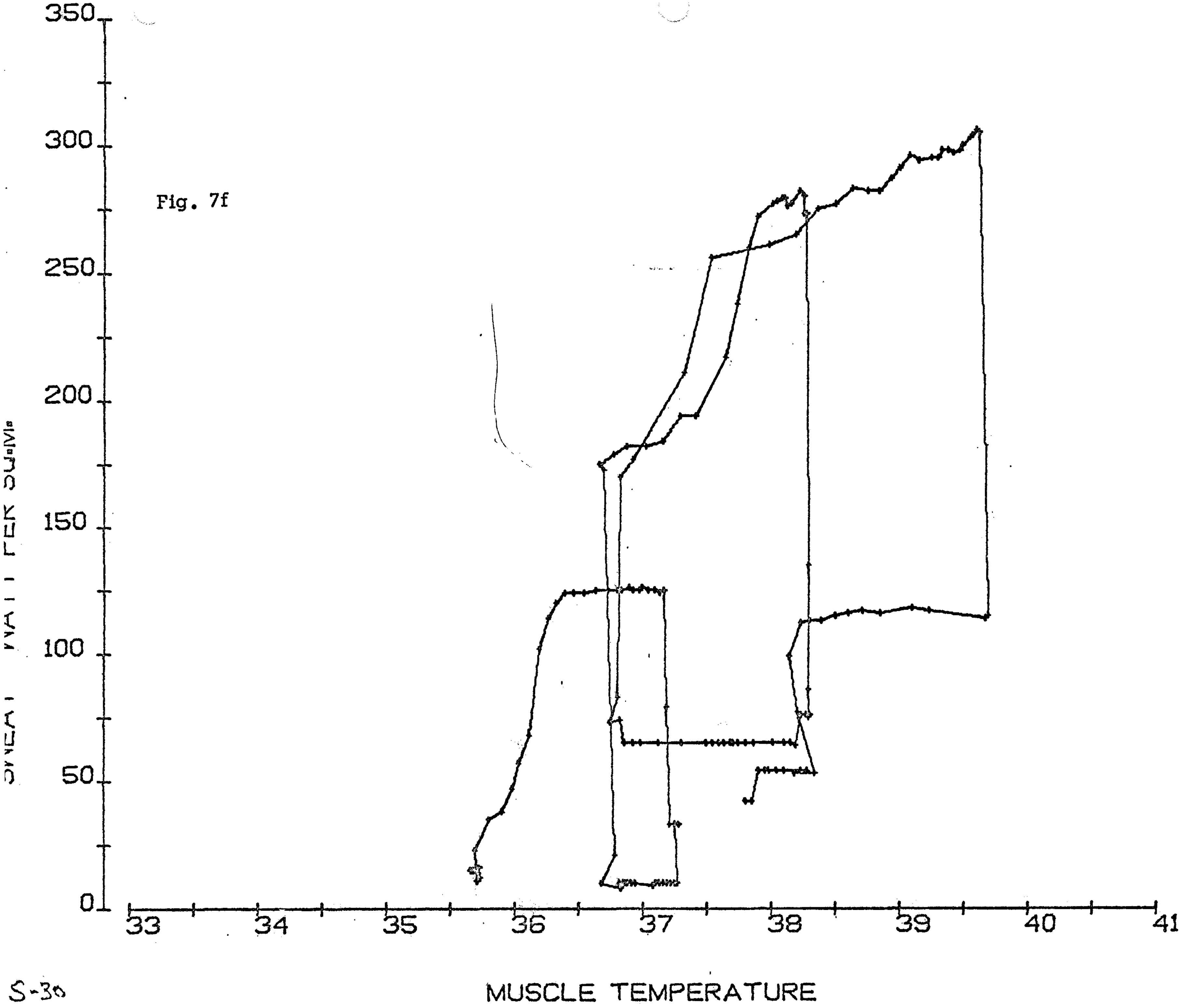

350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
25
26
27
28
29
30
31
32
33
34
SKIN TEMPERATURE

Fig. 7e

S-30

Fig. 7f



350
300
250
200
150
100
50
0
SWEAT WATT PER SQ.M.
33
34
35
36
37
38
39
40
41
MUSCLE TEMPERATURE

S-30

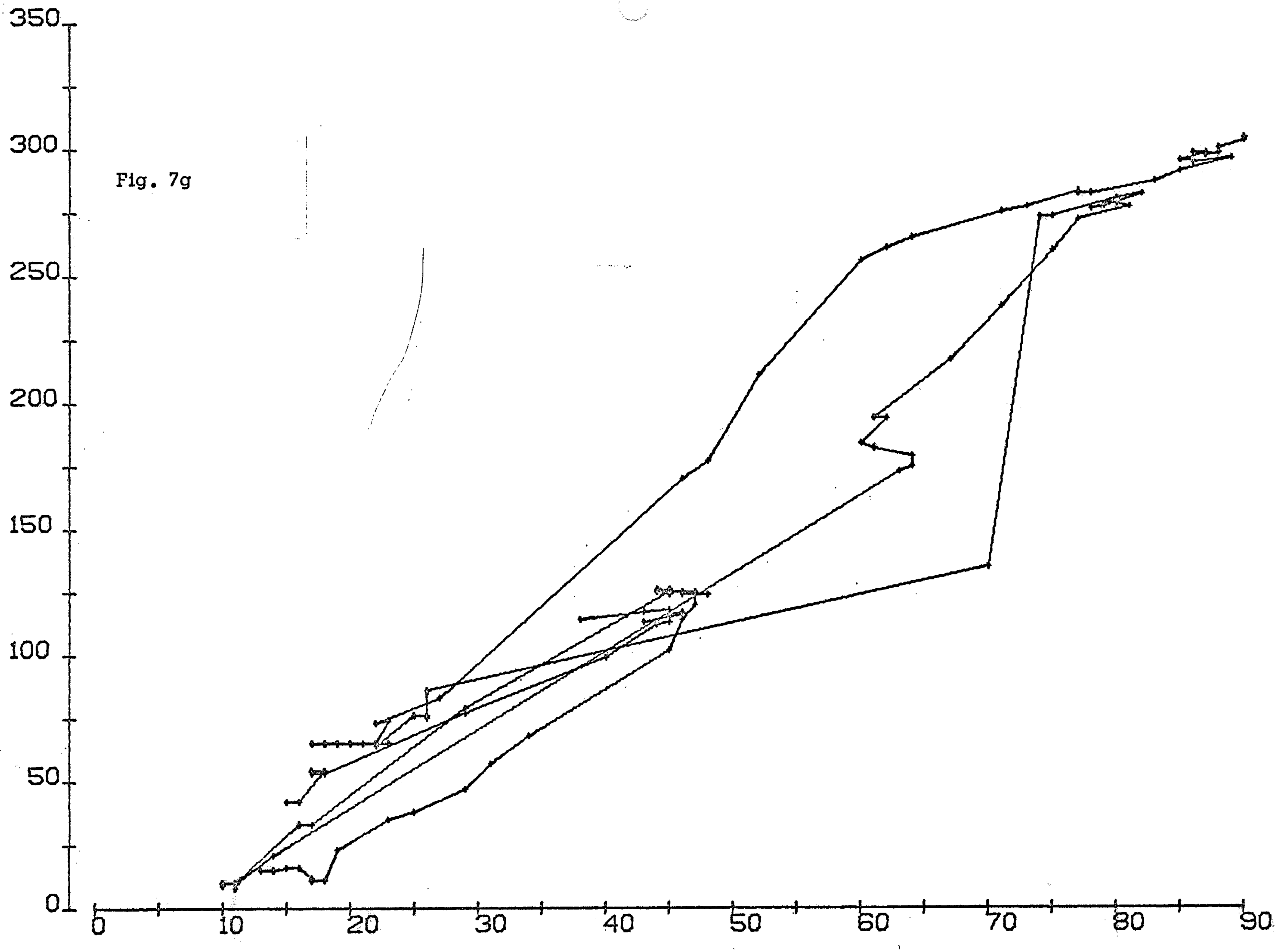


Fig. 7g

CONDUCTANCE WATT PER SQ.M. - C

S-30

Theoretical studies

The extended mathematical model of thermoregulation which was described in concept and detail in the Final Report - A was used in only very slightly modified form.

It was used in simulations of a standardized experiment. The subject was a 70 kg man, with a surface area of 1.88 m^2. The maximum aerobic capacity was assumed to be 4.04 liters O_2 per minute, a value which is normal for a physically fit young adult of this size, but somewhat below the value for a competitive athlete.

The coefficients used in the central controller were all set to zero, for the case of absent or ineffective thermoregulation control, and to the following values for the case of effective and normal thermoregulation:

CSW = 400 Kcal. h^{-1}. per °C temperature rise in the brain

PSW = 60 Kcal. h^{-1} $°C^{-2}$

CDIL = 150 l.h^{-1} per °C temperature rise in the brain.

CCON = 10 per °C temperature drop in the brain

SCON 10 per °C skin temperature drop

PCHIL 10 Kcal. h^{-1}. $°C^{-2}$

In the simulation a nude man initially at equilibrium with a 30°C environment was placed for an initial rest period of 30 minutes in 10, 20, or 30°C at 30% relative humidity. In each temperature the man was subjected to a series of rest and exercise periods, as follows:

0-30 minutes rest, air velocity 0.1 m/sec

30-60 minutes exercise, total O_2 consumption 280 Kcal.h^{-1}, air velocity 0.3 m/sec

60-90 minutes rest, air velocity 0.1 m/sec

90-120 minutes exercise, total O_2 consumption 520 $Kcal.h^{-1}$,
air velocity 0.3 m/sec

120-150 minutes rest, air velocity 0.1 m/sec

150-180 minutes exercise, total O_2 consumption 875 $Kcal.h^{-1}$,
air velocity 0.3 m/sec

180-210 minutes rest, air velocity 0.1 m/sec

A complete listing of the FORTRAN program as used, and of all the input cards is given below. For the case of no thermoregulatory control the card labeled CONTR 19 should be left blank.

```
// DUP
*DELETE             MAN
// FOR
*ONE WORD INTEGERS
*IOCS(CARD,TYPEWRITER)
      DIMENSION T(25),TSET(25),RATE(25),C(25),QB(24),EB(24),BFB(24)
      DIMENSION TC(24),S(6),SKINR(6),SKINS(6),SKINV(6),SKINC(6),WORKM(6)
      DIMENSION CHILM(6),HR(6),HC(6),P(10),F(25),H(6),WARM(25),COLD(25)
      DIMENSION HF(25)
      DIMENSION ERROR(25),Q(24),E(24),BF(24),EMAX(6),BC(24),TD(24)
      CALL ENTER
C
C     READ CONSTANTS FOR CONTROLLED SYSTEM
C
  100 FORMAT(14F5.2)
  101 CONTINUE
      READ(2,100)  C
      READ(2,100)  QB
      READ(2,100)  EB
      READ(2,100)  BFB
      READ(2,100)  TC
      READ(2,100)  S
      READ(2,100)  HR
      READ(2,100)  HC
      READ(2,100)  P
      SA=0.
      DO 110 K=1,6
  110 SA=SA+S(K)
C
C     READ CONSTANTS FOR THE CONTROLLER
C
      READ(2,100)  TSET
      READ(2,100)  RATE
      READ(2,100)CSW,SSW,PSW,CDIL,SDIL,PDIL,CCON,SCON,PCON,CCHIL,SCHIL,
     XPCHIL
      READ(2,100)  SKINR
      READ(2,100)  SKINS
      READ(2,100)  SKINV
      READ(2,100)  SKINC
      READ(2,100)  WORKM
      READ(2,100)  CHILM
C
C     READ INITIAL CONDITIONS
C
      READ(2,100)  T
      TIME=0.
      ITIME=0
      JTIME=0
      DO 102 N=1,25
      F(N)=0.
```

```
  102 CONTINUE
C
C     READ EXPERIMENTAL CONDITIONS
C
      READ(2,100)  TAIR
      READ(2,100)  V
      READ(2,100)  RH
      READ(2,100)  WORK
      IF(WORK-70.)  104,104,105
  104 WORK=0.
      GO TO 106
  105 WORK=(WORK-69.754)*0.78
  106 CONTINUE
      READ(2,200)  INT
  200 FORMAT(I2)
      DO 202 I=1,6
      H(I)=(HR(I)+3.16*HC(I)*V**0.5)*S(I)
  202 CONTINUE
      I=TAIR/5
      PAIR=RH*(P(I)+(P(I+1)-P(I))*(TAIR-5*I)/5.)
C
C     ESTABLISH THERMORECEPTOR OUTPUT
C
  301 CONTINUE
      DO 302 N=1,25
      WARM(N)=0.
      COLD(N)=0.
      ERROR(N)=T(N)-TSET(N)+RATE(N)*F(N)
      IF(ERROR(N))   303,302,304
  303 COLD(N)=-ERROR(N)
      GO TO 302
  304 WARM(N)=ERROR(N)
  302 CONTINUE
C
C     INTEGRATE PERIPHERAL AFFERENTS
C
      WARMS=0.
      COLDS=0.
      DO 305 I=1,6
      K=4*I
      WARMS=WARMS+WARM(K)*SKINR(I)
      COLDS=COLDS+COLD(K)*SKINR(I)
  305 CONTINUE
C
C     DETERMINE EFFERENT OUTFLOW
C
      SWEAT=CSW*WARM(1)+SSW*WARMS+PSW*WARM(1)*WARMS
      DILAT=CDIL*WARM(1)+SDIL*WARMS+PDIL*WARM(1)*WARMS
      STRIC=CCON*COLD(1)+SCON*COLDS+PCON*COLD(1)*COLDS
      CHILL=CCHIL*COLD(1)+SCHIL*COLDS+PCHIL*COLD(1)*COLDS
```

```
C
C     ASSIGN EFFECTOR OUTPUT
C
  400 CONTINUE
      DO 401 I=1,6
      N=4*I-3
      Q(N)=QB(N)
      BF(N)=BFB(N)
      E(N)=EB(N)
      Q(N+1)=QB(N+1)+WORKM(I)*WORK+CHILM(I)*CHILL
      E(N+1)=0.
      BF(N+1)=BFB(N+1)+Q(N+1)-QB(N+1)
      Q(N+2)=QB(N+2)
      E(N+2)=0.
      BF(N+2)=BFB(N+2)
      Q(N+3)=QB(N+3)
      E(N+3)=EB(N+3)+SKINS(I)*SWEAT*2.**((T(N+3)-TSET(N+3))/4.)
      BF(N+3)=(BFB(N+3)+SKINV(I)*DILAT)/(1.+SKINC(I)*STRIC)
      K=T(N+3)/5
      PSKIN=P(K)+(P(K+1)-P(K))*(T(N+3)-5*K)/5.
      EMAX(I)=(PSKIN-PAIR)*2.14*(H(I)-HR(I)*S(I))
      IF(E(N+3)-EMAX(I)) 403,403,402
  402 E(N+3)=EMAX(I)
  403 CONTINUE
  401 CONTINUE
C
C     CALCULATE HEAT FLOWS
C
      DO 500 K=1,24
      BC(K)=BF(K)*(T(K)-T(25))
      TD(K)=TC(K)*(T(K)-T(K+1))
  500 CONTINUE
      DO 501 I=1,6
      K=4*I-3
      HF(K)=Q(K)-E(K)-BC(K)-TD(K)
      HF(K+1)=Q(K+1)-BC(K+1)+TD(K)-TD(K+1)
      HF(K+2)=Q(K+2)-BC(K+2)+TD(K+1)-TD(K+2)
      HF(K+3)=Q(K+3)-BC(K+3)-E(K+3)+TD(K+2)-H(I)*(T(K+3)-TAIR)
  501 CONTINUE
      HF(25)=0.
      DO 502 K=1,24
      HF(25)=HF(25)+BC(K)
  502 CONTINUE
      HF(25)=HF(25)-0.08*WORK
C
C     DETERMINE OPTIMUM INTEGRATION STEP
C
      DT=0.016666667
      DO 600 K=1,25
      F(K)=HF(K)/C(K)
```

```
      U=ABS(F(K))
      IF(U*DT-0.1)   600,600,601
  601 DT=0.1/U
  600 CONTINUE
C
C     CALCULATE NEW TEMPERATURES
C
      DO 700 K=1,25
      T(K)=T(K)+F(K)*DT
  700 CONTINUE
      TIME=TIME+DT
      LTIME=60.*TIME
      IF(LTIME-INT-ITIME) 301,701,701
  701 CONTINUE
C
C     PREPARE FOR OUTPUT
C
      ITIME=ITIME+INT
      CO=0.
      HP=0.
      EV=0.
      TS=0.
      TB=0.
      HFLOW=0.
      SBF=0.
      DO 800 N=1,24
      CO=CO+BF(N)/60.
      HP=HP+Q(N)
      EV=EV+E(N)
  800 CONTINUE
      EV=EV+0.08*WORK
      DO 802 I=1,6
      SBF=SBF+BF(4*I)/60.
      TS=TS+T(4*I)*C(4*I)/3.386
  802 CONTINUE
      DO  801  N=1,25
      TB=TB+T(N)*C(N)/59.56
      HFLOW=HFLOW+HF(N)
  801 CONTINUE
C
C     OUTPUT DATASWITCH 1 UP FOR TABLE, 1 UP FOR PUNCH
C
      HP=HP/SA
      EV=EV/SA
      HFLOW=HFLOW/SA
      COND=(HP-(E(1)+E(5))/SA-HFLOW)/(T(25)-TS)
      CALL DATSW (0,K)
      GO TO (951,950),K
  951 CONTINUE
      IF(ITIME-INT) 909,909,911
```

```
 909 PAUSE
 910 WRITE(1,912)
 912 FORMAT('TIME   S      M      EV     TB     TS     TH     TO     TR     TM
    1    SBF    CO    COND')
     NN=0
 911 IF(NN-42) 913,913,914
 913 WRITE(1,915)ITIME,HFLOW,HP,EV,TB,TS,T(1),T(25),T(5),T(18),SBF,CO,
    1COND
 915 FORMAT(I3,3F7.1,8F6.2,F6.1)
     NN=NN+1
     GO TO 1100
 914 WRITE(1,916)
 916 FORMAT(22(/))
     GO TO 910
 950 CONTINUE
1100 JTIME=JTIME+INT
     CALL DATSW(1,K)
     GO TO (917,1102),K
 917 CONTINUE
     ITA=TAIR*10.
     ISKSW=1.16*(EV-9.5-0.08*WORK/SA)
     IHP=HP
     ITS=TS*100.
     ITR=T(5)*100.
     ITO=T(25)*100.
     ITM=T(18)*100.
     IEV=EV
     ICOND=COND*1.16
     IRM=HP*1.16
     ITB=TB*100.
     WRITE(2,9901)ITIME,ITA,IHP,ITS,ITR,ITO,ITM,IEV,ISKSW,ICOND,IRM,
    XITB,SBF,CO
9901 FORMAT(3I3,4I4,3X,I3,3X,3I3,4X,I4,F4.2,F5.2)
1102 IF(JTIME-30) 301,1101,1101
1101 JTIME=0
     PAUSE
     IF(ITIME-210) 102,101,101
9990 CALL LEAVE
 901 CALL EXIT
     END
// DUP
*STORE      WS   UA   MAN

// XEQ MAN
3.0290.6750.2250.2439.46515.924.2801.2221.2603.0600.5850.4400.1430.067      C       01
0.0900.1683.9929.2501.4401.0880.2410.0670.1350.2252.250                     C       02
11.200.2700.1250.06139.206.38 2.3410.3070.6881.2450.3250.1100.0870.027      QB      03
0.0500.0412.2263.7000.8000.2700.1450.0270.0750.054                          QB      04
4.5              0.612 4.5              3.27               1.185            EB      05
     0.432                   2.980                0.600                     EB      06
```

```
 .0  0.27 0.12 1.44 232.0 6.4  2.3  2.1  0.69 1.24 0.32 0.50 0.1  0.05   BFB    07
0.05 2.0  2.2  3.7  0.8  2.85 0.15 0.03 0.08 3.0                          BFB    08
4.0  5.8  10.2      1.45 4.55 12.7      2.9  7.6  20.8      4.1  7.6      TC     09
8.6       5.25 17.1 30.6      5.05 12.2 10.9                              TC     10
.1326.6804.2536.0946.5966.1299                                       S     11
5.5  4.5  4.5  3.0  4.5  4.0                                              HR     12
0.57 1.5  3.4  5.2  3.1  5.1                                              HC     13
6.5419.20512.7817.5123.6931.7142.0255.1371.6692.30                        P      14
37.0636.4836.1335.9037.1236.8435.5034.6735.6135.0534.5134.2935.4735.41    TSET   15
35.3835.3336.4635.8235.0334.7635.4635.2935.4035.3036.97                   TSET   16
                                                                          RATE   17
                                                                          RATE   18
400.0     60.0 150.0          10.  10.0           10.0                    CONTR  19
.08270.587.0822.22150.186.0399                                            SKINR  20
.081  .482  .154  .031  .219  .035                                        SKINS  21
.132  .322  .095  .122  .23   .1                                          SKINV  22
.05   .15   .05   .35   .05   .35                                         SKINC  23
      .3    .08   .01   .6    .01                                         WORKM  24
.023  .948  .0053.0023.0190.0023                                          CHILM  25
37.0636.4836.1335.9037.1236.8435.5034.6735.6135.0534.5134.2935.4735.41    T      26
35.3835.3336.4635.8235.0334.7635.4635.2935.4035.3036.97                   T      27
10.0                                                                      TAIR   28
0.1                                                                  V     2
0.3                                                                       RH     30
                                                                          WORK   31
1.                                                                        INT    32
10.0                                                                      TAIR   28
0.5                                                                       V      29
0.3                                                                       RH     30
280.                                                                      WORK   31
01                                                                        INT    32
10.0                                                                      TAIR   28
0.1                                                                        V      2
0.3                                                                       RH     30
                                                                          WORK   31
01                                                                        INT    32
10.0                                                                      TAIR   28
0.5                                                                       V      29
0.3                                                                       RH     30
520.                                                                      WORK   31
01                                                                        INT    32
10.0                                                                      TAIR   28
0.1                                                                        V      2
0.3                                                                       RH     30
                                                                          WORK   31
01                                                                        INT    32
10.0                                                                      TAIR   28
0.5                                                                       V      29
0.3                                                                       RH     30
875.                                                                      WORK   31
```

```
                                  INT    32
10.0                        TAIR   28
 0.1                               V      2
0.3                               RH     30
                                  WORK   31
01.                               INT    32
20.0                              TAIR   28
 0.1                               V      2
0.3                               RH     30
                                  WORK   31
01.                               INT    32
20.0                              TAIR   28
0.5                               V      29
0.3                               RH     30
280.                              WORK   31
01.                               INT    32
20.0                              TAIR   28
 0.1                               V      2
0.3                               RH     30
                                  WORK   31
01.                               INT    32
20.0                              TAIR   28
0.5                               V      29
0.3                               RH     30
520.                              WORK   31
 1.                               INT    32
 0.0                              TAIR   28
 0.1                               V      2
0.3                               RH     30
                                  WORK   31
01                                INT    32
20.0                              TAIR   28
0.5                         V       29
0.3                         RH      30
875.                              WORK   31
01.                               INT    32
20.0                              TAIR   28
 0.1                               V      2
0.3                               RH     30
                                  WORK   31
01.                               INT    32
31.                               TAIR   28
0.1                               V      29
 0.3                              RH     30
                                  WORK   31
01.                               INT    32
31.                               TAIR   28
0.5                               V      29
0.3                               RH     30
280.                              WORK   31
```

```
                                                  INT     32
31. ,                                             TAIR    28
0.1,                                              V       29
0.3,                                              RH      30
                                                  WORK    31
01.                                               INT     32
31. ,                                             TAIR    28
0.5,                                              V       29
0.3,                                              RH      30
520. ,                                            WORK    31
01.                                               INT     32
31. ,                                             TAIR    28
0.1,                                          V       29
0.3,                                              RH      30
                                              WORK    31
01.                                           INT     32
31. ,                                             TAIR    28
0.5,                                              V       29
0.3,                                              RH      30
875. ,                                            WORK    31
01.                                               INT     32
31. ,                                             TAIR    28
 0.1,                                              V       2
0.3,                                              RH      30
                                               WORK    31
                                              INT     32
```

In order to clarify the role of thermoregulation and clearly separate it from the inherent physical and physiological characteristics of the system upon which it operates we carried out simulation runs using the experimental schedule described before, but with all thermoregulatory activity removed. It must be emphasized that e.g. the circulatory regulation was left intact so that during exercise the blood flow to the working muscles was increased so that the required oxygen could be supplied. At the same time this blood flow cooled the working muscle, without intervention of functional thermoregulation.

The results of these simulations are presented in 3 tables which follow below. In this and similar tables presented later the column headings represent the following:

TIME	elapsed time in minutes
S	rate of heat storage or heat loss, in Kcal.m^{-2}.h^{-1}
M	rate of heat production, in Kcal.m^{-2}.h^{-1}
EV	total rate of evaporative heat loss, in Kcal.m^{-2}.h^{-1}
TB	true weighted average body temperature, °C
TS	average skin temperature, °C
TH	head core (brain) temperature, °C
TO	temperature of central blood (oesophagus), °C
TR	trunk core (rectal) temperature, °C
TM	leg muscle temperature, °C
SBF	total skin blood flow, l.min^{-1}
CO	cardiac output, l.min^{-1}
COND	equivalent heat conductance from core to skin, Kcal.m^{-2}.h^{-1}.°C^{-1}

The first table (Table 1) gives the results of a simulated 3-1/2 hour run at an environmental temperature of 10°C. The changes in metabolic rate are those imposed by the exercise, the evaporative heat loss rate varies because of increased evaporative heat loss with the increased ventilation rate during exercise, and the changes in cardiac output are due to muscle blood flow to the exercising muscle. All other variables are dependent variables responding to independent variables in a manner dictated by the structure and relationships built into the mathematical model of the physical characteristics of man. Table 2 and Table 3 give the results of identical simulations in 20 and 30°C environments.

It is very illuminating to see the range of ambient temperature and activity levels which man would be able to tolerate in intervals of rest and work. The highest work level can be maintained for 30 minutes only by trained individuals in good physical condition.

It should be mentioned that these simulations do not adequately represent the case of a man in a closed environment in which he is unable to evaporate secreted sweat. In such a case the vasomotor regulation would still be intact and the man would still increase his skin blood flow and suffer the cardiovascular collapse resulting from reduced venous return at elevated central temperatures.

TABLE 1

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
5	-128.1	36.9	9.5	35.93	31.84	36.96	36.77	37.01	35.71	0.19	5.17	32.5
10	-119.8	36.9	9.5	35.60	30.71	36.73	36.50	36.78	35.43	0.19	5.17	26.2
15	-114.8	36.9	9.5	35.28	30.01	36.43	36.19	36.43	35.07	0.19	5.17	23.7
20	-111.2	36.9	9.5	34.97	29.51	36.11	35.88	36.18	34.70	0.19	5.17	22.5
25	-108.2	36.9	9.5	34.68	29.09	35.79	35.56	35.86	34.34	0.19	5.17	21.7
30	-105.8	36.9	9.5	34.40	28.75	35.48	35.25	35.56	34.00	0.19	5.17	21.2
31	-61.3	148.3	18.4	34.38	28.47	35.41	34.97	35.49	34.20	0.19	8.67	30.1
32	-58.0	148.3	18.4	34.35	28.13	35.25	34.92	35.34	34.48	0.19	8.67	28.3
33	-55.2	148.3	18.4	34.31	27.86	35.11	34.91	35.21	34.73	0.19	8.67	26.9
34	-53.4	148.3	18.4	34.28	27.69	35.01	34.89	35.14	34.88	0.19	8.67	26.1
35	-51.8	148.3	18.4	34.25	27.54	34.92	34.88	35.08	35.00	0.19	8.67	25.3
36	-51.1	148.3	18.4	34.23	27.46	34.88	34.87	35.06	35.05	0.19	8.67	25.0
37	-49.9	148.3	18.4	34.20	27.37	34.83	34.86	35.03	35.10	0.19	8.67	24.6
38	-49.4	148.3	18.4	34.17	27.30	34.79	34.85	35.01	35.13	0.19	8.67	24.3
39	-48.5	148.3	18.4	34.15	27.25	34.77	34.84	35.00	35.15	0.19	8.67	24.1
40	-48.0	148.3	18.4	34.13	27.20	34.74	34.83	34.98	35.16	0.19	8.67	23.9
41	-47.7	148.3	18.4	34.10	27.15	34.71	34.82	34.97	35.16	0.19	8.67	23.7
42	-47.4	148.3	18.4	34.07	27.10	34.69	34.80	34.95	35.16	0.19	8.67	23.6
43	-47.0	148.3	18.4	34.04	27.05	34.66	34.79	34.94	35.16	0.19	8.67	23.4
44	-46.6	148.3	18.4	34.03	27.03	34.65	34.78	34.93	35.15	0.19	8.67	23.3
45	-46.3	148.3	18.4	34.00	26.99	34.63	34.76	34.92	35.15	0.19	8.67	23.2
46	-45.9	148.3	18.4	33.96	26.93	34.60	34.73	34.89	35.12	0.19	8.67	23.1
47	-45.6	148.3	18.4	33.96	26.92	34.59	34.73	34.89	35.12	0.19	8.67	23.1
48	-45.6	148.3	18.4	33.93	26.89	34.58	34.71	34.87	35.11	0.19	8.67	23.0
49	-45.1	148.3	18.4	33.91	26.86	34.56	34.70	34.86	35.10	0.19	8.67	22.9
50	-44.8	148.3	18.4	33.88	26.83	34.54	34.67	34.83	35.08	0.19	8.67	22.8
51	-44.6	148.3	18.4	33.85	26.80	34.51	34.65	34.81	35.06	0.19	8.67	22.8
52	-44.4	148.3	18.4	33.84	26.78	34.50	34.64	34.80	35.05	0.19	8.67	22.7
53	-44.3	148.3	18.4	33.81	26.75	34.48	34.62	34.78	35.03	0.19	8.67	22.7
54	-44.0	148.3	18.4	33.79	26.72	34.46	34.60	34.76	35.01	0.19	8.67	22.6
55	-43.8	148.3	18.4	33.76	26.69	34.44	34.58	34.74	35.00	0.19	8.67	22.6
56	-43.4	148.3	18.4	33.73	26.66	34.41	34.55	34.72	34.97	0.19	8.67	22.5
57	-43.2	148.3	18.4	33.71	26.63	34.39	34.53	34.70	34.95	0.19	8.67	22.5
58	-42.9	148.3	18.4	33.69	26.62	34.38	34.52	34.69	34.94	0.19	8.67	22.4
59	-42.7	148.3	18.4	33.67	26.59	34.35	34.49	34.66	34.92	0.19	8.67	22.4
60	-42.6	148.3	18.4	33.64	26.56	34.33	34.47	34.64	34.90	0.19	8.67	22.4
61	-91.6	36.9	9.5	33.62	26.75	34.33	34.32	34.62	34.83	0.19	5.17	16.3
62	-93.2	36.9	9.5	33.57	26.97	34.31	34.22	34.55	34.68	0.19	5.17	17.2
63	-94.3	36.9	9.5	33.51	27.11	34.26	34.15	34.47	34.53	0.19	5.17	17.9
64	-94.9	36.9	9.5	33.46	27.20	34.22	34.09	34.40	34.40	0.19	5.17	18.4
65	-95.5	36.9	9.5	33.42	27.24	34.18	34.04	34.35	34.30	0.19	5.17	18.7
66	-95.7	36.9	9.5	33.34	27.29	34.11	33.96	34.26	34.13	0.19	5.17	19.1
67	-95.8	36.9	9.5	33.32	27.29	34.09	33.94	34.23	34.08	0.19	5.17	19.2

```
 TIME    S       M       EV    TB    TS    TH    TO    TR    TM     SBF    CO    COND
  68   -95.9    36.9     9.5 33.23 27.30 34.00 33.84 34.13 33.90   0.19   5.17   19.6
  69   -95.9    36.9     9.5 33.20 27.30 33.97 33.81 34.10 33.84   0.19   5.17   19.6
  70   -95.8    36.9     9.5 33.15 27.28 33.92 33.75 34.04 33.74   0.19   5.17   19.7
  71   -95.7    36.9     9.5 33.11 27.27 33.88 33.71 34.00 33.67   0.19   5.17   19.8
  72   -95.6    36.9     9.5 33.05 27.24 33.82 33.65 33.94 33.57   0.19   5.17   19.9
  73   -95.3    36.9     9.5 33.01 27.22 33.78 33.61 33.89 33.50   0.19   5.17   19.9
  74   -95.1    36.9     9.5 32.93 27.17 33.70 33.52 33.81 33.36   0.19   5.17   20.0
  75   -94.9    36.9     9.5 32.91 27.16 33.68 33.51 33.79 33.33   0.19   5.17   20.0
  76   -94.8    36.9     9.5 32.86 27.13 33.63 33.46 33.74 33.26   0.19   5.17   20.0
  77   -94.6    36.9     9.5 32.81 27.10 33.58 33.40 33.68 33.17   0.19   5.17   20.1
  78   -94.3    36.9     9.5 32.76 27.06 33.53 33.35 33.63 33.09   0.19   5.17   20.1
  79   -94.0    36.9     9.5 32.71 27.03 33.48 33.31 33.59 33.02   0.19   5.17   20.1
  80   -93.8    36.9     9.5 32.66 26.99 33.43 33.25 33.53 32.94   0.19   5.17   20.1
  81   -93.3    36.9     9.5 32.57 26.92 33.34 33.17 33.44 32.81   0.19   5.17   20.1
  82   -93.0    36.9     9.5 32.54 26.90 33.30 33.13 33.41 32.76   0.19   5.17   20.0
  83   -92.8    36.9     9.5 32.48 26.85 33.25 33.07 33.35 32.68   0.19   5.17   20.0
  84   -92.5    36.9     9.5 32.47 26.84 33.23 33.06 33.34 32.66   0.19   5.17   20.0
  85   -92.2    36.9     9.5 32.42 26.81 33.19 33.01 33.29 32.59   0.19   5.17   20.0
  86   -92.2    36.9     9.5 32.37 26.77 33.14 32.96 33.24 32.52   0.19   5.17   20.0
  87   -91.7    36.9     9.5 32.31 26.71 33.07 32.90 33.17 32.43   0.19   5.17   20.0
  88   -91.4    36.9     9.5 32.25 26.67 33.02 32.84 33.12 32.35   0.19   5.17   20.0
  89   -91.2    36.9     9.5 32.23 26.65 33.00 32.82 33.09 32.32   0.19   5.17   20.0
  90   -91.0    36.9     9.5 32.17 26.61 32.94 32.76 33.04 32.24   0.19   5.17   20.0
  91    77.8   275.4    28.6 32.21 26.26 32.80 32.78 32.96 32.75   0.19  12.67   26.6
  92    79.7   275.4    28.6 32.26 26.08 32.72 32.92 32.95 33.12   0.19  12.67   25.1
  93    80.6   275.4    28.6 32.29 25.99 32.69 33.02 32.98 33.34   0.19  12.67   24.3
  94    81.2   275.4    28.6 32.34 25.92 32.69 33.13 33.04 33.54   0.19  12.67   23.6
  95    81.5   275.4    28.6 32.38 25.88 32.71 33.21 33.11 33.68   0.19  12.67   23.1
  96    81.7   275.4    28.6 32.43 25.85 32.75 33.31 33.20 33.82   0.19  12.67   22.7
  97    81.7   275.4    28.6 32.47 25.84 32.80 33.38 33.27 33.91   0.19  12.67   22.5
  98    81.6   275.4    28.6 32.52 25.84 32.85 33.46 33.36 34.00   0.19  12.67   22.2
  99    81.4   275.4    28.6 32.55 25.84 32.89 33.51 33.41 34.05   0.19  12.67   22.1
 100    81.3   275.4    28.6 32.62 25.85 32.97 33.60 33.51 34.15   0.19  12.67   21.9
 101    81.1   275.4    28.6 32.65 25.86 33.01 33.65 33.56 34.20   0.19  12.67   21.8
 102    80.9   275.4    28.6 32.69 25.87 33.07 33.71 33.63 34.26   0.19  12.67   21.7
 103    80.7   275.4    28.6 32.73 25.89 33.13 33.77 33.69 34.32   0.19  12.67   21.6
 104    80.3   275.4    28.6 32.80 25.92 33.22 33.86 33.79 34.41   0.19  12.67   21.5
 105    80.1   275.4    28.6 32.81 25.92 33.22 33.86 33.80 34.42   0.19  12.67   21.5
 106    79.8   275.4    28.6 32.85 25.94 33.28 33.92 33.85 34.47   0.19  12.67   21.5
 107    79.8   275.4    28.6 32.89 25.96 33.33 33.97 33.91 34.53   0.19  12.67   21.4
 108    79.3   275.4    28.6 32.96 25.99 33.42 34.06 34.00 34.61   0.19  12.67   21.3
 109    79.1   275.4    28.6 33.01 26.01 33.48 34.12 34.06 34.67   0.19  12.67   21.2
 110    78.8   275.4    28.6 33.05 26.03 33.53 34.17 34.11 34.72   0.19  12.67   21.2
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TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
111	78.5	275.4	28.6	33.08	26.05	33.57	34.21	34.16	34.76	0.19	12.67	21.1
112	78.3	275.4	28.6	33.11	26.06	33.60	34.23	34.19	34.79	0.19	12.67	21.1
113	78.0	275.4	28.6	33.15	26.08	33.64	34.28	34.23	34.84	0.19	12.67	21.1
114	77.9	275.4	28.6	33.18	26.10	33.69	34.33	34.28	34.88	0.19	12.67	21.1
115	77.4	275.4	28.6	33.23	26.12	33.74	34.38	34.33	34.93	0.19	12.67	21.0
116	77.3	275.4	28.6	33.28	26.15	33.80	34.44	34.40	34.99	0.19	12.67	21.0
117	76.9	275.4	28.6	33.31	26.17	33.84	34.48	34.43	35.03	0.19	12.67	21.0
118	76.7	275.4	28.6	33.37	26.20	33.90	34.54	34.50	35.09	0.19	12.67	20.9
119	76.5	275.4	28.6	33.40	26.22	33.94	34.57	34.53	35.13	0.19	12.67	20.9
120	76.2	275.4	28.6	33.43	26.23	33.97	34.61	34.57	35.16	0.19	12.67	20.9
121	-91.2	36.9	9.5	33.38	26.59	34.04	34.17	34.53	34.98	0.19	5.17	16.3
122	-92.5	36.9	9.5	33.33	26.75	34.04	34.09	34.45	34.83	0.19	5.17	16.9
123	-93.4	36.9	9.5	33.27	26.89	34.02	34.01	34.35	34.65	0.19	5.17	17.6
124	-94.0	36.9	9.5	33.22	26.97	34.00	33.95	34.27	34.50	0.19	5.17	18.0
125	-94.3	36.9	9.5	33.17	27.01	33.97	33.89	34.21	34.39	0.19	5.17	18.3
126	-94.6	36.9	9.5	33.13	27.04	33.93	33.84	34.15	34.28	0.19	5.17	18.6
127	-94.7	36.9	9.5	33.08	27.06	33.89	33.78	34.09	34.15	0.19	5.17	18.9
128	-94.8	36.9	9.5	33.01	27.07	33.83	33.71	34.01	34.01	0.19	5.17	19.1
129	-94.8	36.9	9.5	32.98	27.07	33.80	33.66	33.96	33.93	0.19	5.17	19.2
130	-94.7	36.9	9.5	32.91	27.06	33.73	33.59	33.88	33.78	0.19	5.17	19.4
131	-94.6	36.9	9.5	32.87	27.05	33.70	33.55	33.84	33.72	0.19	5.17	19.5
132	-94.4	36.9	9.5	32.82	27.03	33.65	33.49	33.79	33.62	0.19	5.17	19.5
133	-94.2	36.9	9.5	32.76	27.00	33.58	33.42	33.71	33.49	0.19	5.17	19.6
134	-94.0	36.9	9.5	32.72	26.98	33.55	33.39	33.67	33.43	0.19	5.17	19.7
135	-93.9	36.9	9.5	32.67	26.95	33.49	33.33	33.62	33.34	0.19	5.17	19.7
136	-93.5	36.9	9.5	32.59	26.90	33.41	33.24	33.53	33.19	0.19	5.17	19.8
137	-93.3	36.9	9.5	32.57	26.89	33.39	33.22	33.51	33.16	0.19	5.17	19.8
138	-93.1	36.9	9.5	32.50	26.85	33.32	33.15	33.44	33.05	0.19	5.17	19.8
139	-92.8	36.9	9.5	32.47	26.82	33.29	33.12	33.40	32.99	0.19	5.17	19.8
140	-92.6	36.9	9.5	32.41	26.78	33.23	33.06	33.34	32.90	0.19	5.17	19.9
141	-92.2	36.9	9.5	32.38	26.76	33.19	33.02	33.30	32.84	0.19	5.17	19.8
142	-92.1	36.9	9.5	32.34	26.73	33.15	32.98	33.26	32.77	0.19	5.17	19.8
143	-91.9	36.9	9.5	32.28	26.69	33.09	32.92	33.20	32.69	0.19	5.17	19.9
144	-91.4	36.9	9.5	32.21	26.63	33.02	32.84	33.12	32.57	0.19	5.17	19.9
145	-91.1	36.9	9.5	32.16	26.59	32.96	32.79	33.07	32.49	0.19	5.17	19.9
146	-90.9	36.9	9.5	32.14	26.58	32.95	32.77	33.05	32.46	0.19	5.17	19.8
147	-90.6	36.9	9.5	32.09	26.54	32.89	32.72	32.99	32.38	0.19	5.17	19.8
148	-90.4	36.9	9.5	32.03	26.50	32.84	32.66	32.94	32.30	0.19	5.17	19.9
149	-90.2	36.9	9.5	32.00	26.47	32.81	32.63	32.90	32.25	0.19	5.17	19.8
150	-89.9	36.9	9.5	31.95	26.43	32.75	32.57	32.85	32.18	0.19	5.17	19.8
151	251.8	463.5	43.7	32.07	26.13	32.58	32.79	32.79	32.92	0.19	18.59	25.9
152	253.0	463.5	43.7	32.20	26.00	32.51	33.10	32.85	33.47	0.19	18.59	24.1
153	253.4	463.5	43.7	32.33	25.95	32.52	33.34	32.98	33.83	0.19	18.59	23.1

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
154	253.3	463.5	43.7	32.47	25.93	32.58	33.56	33.15	34.11	0.19	18.59	22.4
155	253.0	463.5	43.7	32.61	25.94	32.67	33.76	33.33	34.34	0.19	18.59	21.9
156	252.6	463.5	43.7	32.74	25.97	32.78	33.94	33.51	34.54	0.19	18.59	21.5
157	251.9	463.5	43.7	32.89	26.02	32.93	34.15	33.72	34.75	0.19	18.59	21.2
158	251.3	463.5	43.7	33.03	26.06	33.07	34.32	33.90	34.92	0.19	18.59	20.9
159	250.6	463.5	43.7	33.16	26.12	33.21	34.50	34.08	35.10	0.19	18.59	20.7
160	249.8	463.5	43.7	33.30	26.18	33.37	34.67	34.27	35.27	0.19	18.59	20.5
161	249.1	463.5	43.7	33.40	26.22	33.48	34.78	34.39	35.39	0.19	18.59	20.5
162	248.2	463.5	43.7	33.55	26.30	33.65	34.97	34.58	35.57	0.19	18.59	20.3
163	247.6	463.5	43.7	33.68	26.36	33.80	35.13	34.74	35.72	0.19	18.59	20.1
164	246.6	463.5	43.7	33.86	26.45	34.00	35.33	34.96	35.93	0.19	18.59	20.0
165	245.8	463.5	43.7	33.96	26.51	34.11	35.46	35.08	36.05	0.19	18.59	19.9
166	245.4	463.5	43.7	34.05	26.56	34.22	35.56	35.19	36.16	0.19	18.59	19.9
167	244.2	463.5	43.7	34.22	26.66	34.41	35.76	35.40	36.36	0.19	18.59	19.8
168	243.3	463.5	43.7	34.31	26.71	34.51	35.86	35.50	36.46	0.19	18.59	19.8
169	242.6	463.5	43.7	34.46	26.80	34.69	36.04	35.68	36.63	0.19	18.59	19.6
170	241.5	463.5	43.7	34.62	26.90	34.87	36.22	35.87	36.82	0.19	18.59	19.6
171	241.0	463.5	43.7	34.69	26.94	34.95	36.31	35.95	36.90	0.19	18.59	19.5
172	239.9	463.5	43.7	34.86	27.04	35.15	36.50	36.15	37.09	0.19	18.59	19.5
173	238.8	463.5	43.7	34.95	27.10	35.25	36.60	36.26	37.19	0.19	18.59	19.5
174	238.1	463.5	43.7	35.13	27.21	35.44	36.79	36.45	37.38	0.19	18.59	19.4
175	237.3	463.5	43.7	35.20	27.26	35.53	36.89	36.54	37.47	0.19	18.59	19.4
176	236.5	463.5	43.7	35.32	27.33	35.66	37.02	36.68	37.60	0.19	18.59	19.4
177	235.6	463.5	43.7	35.46	27.42	35.81	37.17	36.83	37.75	0.19	18.59	19.3
178	234.4	463.5	43.7	35.64	27.54	36.02	37.37	37.04	37.96	0.19	18.59	19.3
179	233.6	463.5	43.7	35.72	27.59	36.11	37.46	37.13	38.05	0.19	18.59	19.3
180	232.8	463.5	43.7	35.83	27.67	36.23	37.58	37.25	38.17	0.19	18.59	19.3
181	-102.4	36.9	9.5	35.78	28.05	36.38	36.83	37.25	37.98	0.19	5.17	15.3
182	-104.1	36.9	9.5	35.73	28.28	36.43	36.68	37.12	37.75	0.19	5.17	16.2
183	-105.2	36.9	9.5	35.67	28.44	36.45	36.59	37.00	37.54	0.19	5.17	16.8
184	-105.9	36.9	9.5	35.61	28.55	36.44	36.51	36.90	37.36	0.19	5.17	17.3
185	-106.4	36.9	9.5	35.56	28.62	36.42	36.44	36.82	37.21	0.19	5.17	17.7
186	-106.7	36.9	9.5	35.51	28.67	36.39	36.37	36.73	37.06	0.19	5.17	18.0
187	-107.0	36.9	9.5	35.45	28.71	36.35	36.29	36.64	36.90	0.19	5.17	18.3
188	-107.1	36.9	9.5	35.38	28.73	36.30	36.21	36.55	36.74	0.19	5.17	18.6
189	-107.1	36.9	9.5	35.34	28.74	36.26	36.15	36.49	36.63	0.19	5.17	18.7
190	-107.1	36.9	9.5	35.28	28.74	36.20	36.08	36.41	36.49	0.19	5.17	18.9
191	-107.0	36.9	9.5	35.22	28.73	36.15	36.01	36.34	36.37	0.19	5.17	19.1
192	-106.8	36.9	9.5	35.16	28.71	36.08	35.93	36.26	36.22	0.19	5.17	19.2
193	-106.6	36.9	9.5	35.09	28.69	36.01	35.85	36.17	36.08	0.19	5.17	19.3
194	-106.5	36.9	9.5	35.05	28.67	35.97	35.81	36.13	36.00	0.19	5.17	19.4
195	-106.2	36.9	9.5	34.98	28.64	35.89	35.73	36.05	35.86	0.19	5.17	19.5
196	-105.9	36.9	9.5	34.93	28.61	35.85	35.68	35.99	35.77	0.19	5.17	19.5

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
197	-105.7	36.9	9.5	34.87	28.58	35.78	35.60	35.91	35.65	0.19	5.17	19.6
198	-105.5	36.9	9.5	34.83	28.55	35.73	35.56	35.87	35.58	0.19	5.17	19.6
199	-105.1	36.9	9.5	34.75	28.50	35.65	35.47	35.78	35.43	0.19	5.17	19.7
200	-104.9	36.9	9.5	34.71	28.48	35.61	35.42	35.73	35.36	0.19	5.17	19.7
201	-104.5	36.9	9.5	34.66	28.44	35.55	35.37	35.68	35.27	0.19	5.17	19.7
202	-104.2	36.9	9.5	34.59	28.39	35.47	35.29	35.59	35.14	0.19	5.17	19.7
203	-104.0	36.9	9.5	34.54	28.36	35.43	35.24	35.55	35.07	0.19	5.17	19.8
204	-103.7	36.9	9.5	34.50	28.33	35.38	35.19	35.50	35.00	0.19	5.17	19.8
205	-103.2	36.9	9.5	34.41	28.27	35.28	35.09	35.40	34.85	0.19	5.17	19.8
206	-102.9	36.9	9.5	34.36	28.23	35.24	35.04	35.35	34.77	0.19	5.17	19.8
207	-102.7	36.9	9.5	34.32	28.20	35.19	34.99	35.29	34.70	0.19	5.17	19.8
208	-102.4	36.9	9.5	34.27	28.16	35.13	34.94	35.24	34.62	0.19	5.17	19.8
209	-102.1	36.9	9.5	34.22	28.13	35.08	34.89	35.19	34.55	0.19	5.17	19.8
210	-101.8	36.9	9.5	34.17	28.09	35.03	34.83	35.13	34.46	0.19	5.17	19.8

TABLE 2

TIME	S	H	EV	TB	TS	TH	TO	TR	TI	SBF	CO	COND
5	-67.1	36.9	9.5	36.10	33.24	37.01	36.86	37.06	35.76	0.19	5.17	27.4
10	-62.6	36.9	9.5	35.93	32.66	36.89	36.73	36.94	35.62	0.19	5.17	23.3
15	-60.0	36.9	9.5	35.75	32.27	36.72	36.55	36.78	35.41	0.19	5.17	21.5
20	-58.3	36.9	9.5	35.61	32.04	36.58	36.41	36.64	35.25	0.19	5.17	20.7
25	-56.6	36.9	9.5	35.45	31.81	36.40	36.23	36.46	35.05	0.19	5.17	20.1
30	-55.4	36.9	9.5	35.31	31.64	36.24	36.08	36.31	34.88	0.19	5.17	19.7
31	11.7	148.3	18.4	35.31	31.38	36.13	35.76	36.20	35.21	0.19	8.67	28.0
32	13.8	148.3	18.4	35.32	31.20	36.00	35.77	36.07	35.51	0.19	8.67	26.4
33	14.9	148.3	18.4	35.33	31.09	35.91	35.78	36.00	35.71	0.19	8.67	25.5
34	15.9	148.3	18.4	35.34	31.00	35.84	35.80	35.96	35.89	0.19	8.67	24.7
35	16.4	148.3	18.4	35.35	30.94	35.80	35.82	35.94	36.00	0.19	8.67	24.2
36	17.0	148.3	18.4	35.35	30.91	35.78	35.83	35.94	36.07	0.19	8.67	23.8
37	17.3	148.3	18.4	35.36	30.88	35.77	35.85	35.95	36.14	0.19	8.67	23.5
38	17.5	148.3	18.4	35.37	30.86	35.76	35.87	35.96	36.20	0.19	8.67	23.3
39	17.6	148.3	18.4	35.38	30.84	35.76	35.89	35.97	36.25	0.19	8.67	23.1
40	17.7	148.3	18.4	35.39	30.82	35.76	35.91	35.99	36.29	0.19	8.67	22.9
41	17.7	148.3	18.4	35.40	30.81	35.75	35.93	36.01	36.33	0.19	8.67	22.8
42	17.8	148.3	18.4	35.41	30.80	35.77	35.96	36.03	36.36	0.19	8.67	22.6
43	17.8	148.3	18.4	35.42	30.80	35.78	35.97	36.04	36.38	0.19	8.67	22.5
44	17.8	148.3	18.4	35.43	30.79	35.79	35.99	36.06	36.41	0.19	8.67	22.4
45	17.8	148.3	18.4	35.44	30.79	35.81	36.01	36.08	36.44	0.19	8.67	22.3
46	17.8	148.3	18.4	35.45	30.78	35.82	36.02	36.10	36.46	0.19	8.67	22.2
47	17.8	148.3	18.4	35.46	30.78	35.83	36.04	36.12	36.48	0.19	8.67	22.2
48	17.7	148.3	18.4	35.47	30.78	35.85	36.06	36.13	36.50	0.19	8.67	22.1
49	17.7	148.3	18.4	35.48	30.78	35.86	36.07	36.15	36.51	0.19	8.67	22.0
50	17.7	148.3	18.4	35.49	30.77	35.88	36.10	36.17	36.54	0.19	8.67	21.9
51	17.6	148.3	18.4	35.50	30.77	35.90	36.11	36.19	36.56	0.19	8.67	21.9
52	17.6	148.3	18.4	35.50	30.77	35.90	36.11	36.19	36.56	0.19	8.67	21.9
53	17.6	148.3	18.4	35.51	30.77	35.91	36.13	36.21	36.58	0.19	8.67	21.8
54	17.6	148.3	18.4	35.52	30.77	35.92	36.14	36.22	36.60	0.19	8.67	21.8
55	17.5	148.3	18.4	35.53	30.77	35.94	36.15	36.24	36.61	0.19	8.67	21.7
56	17.5	148.3	18.4	35.54	30.77	35.95	36.17	36.25	36.62	0.19	8.67	21.7
57	17.4	148.3	18.4	35.55	30.77	35.96	36.18	36.26	36.64	0.19	8.67	21.6
58	17.4	148.3	18.4	35.56	30.78	35.98	36.19	36.28	36.65	0.19	8.67	21.6
59	17.4	148.3	18.4	35.57	30.78	35.99	36.21	36.30	36.67	0.19	8.67	21.5
60	17.3	148.3	18.4	35.58	30.78	36.01	36.23	36.31	36.69	0.19	8.67	21.5
61	-50.0	36.9	9.5	35.58	30.87	36.02	36.12	36.31	36.66	0.19	5.17	15.6
62	-51.3	36.9	9.5	35.54	31.08	36.03	36.02	36.27	36.52	0.19	5.17	16.9
63	-52.1	36.9	9.5	35.51	31.18	36.03	35.99	36.23	36.41	0.19	5.17	17.5
64	-52.7	36.9	9.5	35.49	31.22	36.02	35.97	36.20	36.35	0.19	5.17	17.8
65	-53.0	36.9	9.5	35.45	31.28	36.01	35.94	36.16	36.24	0.19	5.17	18.2
66	-53.2	36.9	9.5	35.43	31.31	35.99	35.91	36.13	36.15	0.19	5.17	18.5
67	-53.4	36.9	9.5	35.41	31.32	35.98	35.89	36.11	36.10	0.19	5.17	18.7

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
68	-53.5	36.9	9.5	35.36	31.34	35.94	35.85	36.07	35.98	0.19	5.17	19.0
69	-53.6	36.9	9.5	35.34	31.34	35.92	35.83	36.04	35.92	0.19	5.17	19.1
70	-53.5	36.9	9.5	35.32	31.34	35.91	35.82	36.93	35.89	0.19	5.17	19.1
71	-53.5	36.9	9.5	35.30	31.34	35.89	35.79	36.01	35.82	0.19	5.17	19.2
72	-53.5	36.9	9.5	35.26	31.33	35.87	35.76	35.98	35.75	0.19	5.17	19.3
73	-53.4	36.9	9.5	35.24	31.32	35.85	35.74	35.96	35.71	0.19	5.17	19.3
74	-53.3	36.9	9.5	35.19	31.30	35.81	35.70	35.91	35.60	0.19	5.17	19.4
75	-53.2	36.9	9.5	35.18	31.29	35.80	35.69	35.90	35.57	0.19	5.17	19.4
76	-53.0	36.9	9.5	35.16	31.28	35.78	35.67	35.88	35.53	0.19	5.17	19.4
77	-52.9	36.9	9.5	35.12	31.25	35.75	35.63	35.85	35.46	0.19	5.17	19.4
78	-52.8	36.9	9.5	35.09	31.23	35.72	35.61	35.82	35.40	0.19	5.17	19.4
79	-52.6	36.9	9.5	35.07	31.22	35.71	35.59	35.80	35.36	0.19	5.17	19.4
80	-52.5	36.9	9.5	35.04	31.20	35.68	35.56	35.78	35.31	0.19	5.17	19.4
81	-52.4	36.9	9.5	35.02	31.18	35.66	35.54	35.76	35.27	0.19	5.17	19.4
82	-52.3	36.9	9.5	34.99	31.16	35.64	35.52	35.73	35.21	0.19	5.17	19.4
83	-52.0	36.9	9.5	34.96	31.14	35.62	35.50	35.71	35.17	0.19	5.17	19.3
84	-51.8	36.9	9.5	34.94	31.12	35.59	35.47	35.68	35.12	0.19	5.17	19.3
85	-51.7	36.9	9.5	34.89	31.08	35.55	35.43	35.64	35.04	0.19	5.17	19.3
86	-51.5	36.9	9.5	34.87	31.07	35.53	35.41	35.62	35.01	0.19	5.17	19.3
87	-51.4	36.9	9.5	34.85	31.06	35.52	35.40	35.61	34.99	0.19	5.17	19.2
88	-51.2	36.9	9.5	34.83	31.04	35.50	35.37	35.59	34.94	0.19	5.17	19.2
89	-51.1	36.9	9.5	34.80	31.02	35.47	35.35	35.56	34.89	0.19	5.17	19.2
90	-51.0	36.9	9.5	34.77	30.99	35.44	35.32	35.53	34.85	0.19	5.17	19.2
91	134.3	275.4	28.6	34.82	30.80	35.34	35.25	35.47	35.24	0.19	12.67	26.3
92	135.7	275.4	28.6	34.90	30.67	35.25	35.42	35.44	35.66	0.19	12.67	24.3
93	136.3	275.4	28.6	34.98	30.61	35.22	35.57	35.49	35.94	0.19	12.67	23.2
94	136.5	275.4	28.6	35.05	30.58	35.24	35.69	35.56	36.14	0.19	12.67	22.5
95	136.5	275.4	28.6	35.11	30.58	35.26	35.77	35.63	36.27	0.19	12.67	22.1
96	136.3	275.4	28.6	35.19	30.59	35.32	35.89	35.73	36.42	0.19	12.67	21.7
97	136.1	275.4	28.6	35.27	30.61	35.38	35.99	35.83	36.54	0.19	12.67	21.4
98	135.6	275.4	28.6	35.33	30.63	35.44	36.08	35.91	36.63	0.19	12.67	21.2
99	135.4	275.4	28.6	35.42	30.66	35.54	36.20	36.04	36.76	0.19	12.67	21.0
100	134.8	275.4	28.6	35.49	30.70	35.62	36.29	36.13	36.85	0.19	12.67	20.8
101	134.6	275.4	28.6	35.55	30.73	35.69	36.36	36.21	36.93	0.19	12.67	20.7
102	134.0	275.4	28.6	35.67	30.78	35.81	36.50	36.36	37.07	0.19	12.67	20.5
103	133.6	275.4	28.6	35.68	30.79	35.83	36.52	36.38	37.09	0.19	12.67	20.5
104	133.2	275.4	28.6	35.76	30.83	35.92	36.61	36.48	37.18	0.19	12.67	20.4
105	132.7	275.4	28.6	35.85	30.88	36.03	36.72	36.59	37.29	0.19	12.67	20.3
106	132.1	275.4	28.6	35.89	30.91	36.07	36.77	36.64	37.34	0.19	12.67	20.3
107	131.6	275.4	28.6	35.97	30.95	36.16	36.86	36.73	37.43	0.19	12.67	20.2
108	131.5	275.4	28.6	36.04	30.99	36.24	36.94	36.81	37.51	0.19	12.67	20.1
109	130.7	275.4	28.6	36.15	31.05	36.37	37.08	36.95	37.64	0.19	12.67	20.0
110	130.3	275.4	28.6	36.18	31.07	36.40	37.10	36.98	37.67	0.19	12.67	20.1

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
111	129.9	275.4	28.6	36.25	31.12	36.49	37.19	37.07	37.76	0.19	12.67	20.0
112	129.5	275.4	28.6	36.33	31.16	36.58	37.28	37.16	37.84	0.19	12.67	19.9
113	129.0	275.4	28.6	36.40	31.21	36.65	37.35	37.24	37.92	0.19	12.67	19.9
114	128.3	275.4	28.6	36.46	31.24	36.72	37.42	37.30	37.98	0.19	12.67	19.9
115	128.1	275.4	28.6	36.51	31.28	36.78	37.48	37.37	38.05	0.19	12.67	19.8
116	127.3	275.4	28.6	36.60	31.33	36.88	37.58	37.46	38.14	0.19	12.67	19.8
117	127.1	275.4	28.6	36.67	31.38	36.96	37.66	37.55	38.23	0.19	12.67	19.8
118	126.5	275.4	28.6	36.72	31.40	37.01	37.71	37.60	38.27	0.19	12.67	19.8
119	126.3	275.4	28.6	36.79	31.45	37.09	37.79	37.68	38.35	0.19	12.67	19.7
120	125.5	275.4	28.6	36.87	31.50	37.18	37.88	37.77	38.44	0.19	12.67	19.7
121	-56.5	36.9	9.5	36.85	31.70	37.25	37.52	37.78	38.35	0.19	5.17	15.2
122	-57.8	36.9	9.5	36.81	31.89	37.30	37.42	37.71	38.19	0.19	5.17	16.2
123	-58.6	36.9	9.5	36.78	32.01	37.31	37.37	37.65	38.05	0.19	5.17	16.9
124	-59.1	36.9	9.5	36.75	32.07	37.32	37.34	37.60	37.95	0.19	5.17	17.3
125	-59.5	36.9	9.5	36.72	32.13	37.31	37.30	37.56	37.84	0.19	5.17	17.7
126	-59.9	36.9	9.5	36.69	32.16	37.30	37.26	37.52	37.74	0.19	5.17	18.0
127	-60.0	36.9	9.5	36.65	32.19	37.28	37.22	37.47	37.62	0.19	5.17	18.3
128	-60.1	36.9	9.5	36.63	32.20	37.26	37.20	37.44	37.56	0.19	5.17	18.4
129	-60.2	36.9	9.5	36.60	32.21	37.24	37.17	37.41	37.48	0.19	5.17	18.6
130	-60.2	36.9	9.5	36.54	32.22	37.20	37.11	37.35	37.34	0.19	5.17	18.8
131	-60.2	36.9	9.5	36.53	32.22	37.19	37.10	37.34	37.32	0.19	5.17	18.9
132	-60.1	36.9	9.5	36.49	32.21	37.16	37.06	37.29	37.21	0.19	5.17	19.0
133	-60.0	36.9	9.5	36.47	32.20	37.14	37.03	37.27	37.15	0.19	5.17	19.0
134	-59.9	36.9	9.5	36.43	32.19	37.11	37.00	37.23	37.07	0.19	5.17	19.1
135	-59.8	36.9	9.5	36.41	32.18	37.08	36.97	37.20	37.02	0.19	5.17	19.1
136	-59.6	36.9	9.5	36.38	32.16	37.06	36.94	37.17	36.96	0.19	5.17	19.2
137	-59.6	36.9	9.5	36.34	32.15	37.03	36.91	37.14	36.89	0.19	5.17	19.2
138	-59.3	36.9	9.5	36.29	32.11	36.98	36.86	37.08	36.77	0.19	5.17	19.2
139	-59.2	36.9	9.5	36.25	32.09	36.95	36.82	37.05	36.70	0.19	5.17	19.3
140	-59.0	36.9	9.5	36.23	32.07	36.92	36.80	37.03	36.65	0.19	5.17	19.3
141	-58.8	36.9	9.5	36.19	32.05	36.89	36.76	36.99	36.58	0.19	5.17	19.3
142	-58.7	36.9	9.5	36.16	32.03	36.86	36.73	36.96	36.52	0.19	5.17	19.3
143	-58.5	36.9	9.5	36.16	32.02	36.86	36.73	36.96	36.51	0.19	5.17	19.2
144	-58.3	36.9	9.5	36.10	31.99	36.81	36.68	36.91	36.42	0.19	5.17	19.3
145	-58.2	36.9	9.5	36.09	31.98	36.80	36.67	36.90	36.40	0.19	5.17	19.2
146	-58.0	36.9	9.5	36.06	31.96	36.77	36.64	36.87	36.35	0.19	5.17	19.2
147	-57.8	36.9	9.5	36.03	31.94	36.74	36.61	36.84	36.29	0.19	5.17	19.2
148	-57.6	36.9	9.5	36.00	31.91	36.71	36.58	36.80	36.24	0.19	5.17	19.2
149	-57.4	36.9	9.5	35.96	31.89	36.68	36.54	36.77	36.17	0.19	5.17	19.2
150	-57.3	36.9	9.5	35.93	31.88	36.64	36.51	36.73	36.11	0.19	5.17	19.2
151	297.8	463.5	43.7	36.01	31.70	36.53	36.54	36.68	36.61	0.19	18.59	26.1
152	298.9	463.5	43.7	36.18	31.58	36.42	36.99	36.70	37.24	0.19	18.59	23.0
153	299.1	463.5	43.7	36.33	31.56	36.41	37.16	36.81	37.64	0.19	18.59	22.3

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TIME   S       M       EV    TB    TS    TH    TO    TR    TM     SBF   CO    COND
154   298.7   463.5   43.7 36.51 31.57 36.48 37.44 37.00 37.99   0.19 18.59  21.4
155   298.3   463.5   43.7 36.65 31.60 36.56 37.64 37.17 38.22   0.19 18.59  20.9
156   297.6   463.5   43.7 36.82 31.65 36.69 37.80 37.38 38.45   0.19 18.59  20.4
157   296.9   463.5   43.7 36.96 31.70 36.81 38.04 37.56 38.64   0.19 18.59  20.1
158   296.1   463.5   43.7 37.12 31.77 36.96 38.23 37.76 38.84   0.19 18.59  19.8
159   295.2   463.5   43.7 37.29 31.85 37.14 38.45 37.98 39.06   0.19 18.59  19.6
160   294.2   463.5   43.7 37.42 31.91 37.28 38.61 38.15 39.22   0.19 18.59  19.4
161   293.2   463.5   43.7 37.59 32.00 37.46 38.80 38.35 39.41   0.19 18.59  19.3
162   292.1   463.5   43.7 37.75 32.08 37.64 39.00 38.56 39.61   0.19 18.59  19.1
163   291.4   463.5   43.7 37.90 32.17 37.80 39.18 38.74 39.78   0.19 18.59  18.9
164   290.3   463.5   43.7 38.07 32.26 37.99 39.38 38.94 39.98   0.19 18.59  18.8
165   289.1   463.5   43.7 38.25 32.36 38.19 39.58 39.15 40.18   0.19 18.59  18.7
166   288.1   463.5   43.7 38.36 32.43 38.31 39.70 39.28 40.31   0.19 18.59  18.7
167   287.4   463.5   43.7 38.51 32.52 38.49 39.89 39.46 40.49   0.19 18.59  18.6
168   286.2   463.5   43.7 38.69 32.63 38.69 40.09 39.67 40.69   0.19 18.59  18.5
169   284.9   463.5   43.7 38.87 32.74 38.89 40.30 39.88 40.90   0.19 18.59  18.4
170   284.2   463.5   43.7 38.96 32.80 38.99 40.40 39.98 40.99   0.19 18.59  18.4
171   283.1   463.5   43.7 39.10 32.89 39.15 40.55 40.15 41.15   0.19 18.59  18.4
172   282.3   463.5   43.7 39.26 32.99 39.33 40.73 40.33 41.33   0.19 18.59  18.3
173   281.1   463.5   43.7 39.41 33.08 39.49 40.89 40.50 41.49   0.19 18.59  18.3
174   280.1   463.5   43.7 39.57 33.19 39.67 41.08 40.68 41.67   0.19 18.59  18.3
175   278.6   463.5   43.7 39.77 33.32 39.90 41.30 40.91 41.90   0.19 18.59  18.2
176   278.0   463.5   43.7 39.85 33.37 39.99 41.39 41.00 41.99   0.19 18.59  18.2
177   276.7   463.5   43.7 40.04 33.50 40.20 41.60 41.21 42.20   0.19 18.59  18.2
178   275.4   463.5   43.7 40.20 33.61 40.38 41.78 41.39 42.37   0.19 18.59  18.2
179   274.7   463.5   43.7 40.29 33.66 40.47 41.88 41.49 42.46   0.19 18.59  18.2
180   273.5   463.5   43.7 40.43 33.76 40.62 42.01 41.64 42.61   0.19 18.59  18.2
181   -74.3    36.9    9.5 40.38 34.12 40.81 41.25 41.64 42.41   0.19  5.17  14.9
182   -75.8    36.9    9.5 40.34 34.33 40.88 41.15 41.52 42.20   0.19  5.17  15.8
183   -76.5    36.9    9.5 40.30 34.43 40.91 41.09 41.45 42.06   0.19  5.17  16.3
184   -77.2    36.9    9.5 40.27 34.52 40.92 41.03 41.37 41.91   0.19  5.17  16.8
185   -77.7    36.9    9.5 40.22 34.60 40.92 40.97 41.30 41.75   0.19  5.17  17.2
186   -78.1    36.9    9.5 40.17 34.66 40.90 40.91 41.22 41.59   0.19  5.17  17.6
187   -78.3    36.9    9.5 40.14 34.69 40.88 40.86 41.16 41.48   0.19  5.17  17.9
188   -78.4    36.9    9.5 40.10 34.72 40.85 40.81 41.10 41.36   0.19  5.17  18.1
189   -78.5    36.9    9.5 40.05 34.73 40.82 40.75 41.04 41.22   0.19  5.17  18.4
190   -78.5    36.9    9.5 40.01 34.74 40.79 40.71 40.99 41.12   0.19  5.17  18.5
191   -78.5    36.9    9.5 39.97 34.74 40.74 40.65 40.93 41.00   0.19  5.17  18.7
192   -78.4    36.9    9.5 39.93 34.73 40.71 40.61 40.89 40.92   0.19  5.17  18.8
193   -78.3    36.9    9.5 39.88 34.72 40.67 40.56 40.83 40.80   0.19  5.17  18.9
194   -78.1    36.9    9.5 39.85 34.71 40.63 40.51 40.79 40.71   0.19  5.17  19.0
195   -78.0    36.9    9.5 39.79 34.69 40.58 40.45 40.72 40.59   0.19  5.17  19.1
196   -77.9    36.9    9.5 39.76 34.67 40.55 40.42 40.69 40.52   0.19  5.17  19.1
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TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
197	-77.6	36.9	9.5	39.72	34.65	40.51	40.38	40.64	40.44	0.19	5.17	19.1
198	-77.4	36.9	9.5	39.66	34.62	40.45	40.31	40.58	40.31	0.19	5.17	19.2
199	-77.3	36.9	9.5	39.63	34.60	40.42	40.28	40.54	40.25	0.19	5.17	19.2
200	-77.1	36.9	9.5	39.59	34.58	40.37	40.23	40.49	40.16	0.19	5.17	19.3
201	-76.8	36.9	9.5	39.56	34.56	40.35	40.20	40.46	40.10	0.19	5.17	19.3
202	-76.7	36.9	9.5	39.51	34.53	40.30	40.15	40.41	40.01	0.19	5.17	19.3
203	-76.4	36.9	9.5	39.47	34.50	40.26	40.11	40.37	39.94	0.19	5.17	19.3
204	-76.2	36.9	9.5	39.43	34.48	40.22	40.07	40.33	39.86	0.19	5.17	19.4
205	-76.0	36.9	9.5	39.40	34.45	40.18	40.03	40.29	39.79	0.19	5.17	19.4
206	-75.8	36.9	9.5	39.35	34.42	40.13	39.98	40.24	39.71	0.19	5.17	19.4
207	-75.5	36.9	9.5	39.32	34.40	40.10	39.95	40.21	39.66	0.19	5.17	19.4
208	-75.4	36.9	9.5	39.28	34.37	40.06	39.90	40.16	39.58	0.19	5.17	19.4
209	-75.0	36.9	9.5	39.22	34.32	39.99	39.84	40.09	39.47	0.19	5.17	19.4
210	-74.8	36.9	9.5	39.19	34.30	39.96	39.81	40.06	39.42	0.19	5.17	19.4

TABLE 3

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
5	0.3	36.9	9.5	36.29	34.81	37.06	36.97	37.11	35.82	0.19	5.17	14.7
10	0.3	36.9	9.5	36.29	34.81	37.06	36.97	37.12	35.82	0.19	5.17	14.7
15	0.3	36.9	9.5	36.29	34.81	37.06	36.97	37.12	35.82	0.19	5.17	14.7
20	0.3	36.9	9.5	36.29	34.81	37.06	36.97	37.12	35.82	0.19	5.17	14.7
25	0.3	36.9	9.5	36.39	34.81	37.06	36.97	37.12	35.82	0.19	5.17	14.7
30	0.3	36.9	9.5	36.30	34.81	37.06	36.97	37.12	35.82	0.19	5.17	14.7
31	91.0	148.3	18.4	36.33	34.74	36.98	36.64	37.04	36.14	0.19	8.67	22.8
32	91.5	148.3	18.4	36.38	34.69	36.88	36.68	36.94	36.44	0.19	8.67	21.7
33	91.8	148.3	18.4	36.44	34.68	36.82	36.72	36.89	36.69	0.19	8.67	20.9
34	91.8	148.3	18.4	36.49	34.68	36.78	36.77	36.88	36.89	0.19	8.67	20.4
35	91.7	148.3	18.4	36.53	34.68	36.77	36.81	36.88	37.01	0.19	8.67	20.1
36	91.4	148.3	18.4	36.61	34.72	36.77	36.90	36.93	37.23	0.19	8.67	19.7
37	91.2	148.3	18.4	36.62	34.72	36.77	36.92	36.93	37.25	0.19	8.67	19.7
38	90.9	148.3	18.4	36.67	34.75	36.80	36.98	36.98	37.35	0.19	8.67	19.6
39	90.7	148.3	18.4	36.73	34.78	36.83	37.04	37.03	37.45	0.19	8.67	19.4
40	90.3	148.3	18.4	36.78	34.81	36.87	37.10	37.09	37.54	0.19	8.67	19.3
41	89.8	148.3	18.4	36.86	34.86	36.93	37.19	37.17	37.65	0.19	8.67	19.2
42	89.4	148.3	18.4	36.86	34.86	36.94	37.20	37.18	37.65	0.19	8.67	19.3
43	89.4	148.3	18.4	36.91	34.89	36.98	37.25	37.23	37.72	0.19	8.67	19.1
44	89.0	148.3	18.4	36.96	34.93	37.04	37.31	37.29	37.79	0.19	8.67	19.1
45	88.3	148.3	18.4	37.04	34.98	37.11	37.40	37.38	37.88	0.19	8.67	19.1
46	88.0	148.3	18.4	37.07	35.00	37.15	37.43	37.41	37.92	0.19	8.67	19.1
47	87.5	148.3	18.4	37.10	35.02	37.18	37.47	37.45	37.96	0.19	8.67	19.1
48	87.5	148.3	18.4	37.14	35.04	37.22	37.51	37.50	38.00	0.19	8.67	19.0
49	87.2	148.3	18.4	37.19	35.08	37.28	37.57	37.56	38.06	0.19	8.67	19.0
50	86.7	148.3	18.4	37.26	35.12	37.35	37.65	37.63	38.14	0.19	8.67	18.9
51	86.3	148.3	18.4	37.29	35.14	37.39	37.69	37.67	38.18	0.19	8.67	18.9
52	86.0	148.3	18.4	37.33	35.17	37.43	37.72	37.71	38.22	0.19	8.67	19.0
53	85.8	148.3	18.4	37.37	35.19	37.47	37.77	37.75	38.26	0.19	8.67	18.9
54	85.5	148.3	18.4	37.42	35.22	37.52	37.82	37.81	38.32	0.19	8.67	18.8
55	85.1	148.3	18.4	37.46	35.25	37.57	37.86	37.86	38.36	0.19	8.67	18.9
56	84.9	148.3	18.4	37.51	35.28	37.62	37.92	37.91	38.42	0.19	8.67	18.8
57	84.3	148.3	18.4	37.55	35.31	37.67	37.97	37.96	38.47	0.19	8.67	18.9
58	84.3	148.3	18.4	37.59	35.34	37.71	38.01	38.01	38.52	0.19	8.67	18.8
59	83.7	148.3	18.4	37.64	35.37	37.76	38.06	38.06	38.56	0.19	8.67	18.9
60	83.6	148.3	18.4	37.68	35.40	37.81	38.11	38.10	38.61	0.19	8.67	18.7
61	-4.8	36.9	9.5	37.68	35.54	37.88	37.95	38.13	38.54	0.19	5.17	15.3
62	-5.2	36.9	9.5	37.68	35.59	37.91	37.99	38.12	38.48	0.19	5.17	15.5
63	-5.9	36.9	9.5	37.67	35.64	37.94	37.98	38.12	38.43	0.19	5.17	16.2
64	-6.1	36.9	9.5	37.67	35.68	37.96	37.98	38.13	38.37	0.19	5.17	16.6
65	-6.4	36.9	9.5	37.67	35.71	37.99	37.99	38.13	38.31	0.19	5.17	16.9
66	-6.5	36.9	9.5	37.66	35.73	38.00	38.00	38.13	38.27	0.19	5.17	17.1
67	-6.6	36.9	9.5	37.65	35.75	38.02	38.00	38.14	38.22	0.19	5.17	17.2

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
68	-6.7	36.9	9.5	37.66	35.76	38.03	38.01	38.14	38.20	0.19	5.17	17.3
69	-6.8	36.9	9.5	37.65	35.77	38.04	38.01	38.15	38.16	0.19	5.17	17.4
70	-6.9	36.9	9.5	37.65	35.78	38.05	38.02	38.15	38.12	0.19	5.17	17.4
71	-6.9	36.9	9.5	37.64	35.79	38.05	38.02	38.16	38.09	0.19	5.17	17.4
72	-6.9	36.9	9.5	37.64	35.79	38.06	38.03	38.16	38.07	0.19	5.17	17.5
73	-7.0	36.9	9.5	37.64	35.79	38.07	38.03	38.17	38.03	0.19	5.17	17.5
74	-7.0	36.9	9.5	37.63	35.80	38.08	38.04	38.18	38.00	0.19	5.17	17.4
75	-7.0	36.9	9.5	37.63	35.80	38.09	38.04	38.18	37.97	0.19	5.17	17.4
76	-7.0	36.9	9.5	37.63	35.80	38.09	38.05	38.19	37.94	0.19	5.17	17.4
77	-7.0	36.9	9.5	37.62	35.80	38.10	38.05	38.19	37.92	0.19	5.17	17.4
78	-7.0	36.9	9.5	37.62	35.80	38.10	38.05	38.19	37.89	0.19	5.17	17.3
79	-7.0	36.9	9.5	37.62	35.80	38.11	38.06	38.20	37.87	0.19	5.17	17.3
80	-6.9	36.9	9.5	37.61	35.80	38.12	38.06	38.20	37.84	0.19	5.17	17.3
81	-6.9	36.9	9.5	37.61	35.80	38.12	38.07	38.21	37.82	0.19	5.17	17.2
82	-6.9	36.9	9.5	37.60	35.80	38.13	38.07	38.21	37.80	0.19	5.17	17.2
83	-6.9	36.9	9.5	37.60	35.80	38.13	38.07	38.21	37.77	0.19	5.17	17.1
84	-6.9	36.9	9.5	37.59	35.79	38.14	38.07	38.22	37.75	0.19	5.17	17.1
85	-6.8	36.9	9.5	37.59	35.79	38.14	38.08	38.22	37.73	0.19	5.17	17.1
86	-6.8	36.9	9.5	37.59	35.79	38.14	38.08	38.22	37.70	0.19	5.17	17.0
87	-6.8	36.9	9.5	37.59	35.79	38.14	38.08	38.22	37.70	0.19	5.17	17.0
88	-6.8	36.9	9.5	37.58	35.79	38.15	38.08	38.23	37.68	0.19	5.17	17.0
89	-6.8	36.9	9.5	37.58	35.79	38.15	38.08	38.23	37.66	0.19	5.17	16.9
90	-6.7	36.9	9.5	37.57	35.78	38.15	38.09	38.23	37.64	0.19	5.17	16.9
91	197.5	275.4	28.6	37.65	35.70	38.06	37.96	38.17	38.03	0.19	12.67	23.9
92	198.0	275.4	28.6	37.77	35.66	37.98	38.14	38.14	38.43	0.19	12.67	21.6
93	198.0	275.4	28.6	37.88	35.67	37.96	38.30	38.19	38.72	0.19	12.67	20.3
94	197.6	275.4	28.6	38.00	35.70	37.99	38.45	38.29	38.96	0.19	12.67	19.5
95	197.2	275.4	28.6	38.10	35.73	38.04	38.59	38.39	39.12	0.19	12.67	19.0
96	196.7	275.4	28.6	38.21	35.78	38.12	38.72	38.51	39.28	0.19	12.67	18.6
97	196.1	275.4	28.6	38.30	35.82	38.19	38.82	38.60	39.39	0.19	12.67	18.4
98	195.4	275.4	28.6	38.42	35.88	38.30	38.97	38.75	39.55	0.19	12.67	18.1
99	194.8	275.4	28.6	38.55	35.95	38.42	39.12	38.90	39.70	0.19	12.67	17.9
100	194.3	275.4	28.6	38.66	35.98	38.47	39.19	38.96	39.77	0.19	12.67	17.8
101	193.6	275.4	28.6	38.73	36.06	38.60	39.33	39.11	39.92	0.19	12.67	17.7
102	192.7	275.4	28.6	38.82	36.11	38.69	39.43	39.22	40.02	0.19	12.67	17.7
103	192.1	275.4	28.6	38.89	36.15	38.77	39.52	39.30	40.10	0.19	12.67	17.6
104	191.5	275.4	28.6	39.00	36.22	38.89	39.64	39.43	40.23	0.19	12.67	17.5
105	190.7	275.4	28.6	39.15	36.31	39.05	39.81	39.60	40.39	0.19	12.67	17.3
106	189.9	275.4	28.6	39.20	36.35	39.11	39.88	39.67	40.46	0.19	12.67	17.4
107	189.4	275.4	28.6	39.33	36.43	39.25	40.02	39.81	40.60	0.19	12.67	17.2
108	188.5	275.4	28.6	39.44	36.49	39.37	40.14	39.94	40.72	0.19	12.67	17.3
109	188.0	275.4	28.6	39.54	36.56	39.48	40.25	40.05	40.83	0.19	12.67	17.2
110	187.4	275.4	28.6	39.60	36.69	39.55	40.32	40.12	40.90	0.19	12.67	17.2

TIME	S	M	EV	TB	TS	TH	TO	TR	TI	SBF	CO	COND
111	186.5	275.4	28.6	39.71	36.67	39.67	40.45	40.25	41.02	0.19	12.67	17.2
112	185.7	275.4	28.6	39.82	36.74	39.79	40.57	40.36	41.14	0.19	12.67	17.2
113	185.0	275.4	28.6	39.92	36.81	39.90	40.68	40.48	41.25	0.19	12.67	17.2
114	184.5	275.4	28.6	39.99	36.85	39.98	40.75	40.56	41.33	0.19	12.67	17.1
115	183.6	275.4	28.6	40.14	36.95	40.14	40.91	40.72	41.49	0.19	12.67	17.1
116	183.0	275.4	28.6	40.23	37.01	40.24	41.01	40.82	41.58	0.19	12.67	17.1
117	182.3	275.4	28.6	40.29	37.05	40.31	41.08	40.89	41.65	0.19	12.67	17.2
118	181.4	275.4	28.6	40.42	37.14	40.45	41.22	41.03	41.79	0.19	12.67	17.2
119	181.0	275.4	28.6	40.51	37.20	40.54	41.31	41.13	41.89	0.19	12.67	17.1
120	180.1	275.4	28.6	40.57	37.24	40.61	41.38	41.20	41.95	0.19	12.67	17.2
121	-19.0	36.9	9.5	40.56	37.46	40.75	40.98	41.21	41.82	0.19	5.17	14.5
122	-19.7	36.9	9.5	40.54	37.56	40.81	40.97	41.18	41.72	0.19	5.17	15.2
123	-20.1	36.9	9.5	40.54	37.61	40.84	40.96	41.16	41.66	0.19	5.17	15.6
124	-20.7	36.9	9.5	40.52	37.70	40.88	40.94	41.13	41.52	0.19	5.17	16.3
125	-21.1	36.9	9.5	40.51	37.73	40.90	40.94	41.12	41.47	0.19	5.17	16.5
126	-21.2	36.9	9.5	40.50	37.76	40.91	40.93	41.11	41.39	0.19	5.17	16.8
127	-21.4	36.9	9.5	40.49	37.78	40.92	40.92	41.10	41.35	0.19	5.17	17.0
128	-21.5	36.9	9.5	40.48	37.80	40.92	40.91	41.09	41.29	0.19	5.17	17.2
129	-21.7	36.9	9.5	40.47	37.82	40.93	40.90	41.08	41.21	0.19	5.17	17.4
130	-21.7	36.9	9.5	40.46	37.83	40.93	40.90	41.07	41.16	0.19	5.17	17.5
131	-21.8	36.9	9.5	40.45	37.84	40.93	40.89	41.06	41.11	0.19	5.17	17.6
132	-21.8	36.9	9.5	40.43	37.84	40.93	40.88	41.05	41.05	0.19	5.17	17.7
133	-21.8	36.9	9.5	40.42	37.85	40.92	40.88	41.04	41.00	0.19	5.17	17.8
134	-21.8	36.9	9.5	40.41	37.85	40.92	40.87	41.04	40.95	0.19	5.17	17.8
135	-21.8	36.9	9.5	40.40	37.85	40.92	40.86	41.03	40.91	0.19	5.17	17.9
136	-21.8	36.9	9.5	40.38	37.84	40.91	40.85	41.02	40.84	0.19	5.17	17.9
137	-21.7	36.9	9.5	40.37	37.84	40.91	40.85	41.02	40.82	0.19	5.17	17.9
138	-21.7	36.9	9.5	40.37	37.84	40.91	40.84	41.01	40.78	0.19	5.17	17.9
139	-21.6	36.9	9.5	40.35	37.84	40.90	40.84	41.00	40.74	0.19	5.17	17.9
140	-21.6	36.9	9.5	40.34	37.83	40.90	40.83	41.00	40.70	0.19	5.17	17.9
141	-21.6	36.9	9.5	40.33	37.83	40.89	40.82	40.99	40.66	0.19	5.17	17.9
142	-21.5	36.9	9.5	40.32	37.82	40.89	40.81	40.98	40.62	0.19	5.17	17.9
143	-21.4	36.9	9.5	40.31	37.82	40.88	40.81	40.98	40.59	0.19	5.17	17.9
144	-21.4	36.9	9.5	40.30	37.81	40.88	40.80	40.97	40.56	0.19	5.17	17.9
145	-21.3	36.9	9.5	40.29	37.81	40.87	40.80	40.96	40.53	0.19	5.17	17.9
146	-21.3	36.9	9.5	40.27	37.80	40.87	40.79	40.96	40.49	0.19	5.17	17.9
147	-21.2	36.9	9.5	40.26	37.79	40.86	40.78	40.95	40.46	0.19	5.17	17.8
148	-21.1	36.9	9.5	40.25	37.78	40.86	40.77	40.94	40.42	0.19	5.17	17.8
149	-21.1	36.9	9.5	40.24	37.78	40.85	40.77	40.94	40.40	0.19	5.17	17.8
150	-21.0	36.9	9.5	40.23	37.77	40.84	40.76	40.93	40.37	0.19	5.17	17.8
151	350.1	463.5	43.7	40.41	37.65	40.68	40.89	40.86	41.14	0.19	18.59	22.
152	350.2	463.5	43.7	40.62	37.64	40.62	41.25	40.94	41.70	0.19	18.59	20.
153	349.8	463.5	43.7	40.79	37.67	40.65	41.50	41.08	42.03	0.19	18.59	19.

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
154	349.1	463.5	43.7	40.97	37.73	40.74	41.75	41.27	42.33	0.19	18.59	18.7
155	348.1	463.5	43.7	41.18	37.81	40.88	42.03	41.51	42.63	0.19	18.59	18.1
156	347.1	463.5	43.7	41.36	37.89	41.02	42.25	41.72	42.85	0.19	18.59	17.7
157	346.1	463.5	43.7	41.52	37.97	41.16	42.43	41.91	43.05	0.19	18.59	17.5
158	345.0	463.5	43.7	41.70	38.06	41.33	42.65	42.13	43.26	0.19	18.59	17.3
159	343.8	463.5	43.7	41.88	38.15	41.51	42.87	42.35	43.48	0.19	18.59	17.1
160	342.6	463.5	43.7	42.07	38.26	41.70	43.08	42.57	43.70	0.19	18.59	16.9
161	341.4	463.5	43.7	42.25	38.36	41.90	43.30	42.79	43.92	0.19	18.59	16.8
162	340.6	463.5	43.7	42.41	38.46	42.07	43.50	42.99	44.10	0.19	18.59	16.6
163	339.3	463.5	43.7	42.60	38.57	42.28	43.72	43.21	44.32	0.19	18.59	16.5
154	338.0	463.5	43.7	42.79	38.68	42.49	43.94	43.43	44.54	0.19	18.59	16.4
165	336.7	463.5	43.7	42.99	38.80	42.70	44.15	43.66	44.76	0.19	18.59	16.4
166	335.3	463.5	43.7	43.18	38.92	42.92	44.37	43.88	44.98	0.19	18.59	16.3
167	334.0	463.5	43.7	43.37	39.05	43.13	44.59	44.10	45.19	0.19	18.59	16.3
168	332.8	463.5	43.7	43.49	39.12	43.26	44.72	44.24	45.33	0.19	18.59	16.3
169	331.9	463.5	43.7	43.66	39.23	43.45	44.92	44.44	45.52	0.19	18.59	16.2
170	330.5	463.5	43.7	43.86	39.36	43.67	45.13	44.66	45.73	0.19	18.59	16.2
171	329.1	463.5	43.7	44.05	39.49	43.88	45.35	44.88	45.95	0.19	18.59	16.2
172	327.9	463.5	43.7	44.18	39.57	44.02	45.48	45.02	46.09	0.19	18.59	16.3
173	326.5	463.5	43.7	44.38	39.70	44.24	45.70	45.24	46.31	0.19	18.59	16.3
174	325.6	463.5	43.7	44.55	39.82	44.43	45.90	45.44	46.49	0.19	18.59	16.2
175	324.2	463.5	43.7	44.75	39.95	44.65	46.12	45.66	46.71	0.19	18.59	16.2
176	322.7	463.5	43.7	44.95	40.09	44.88	46.34	45.84	46.94	0.19	18.59	16.3
177	321.8	463.5	43.7	45.05	40.16	44.99	46.45	46.00	47.04	0.19	18.59	16.3
178	320.5	463.5	43.7	45.22	40.27	45.17	46.62	46.18	47.22	0.19	18.59	16.3
179	319.5	463.5	43.7	45.39	40.39	45.35	46.81	46.37	47.41	0.19	18.59	16.3
180	317.9	463.5	43.7	45.60	40.53	45.59	47.04	46.60	47.64	0.19	18.59	16.3
181	-43.3	36.9	9.5	45.58	40.77	45.76	46.35	46.65	47.51	0.19	5.17	13.5
182	-44.6	36.9	9.5	45.56	40.97	45.88	46.23	46.56	47.33	0.19	5.17	14.5
183	-45.5	36.9	9.5	45.53	41.09	45.94	46.19	46.49	47.17	0.19	5.17	15.2
184	-46.1	36.9	9.5	45.51	41.17	45.98	46.15	46.44	47.06	0.19	5.17	15.7
185	-46.5	36.9	9.5	45.49	41.24	46.00	46.12	46.39	46.95	0.19	5.17	16.1
186	-46.9	36.9	9.5	45.46	41.30	46.01	46.08	46.34	46.82	0.19	5.17	16.5
187	-47.3	36.9	9.5	45.43	41.35	46.01	46.04	46.29	46.68	0.19	5.17	16.9
188	-47.5	36.9	9.5	45.41	41.38	46.00	46.02	46.26	46.61	0.19	5.17	17.1
189	-47.7	36.9	9.5	45.38	41.41	45.99	45.97	46.21	46.47	0.19	5.17	17.5
190	-47.7	36.9	9.5	45.36	41.42	45.98	45.95	46.18	46.39	0.19	5.17	17.6
191	-47.8	36.9	9.5	45.34	41.43	45.97	45.92	46.16	46.32	0.19	5.17	17.8
192	-47.8	36.9	9.5	45.31	41.44	45.95	45.90	46.13	46.24	0.19	5.17	17.9
193	-47.8	36.9	9.5	45.27	41.44	45.92	45.85	46.08	46.11	0.19	5.17	18.1
194	-47.8	36.9	9.5	45.26	41.44	45.91	45.84	46.06	46.06	0.19	5.17	18.1
195	-47.7	36.9	9.5	45.23	41.44	45.88	45.81	46.03	45.97	0.19	5.17	18.3
196	-47.7	36.9	9.5	45.21	41.43	45.87	45.79	46.01	45.92	0.19	5.17	18.3

TIME	S	M	EV	TB	TS	TP	TO	TR	TM	SBF	CO	COND
197	-47.6	36.9	9.5	45.18	41.42	45.84	45.75	45.97	45.81	0.19	5.17	18.4
198	-47.4	36.9	9.5	45.16	41.42	45.82	45.73	45.95	45.76	0.19	5.17	18.4
199	-47.4	36.9	9.5	45.13	41.40	45.80	45.70	45.92	45.68	0.19	5.17	18.5
200	-47.2	36.9	9.5	45.10	41.39	45.77	45.68	45.89	45.62	0.19	5.17	18.5
201	-47.1	36.9	9.5	45.08	41.38	45.76	45.65	45.87	45.56	0.19	5.17	18.5
202	-47.0	36.9	9.5	45.05	41.37	45.73	45.63	45.84	45.49	0.19	5.17	18.6
203	-46.8	36.9	9.5	45.02	41.35	45.70	45.59	45.80	45.41	0.19	5.17	18.6
204	-46.7	36.9	9.5	44.99	41.33	45.67	45.56	45.78	45.34	0.19	5.17	18.6
205	-46.5	36.9	9.5	44.96	41.32	45.65	45.54	45.75	45.28	0.19	5.17	18.6
206	-46.4	36.9	9.5	44.95	41.31	45.64	45.53	45.74	45.26	0.19	5.17	18.6
207	-46.3	36.9	9.5	44.93	41.30	45.62	45.51	45.72	45.22	0.19	5.17	18.6
208	-46.2	36.9	9.5	44.91	41.28	45.60	45.49	45.70	45.17	0.19	5.17	18.6
209	-46.1	36.9	9.5	44.89	41.27	45.58	45.46	45.68	45.11	0.19	5.17	18.6
210	-46.0	36.9	9.5	44.86	41.25	45.56	45.44	45.65	45.06	0.19	5.17	18.6

In the next three tables we present the results of simulation runs of intermittent rest and exercise periods at 25, 50 and 75% of maximum aerobic capacity at 10, 20 and 30°C with controller coefficients which have been found to give close correspondence to actual experimental runs. The values used were:

CSW	400 $\mathrm{kcal.h^{-1}.°C^{-1}}$
PSW	60 $\mathrm{kcal.h^{-1}.°C^{-2}}$
CDIL	150 $\mathrm{l.h^{-1}.°C^{-1}}$
PCHIL	10 $\mathrm{kcal.h^{-1}.°C^{-2}}$
CCON	10 $\mathrm{°C^{-1}}$
SCON	10 $\mathrm{°C^{-1}}$

All regulator coefficients not specifically mentioned above are assumed to be zero. The "set points" for the various compartments are as given in the listing of the simulation program. The specific "set points" used were derived from the equilibrium temperatures reached in the various compartments in a thermally neutral environment at rest in the absence of any controls.

Table 4 gives the results of a simulation at an environmental temperature of 10°C, with identical runs at 20°C in Table 5, and at 30°C in Table 6. In all cases the simulation starts at time zero in the condition of a previous exposure to the equilibrium temperature of 31°C.

TABLE 4

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
1	-140.5.	36.9.	10.1.	36.21	33.55	37.06	36.99	37.12	35.81	0.07	5.05	50.2.
2	-135.7.	36.9.	10.9.	36.14	32.76	37.06	37.00	37.13	35.80	0.05	5.03	39.6.
3	-131.4.	36.9.	11.4.	36.07	32.08	37.07	37.00	37.13	35.78	0.05	5.02	33.2.
4	-127.8.	36.9.	11.6.	36.00	31.56	37.07	37.00	37.14	35.74	0.04	5.02	29.4.
5	-124.1.	36.9.	11.4.	35.93	31.07	37.07	37.01	37.14	35.70	0.04	5.01	26.3.
6	-120.9.	36.9.	11.1.	35.86	30.66	37.07	37.00	37.15	35.65	0.03	5.01	24.1.
7	-118.1.	36.9.	10.6.	35.81	30.35	37.06	37.00	37.15	35.60	0.03	5.00	22.5.
8	-114.9.	36.9.	9.9.	35.74	30.00	37.06	37.00	37.15	35.53	0.02	5.00	20.9.
9	-112.4.	37.0.	9.5.	35.68	29.73	37.05	37.00	37.15	35.46	0.02	5.00	19.9.
10	-110.3.	37.3.	9.5.	35.62	29.48	37.04	36.99	37.15	35.39	0.02	5.01	19.0.
11	-108.6.	37.6.	9.5.	35.57	29.30	37.03	36.99	37.15	35.33	0.02	5.02	18.4.
12	-106.5.	38.1.	9.5.	35.51	29.08	37.02	36.98	37.14	35.25	0.02	5.03	17.7.
13	-104.3.	38.8.	9.5.	35.45	28.87	37.00	36.96	37.13	35.17	0.02	5.05	17.0.
14	-102.5.	39.3.	9.5.	35.40	28.71	36.99	36.95	37.12	35.10	0.02	5.07	16.6.
15	-100.7.	40.0.	9.5.	35.35	28.55	36.98	36.94	37.11	35.03	0.02	5.09	16.2.
16	-98.3.	41.0.	9.5.	35.29	28.36	36.96	36.92	37.10	34.94	0.02	5.12	15.7.
17	-96.3.	41.9.	9.5.	35.23	28.22	36.94	36.90	37.08	34.87	0.02	5.15	15.3.
18	-94.2.	43.0.	9.5.	35.18	28.07	36.92	36.88	37.07	34.79	0.02	5.18	15.0.
19	-92.5.	43.8.	9.5.	35.14	27.96	36.90	36.86	37.05	34.72	0.01	5.21	14.7.
20	-90.2.	45.1.	9.5.	35.09	27.82	36.88	36.84	37.03	34.64	0.01	5.25	14.4.
21	-88.4.	46.1.	9.5.	35.05	27.71	36.86	36.82	37.02	34.58	0.01	5.28	14.2.
22	-85.8.	47.7.	9.5.	34.99	27.57	36.83	36.79	36.99	34.49	0.01	5.33	13.9.
23	-83.8.	48.9.	9.5.	34.95	27.47	36.81	36.77	36.97	34.42	0.01	5.37	13.7.
24	-81.7.	50.2.	9.5.	34.91	27.36	36.79	36.75	36.95	34.35	0.01	5.41	13.5.
25	-79.5.	51.6.	9.5.	34.86	27.26	36.76	36.73	36.93	34.27	0.01	5.45	13.3.
26	-77.3.	53.1.	9.5.	34.82	27.15	36.74	36.71	36.91	34.20	0.01	5.50	13.1.
27	-74.9.	54.7.	9.5.	34.78	27.05	36.71	36.69	36.89	34.12	0.01	5.55	12.9.
28	-73.3.	55.8.	9.5.	34.75	26.97	36.70	36.67	36.87	34.07	0.01	5.58	12.8.
29	-70.9.	57.4.	9.5.	34.70	26.87	36.67	36.65	36.85	33.99	0.01	5.63	12.6.
30	-69.2.	58.6.	9.5.	34.67	26.80	36.65	36.63	36.83	33.93	0.01	5.67	12.5.
31	-30.0.	152.9.	16.5.	34.65	26.37	36.52	35.95	36.64	34.36	0.01	8.64	18.6.
32	-19.0.	161.3.	16.5.	34.64	26.12	36.39	35.94	36.47	34.66	0.01	8.90	17.8.
33	-8.6.	169.5.	16.5.	34.63	25.90	36.27	35.94	36.33	34.95	0.01	9.16	17.2.
34	-1.3.	175.3.	16.5.	34.63	25.75	36.18	35.95	36.25	35.15	0.01	9.34	16.8.
35	5.0.	180.4.	16.5.	34.63	25.62	36.12	35.97	36.19	35.34	0.01	9.50	16.4.
36	8.6.	183.3.	16.5.	34.64	25.54	36.08	35.99	36.17	35.46	0.01	9.59	16.2.
37	11.6.	185.6.	16.5.	34.64	25.47	36.06	36.01	36.16	35.57	0.01	9.66	16.0.
38	13.8.	187.3.	16.5.	34.65	25.40	36.04	36.03	36.17	35.68	0.01	9.72	15.8.
39	14.6.	187.8.	16.5.	34.66	25.37	36.04	36.05	36.17	35.72	0.01	9.73	15.7.
40	15.6.	188.4.	16.5.	34.67	25.32	36.04	36.08	36.19	35.81	0.01	9.75	15.6.
41	15.8.	188.5.	16.5.	34.67	25.29	36.04	36.09	36.20	35.86	0.01	9.75	15.5.
42	15.8.	188.3.	16.5.	34.68	25.26	36.05	36.11	36.22	35.90	0.01	9.75	15.4.
43	15.5.	187.9.	16.5.	34.69	25.24	36.06	36.13	36.24	35.94	0.01	9.73	15.3.

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
44	15.0	187.2	16.5	34.70	25.22	36.08	36.15	36.26	35.97	0.01	9.71	15.3
45	14.2	186.2	16.5	34.71	25.20	36.09	36.16	36.27	36.00	0.01	9.68	15.2
46	13.8	185.8	16.5	34.71	25.19	36.10	36.18	36.29	36.02	0.01	9.67	15.2
47	13.2	185.2	16.5	34.72	25.17	36.12	36.19	36.31	36.05	0.01	9.65	15.1
48	12.0	183.8	16.5	34.73	25.15	36.13	36.21	36.32	36.07	0.01	9.61	15.1
49	11.3	183.1	16.5	34.73	25.14	36.15	36.22	36.34	36.09	0.01	9.58	15.0
50	10.6	182.3	16.5	34.74	25.12	36.17	36.24	36.36	36.12	0.01	9.56	15.0
51	10.0	181.6	16.5	34.74	25.11	36.17	36.24	36.36	36.13	0.01	9.54	14.9
52	9.4	181.0	16.5	34.75	25.10	36.18	36.25	36.38	36.14	0.01	9.52	14.9
53	9.3	180.9	16.5	34.75	25.09	36.20	36.26	36.39	36.16	0.01	9.51	14.9
54	8.1	179.6	16.5	34.76	25.07	36.21	36.28	36.40	36.18	0.01	9.47	14.8
55	7.8	179.2	16.5	34.76	25.06	36.22	36.29	36.41	36.19	0.01	9.46	14.8
56	7.4	178.8	16.5	34.77	25.05	36.23	36.29	36.42	36.20	0.01	9.45	14.8
57	6.9	178.3	16.5	34.77	25.04	36.24	36.30	36.43	36.21	0.01	9.43	14.7
58	6.3	177.6	16.5	34.77	25.03	36.25	36.31	36.44	36.22	0.01	9.41	14.7
59	5.8	177.0	16.5	34.78	25.02	36.25	36.32	36.45	36.23	0.01	9.39	14.7
60	5.7	176.9	16.5	34.78	25.01	36.26	36.32	36.46	36.24	0.01	9.39	14.7
61	-31.3	86.8	9.5	34.76	25.35	36.29	36.44	36.49	36.06	0.01	6.56	10.2
62	-35.4	84.2	9.5	34.74	25.53	36.32	36.46	36.53	35.89	0.01	6.47	10.5
63	-38.2	82.2	9.5	34.72	25.65	36.35	36.48	36.56	35.73	0.01	6.41	10.6
64	-40.3	80.7	9.5	34.71	25.73	36.37	36.49	36.59	35.61	0.01	6.36	10.7
65	-42.1	79.2	9.5	34.68	25.78	36.39	36.50	36.61	35.47	0.01	6.32	10.8
66	-43.7	77.9	9.5	34.66	25.83	36.41	36.51	36.63	35.33	0.01	6.27	10.9
67	-45.1	76.8	9.5	34.63	25.85	36.43	36.52	36.64	35.19	0.01	6.24	10.9
68	-45.8	76.1	9.5	34.61	25.85	36.44	36.52	36.65	35.09	0.01	6.22	10.9
69	-46.3	75.5	9.5	34.58	25.85	36.45	36.53	36.66	34.99	0.01	6.20	10.9
70	-46.7	75.0	9.5	34.56	25.84	36.46	36.53	36.67	34.89	0.01	6.18	10.9
71	-47.0	74.7	9.5	34.53	25.83	36.46	36.53	36.67	34.79	0.01	6.17	10.9
72	-47.1	74.4	9.5	34.51	25.80	36.47	36.53	36.68	34.70	0.01	6.16	10.8
73	-47.0	74.2	9.5	34.49	25.79	36.47	36.53	36.68	34.63	0.01	6.16	10.8
74	-46.9	74.1	9.5	34.46	25.76	36.47	36.53	36.68	34.54	0.01	6.16	10.8
75	-46.7	74.1	9.5	34.43	25.73	36.48	36.53	36.68	34.44	0.01	6.16	10.7
76	-46.4	74.2	9.5	34.41	25.70	36.48	36.52	36.68	34.38	0.01	6.16	10.7
77	-46.0	74.3	9.5	34.39	25.67	36.48	36.52	36.68	34.30	0.01	6.16	10.6
78	-45.6	74.5	9.5	34.36	25.63	36.48	36.52	36.67	34.20	0.01	6.17	10.5
79	-45.2	74.6	9.5	34.34	25.61	36.48	36.51	36.67	34.14	0.01	6.17	10.5
80	-44.6	74.9	9.5	34.32	25.57	36.47	36.51	36.67	34.07	0.01	6.18	10.4
81	-44.0	75.2	9.5	34.28	25.53	36.47	36.50	36.67	33.97	0.01	6.19	10.4
82	-43.6	75.4	9.5	34.26	25.50	36.47	36.50	36.66	33.91	0.01	6.20	10.3
83	-43.1	75.7	9.5	34.24	25.48	36.47	36.50	36.66	33.86	0.01	6.20	10.3
84	-42.6	75.9	9.5	34.23	25.45	36.46	36.49	36.66	33.80	0.01	6.21	10.3
85	-41.8	76.4	9.5	34.20	25.41	36.46	36.49	36.65	33.73	0.01	6.23	10.2
86	-41.3	76.7	9.5	34.18	25.39	36.46	36.48	36.65	33.67	0.01	6.24	10.2

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
87	-40.6.	77.1.	9.5.	34.15	25.34	36.45	36.48	36.64	33.57	0.01	6.25	10.1.
88	-40.0.	77.5.	9.5.	34.13	25.31	36.45	36.47	36.64	33.52	0.01	6.26	10.1.
89	-39.5.	77.8.	9.5.	34.11	25.28	36.44	36.47	36.63	33.46	0.01	6.27	10.0.
90	-38.9.	78.1.	9.5.	34.08	25.26	36.44	36.46	36.63	33.40	0.01	6.28	10.0
91	90.4.	268.3.	24.4.	34.10	25.11	36.38	35.52	36.54	33.80	0.01	12.26	16.6.
92	108.1.	283.9.	24.4.	34.16	24.88	36.16	35.55	36.22	34.60	0.01	12.75	16.0.
93	118.1.	293.4.	24.4.	34.22	24.79	36.02	35.67	36.07	35.14	0.01	13.05	15.6.
94	123.1.	298.3.	24.4.	34.28	24.76	35.95	35.78	36.00	35.52	0.01	13.21	15.4.
95	124.8.	300.3.	24.4.	34.34	24.76	35.92	35.86	35.99	35.78	0.01	13.27	15.3.
96	124.4.	300.5.	24.4.	34.41	24.77	35.92	35.94	36.01	35.98	0.01	13.28	15.3.
97	122.6.	299.2.	24.4.	34.47	24.80	35.93	36.02	36.05	36.14	0.01	13.24	15.3.
98	119.2.	296.6.	24.4.	34.55	24.84	35.97	36.11	36.12	36.29	0.01	13.15	15.3.
99	116.1.	294.1.	24.4.	34.60	24.87	36.00	36.17	36.17	36.39	0.01	13.08	15.3.
100	112.3.	291.0.	24.4.	34.66	24.91	36.05	36.23	36.23	36.48	0.01	12.98	15.3.
101	107.8.	287.1.	24.4.	34.73	24.96	36.10	36.31	36.30	36.57	0.01	12.86	15.3.
102	103.9.	283.8.	24.4.	34.78	24.99	36.15	36.36	36.36	36.64	0.01	12.75	15.3.
103	99.6.	280.0.	24.4.	34.84	25.03	36.21	36.43	36.43	36.72	0.01	12.63	15.4.
104	94.7.	275.8.	24.4.	34.90	25.08	36.27	36.49	36.50	36.79	0.01	12.50	15.4.
105	91.1.	272.6.	24.4.	34.94	25.11	36.32	36.54	36.56	36.85	0.01	12.40	15.4.
106	87.2.	269.2.	24.4.	34.99	25.14	36.37	36.60	36.62	36.91	0.01	12.29	15.4.
107	83.0.	265.5.	24.4.	35.05	25.17	36.43	36.65	36.68	36.97	0.01	12.18	15.4.
108	79.5.	262.4.	24.4.	35.08	25.20	36.47	36.69	36.72	37.01	0.01	12.08	15.4.
109	77.3.	260.4.	24.4.	35.12	25.22	36.51	36.73	36.77	37.06	0.01	12.01	15.4.
110	73.2.	256.7.	24.4.	35.16	25.24	36.55	36.77	36.81	37.10	0.01	11.90	15.5.
111	71.1.	254.9.	24.4.	35.20	25.27	36.60	36.81	36.86	37.15	0.01	11.84	15.4.
112	68.3.	252.3.	24.4.	35.22	25.28	36.63	36.84	36.89	37.18	0.01	11.76	15.5.
113	65.8.	250.1.	24.4.	35.26	25.31	36.67	36.89	36.94	37.23	0.01	11.69	15.5.
114	62.9.	247.5.	24.4.	35.29	25.32	36.71	36.92	36.98	37.27	0.01	11.61	15.5.
115	59.8.	244.7.	24.4.	35.33	25.34	36.75	36.96	37.02	37.31	0.01	11.52	15.5.
116	56.4.	241.6.	24.4.	35.35	25.36	36.78	36.99	37.05	37.34	0.01	11.42	15.5.
117	55.1.	240.4.	24.4.	35.38	25.37	36.81	37.02	37.08	37.38	0.01	11.39	15.5.
118	52.9.	238.4.	24.4.	35.41	25.39	36.84	37.04	37.12	37.41	0.01	11.33	15.5.
119	49.8.	235.7.	24.4.	35.44	25.40	36.87	37.08	37.15	37.44	0.01	11.24	15.5.
120	48.5.	234.5.	24.4.	35.47	25.42	36.90	37.11	37.19	37.48	0.01	11.20	15.4.
121	-76.2.	45.8.	9.5.	35.44	25.72	36.91	37.04	37.19	37.32	0.01	5.26	10.3.
122	-78.1.	45.5.	9.5.	35.39	25.94	36.91	37.02	37.19	37.11	0.01	5.26	10.7.
123	-79.0.	45.5.	9.5.	35.35	26.07	36.91	37.01	37.18	36.94	0.01	5.76	10.9.
124	-79.4.	45.8.	9.5.	35.31	26.16	36.91	36.99	37.17	36.76	0.01	5.26	11.1.
125	-79.4.	46.2.	9.5.	35.26	26.22	36.90	36.98	37.16	36.59	0.01	5.28	11.2.
126	-79.2.	46.6.	9.5.	35.23	26.26	36.89	36.97	37.15	36.46	0.01	5.29	11.3.
127	-78.7.	47.1.	9.5.	35.18	26.27	36.88	36.95	37.13	36.32	0.01	5.31	11.3.
128	-78.0.	47.8.	9.5.	35.14	26.28	36.87	36.94	37.12	36.17	0.01	5.33	11.3.
129	-77.1.	48.6.	9.5.	35.09	26.27	36.86	36.92	37.10	36.03	0.01	5.35	11.3.

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
130	-76.3.	49.3.	9.5.	35.0.6	26.2.6	36.8.5	36.9.0	37.0.9	35.9.2	0.0.1	5.3.8	11.3.
131	-75.3.	50.1.	9.5.	35.0.2	26.2.4	36.8.4	36.8.9	37.0.8	35.8.1	0.0.1	5.4.0	11.3.
132	-74.2.	50.9.	9.5.	34.9.8	26.2.1	36.8.2	36.8.7	37.0.6	35.7.0	0.0.1	5.4.3	11.2.
133	-73.0.	51.8.	9.5.	34.9.4	26.1.8	36.8.1	36.8.5	37.0.4	35.5.9	0.0.1	5.4.5	11.2.
134	-71.7.	52.8.	9.5.	34.9.0	26.1.4	36.7.9	36.8.4	37.0.3	35.4.8	0.0.1	5.4.9	11.2.
135	-70.3.	53.9.	9.5.	34.8.6	26.1.0	36.7.8	36.8.2	37.0.1	35.3.7	0.0.1	5.5.2	11.1.
136	-69.3.	54.7.	9.5.	34.8.3	26.0.7	36.7.7	36.8.0	36.9.9	35.2.9	0.0.1	5.5.4	11.1.
137	-67.6.	55.9.	9.5.	34.7.8	26.0.2	36.7.5	36.7.8	36.9.7	35.1.7	0.0.1	5.5.8	11.0.
138	-66.4.	56.8.	9.5.	34.7.5	25.9.9	36.7.4	36.7.7	36.9.6	35.0.9	0.0.1	5.6.1	10.9.
139	-65.2.	57.7.	9.5.	34.7.2	25.9.5	36.7.2	36.7.5	36.9.4	35.0.1	0.0.1	5.6.4	10.9.
140	-63.9.	58.6.	9.5.	34.6.9	25.9.1	36.7.1	36.7.3	36.9.3	34.9.3	0.0.1	5.6.7	10.8.
141	-62.6.	59.7.	9.5.	34.6.6	25.8.7	36.6.9	36.7.2	36.9.1	34.8.5	0.0.1	5.7.0	10.8.
142	-61.2.	60.7.	9.5.	34.6.2	25.8.3	36.6.8	36.7.0	36.8.9	34.7.6	0.0.1	5.7.3	10.7.
143	-59.7.	61.8.	9.5.	34.5.9	25.7.9	36.6.6	36.6.9	36.8.8	34.6.8	0.0.1	5.7.7	10.7.
144	-58.1.	63.0.	9.5.	34.5.5	25.7.5	36.6.5	36.6.7	36.8.6	34.5.8	0.0.1	5.8.1	10.6.
145	-57.2.	63.8.	9.5.	34.5.3	25.7.2	36.6.4	36.6.6	36.8.5	34.5.3	0.0.1	5.8.3	10.6.
146	-55.6.	65.0.	9.5.	34.5.0	25.6.8	36.6.2	36.6.4	36.8.3	34.4.5	0.0.1	5.8.7	10.5.
147	-54.3.	65.9.	9.5.	34.4.7	25.6.4	36.6.1	36.6.3	36.8.1	34.3.6	0.0.1	5.9.0	10.5.
148	-53.4.	66.7.	9.5.	34.4.4	25.6.1	36.6.0	36.6.2	36.8.0	34.3.0	0.0.1	5.9.2	10.4.
149	-51.8.	67.9.	9.5.	34.4.2	25.5.7	36.5.9	36.6.0	36.7.9	34.2.3	0.0.1	5.9.6	10.4.
150	-50.6.	68.8.	9.5.	34.3.8	25.5.3	36.5.7	36.5.9	36.7.7	34.1.3	0.0.1	5.9.9	10.3.
151	218.3.	411.0.	36.1.	34.4.5	25.3.1	36.4.4	35.5.9	36.5.7	34.9.4	0.0.1	16.7.5	18.2.
152	230.8.	422.6.	36.1.	34.5.7	25.1.8	36.2.6	35.9.0	36.3.4	35.7.6	0.0.1	17.1.2	17.4.
153	234.6.	426.7.	36.1.	34.6.9	25.1.6	36.2.0	36.1.4	36.2.9	36.2.7	0.0.1	17.2.5	17.0.
154	233.5.	426.3.	36.1.	34.8.2	25.1.7	36.2.0	36.3.3	36.3.2	36.6.2	0.0.1	17.2.3	16.8.
155	229.7.	423.4.	36.1.	34.9.3	25.2.1	36.2.4	36.4.9	36.4.0	36.8.7	0.0.1	17.1.4	16.7.
156	223.8.	418.4.	36.1.	35.0.6	25.2.6	36.3.1	36.6.5	36.5.1	37.0.8	0.0.1	16.9.9	16.6.
157	216.4.	412.0.	36.1.	35.1.8	25.3.2	36.4.1	36.8.1	36.6.5	37.2.6	0.0.1	16.7.9	16.6.
158	209.4.	406.0.	36.1.	35.2.9	25.3.8	36.5.0	36.9.4	36.7.7	37.4.1	0.0.1	16.6.0	16.5.
159	201.3.	398.8.	36.1.	35.4.0	25.4.4	36.6.1	37.0.8	36.9.1	37.5.6	0.0.1	16.3.7	16.5.
160	193.3.	391.8.	36.1.	35.5.1	25.5.0	36.7.2	37.2.1	37.0.5	37.6.9	0.0.1	16.1.5	16.5.
161	186.2.	385.4.	36.1.	35.6.1	25.5.6	36.8.3	37.3.2	37.1.7	37.8.1	0.0.1	15.9.5	16.5.
162	178.2.	378.3.	36.1.	35.7.1	25.6.2	36.9.5	37.4.4	37.3.0	37.9.4	0.0.1	15.7.3	16.5.
163	171.6.	372.4.	36.1.	35.8.0	25.6.7	37.0.4	37.5.5	37.4.1	38.0.5	0.0.1	15.5.4	16.5.
164	165.4.	369.6.	38.8.	35.8.9	25.7.3	37.1.5	37.6.5	37.5.3	38.1.6	0.0.2	15.4.7	16.7.
165	161.4.	369.6.	42.2.	35.9.6	25.8.0	37.2.3	37.7.3	37.6.2	38.2.4	0.0.4	15.4.8	17.0.
166	154.3.	369.6.	47.9.	36.0.7	25.9.2	37.3.5	37.8.4	37.7.5	38.3.6	0.0.7	15.5.1	17.6.
167	150.5.	369.6.	50.9.	36.1.3	25.9.9	37.4.1	37.9.0	37.8.1	38.4.2	0.0.9	15.5.3	17.9.
168	144.6.	369.6.	55.6.	36.2.1	26.1.0	37.5.0	37.9.3	37.9.0	38.5.0	0.1.1	15.5.5	18.6.
169	139.6.	369.6.	59.4.	36.3.0	26.2.3	37.5.9	38.0.2	38.0.0	38.5.9	0.1.3	15.5.7	19.0.
170	136.3.	369.6.	62.0.	36.3.5	26.3.0	37.6.4	38.0.8	38.0.5	38.6.3	0.1.4	15.5.8	19.4.
171	128.4.	369.6.	68.3.	36.4.4	26.4.4	37.7.4	38.1.3	38.1.4	38.7.2	0.1.7	15.6.1	20.2.
172	123.7.	369.6.	72.0.	36.4.8	26.5.0	37.7.7	38.1.8	38.1.8	38.7.6	0.1.8	15.6.3	20.6.

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
173	120.1	369.6	74.8	36.55	26.60	37.84	38.26	38.24	38.82	0.20	15.64	20.9
174	114.5	369.6	79.1	36.63	26.73	37.92	38.32	38.32	38.89	0.22	15.66	21.5
175	111.6	369.6	81.4	36.67	26.79	37.96	38.33	38.35	38.93	0.23	15.67	21.9
176	107.2	369.6	84.8	36.73	26.88	38.01	38.38	38.40	38.98	0.24	15.69	22.4
177	103.1	369.6	88.0	36.79	26.97	38.06	38.47	38.45	39.02	0.26	15.70	22.7
178	98.3	369.6	91.8	36.85	27.08	38.13	38.49	38.50	39.07	0.28	15.72	23.3
179	95.6	369.6	93.9	36.89	27.13	38.16	38.52	38.53	39.10	0.29	15.73	23.6
180	91.1	369.6	97.5	36.94	27.22	38.21	38.49	38.58	39.15	0.30	15.75	24.2
181	-159.3	36.9	69.7	36.85	27.64	38.14	37.84	38.45	38.94	0.31	5.28	18.7
182	-156.2	36.9	65.4	36.76	27.81	38.02	37.69	38.26	38.73	0.28	5.25	19.0
183	-151.9	36.9	60.6	36.69	27.88	37.91	37.60	38.11	38.56	0.25	5.23	18.9
184	-146.4	36.9	54.9	36.60	27.91	37.80	37.51	37.96	38.37	0.22	5.20	18.5
185	-141.1	36.9	49.7	36.52	27.90	37.71	37.45	37.85	38.20	0.20	5.17	18.1
186	-136.4	36.9	45.3	36.45	27.87	37.63	37.39	37.76	38.05	0.17	5.15	17.7
187	-131.6	36.9	40.9	36.38	27.82	37.56	37.35	37.68	37.90	0.15	5.13	17.2
188	-127.9	36.9	37.6	36.32	27.77	37.50	37.31	37.62	37.77	0.13	5.11	16.7
189	-123.3	36.9	33.6	36.24	27.69	37.43	37.27	37.55	37.61	0.12	5.09	16.2
190	-119.8	36.9	30.6	36.18	27.63	37.38	37.24	37.50	37.48	0.10	5.08	15.8
191	-116.4	36.9	27.8	36.12	27.55	37.33	37.21	37.46	37.34	0.09	5.06	15.3
192	-112.9	36.9	24.9	36.05	27.47	37.29	37.19	37.42	37.21	0.08	5.05	14.9
193	-110.4	36.9	22.9	36.00	27.41	37.26	37.18	37.40	37.11	0.07	5.04	14.6
194	-107.3	36.9	20.4	35.94	27.33	37.22	37.16	37.37	36.97	0.06	5.03	14.1
195	-105.1	36.9	18.7	35.89	27.27	37.20	37.15	37.35	36.87	0.05	5.02	13.9
196	-103.0	36.9	17.2	35.84	27.20	37.17	37.13	37.33	36.76	0.04	5.02	13.6
197	-100.4	36.9	15.3	35.77	27.11	37.15	37.12	37.31	36.62	0.04	5.01	13.2
198	-98.6	36.9	14.0	35.72	27.05	37.12	37.11	37.30	36.52	0.03	5.01	13.0
199	-96.9	36.9	12.8	35.67	26.98	37.11	37.10	37.28	36.41	0.03	5.00	12.7
200	-95.2	36.9	11.7	35.62	26.91	37.09	37.09	37.27	36.31	0.02	5.00	12.5
201	-93.6	36.9	10.7	35.57	26.84	37.07	37.08	37.26	36.20	0.02	4.99	12.2
202	-92.6	36.9	10.1	35.53	26.79	37.06	37.08	37.25	36.13	0.01	4.99	12.1
203	-91.1	37.2	9.5	35.48	26.72	37.04	37.07	37.24	36.02	0.01	5.00	11.9
204	-89.6	38.2	9.5	35.42	26.64	37.03	37.06	37.23	35.91	0.01	5.03	11.8
205	-88.6	38.8	9.5	35.39	26.59	37.02	37.05	37.23	35.83	0.01	5.04	11.7
206	-87.1	39.7	9.5	35.33	26.52	37.00	37.04	37.21	35.72	0.01	5.08	11.6
207	-86.0	40.4	9.5	35.29	26.47	36.99	37.03	37.21	35.64	0.01	5.10	11.5
208	-84.3	41.4	9.5	35.24	26.40	36.98	37.01	37.19	35.53	0.01	5.13	11.4
209	-83.0	42.3	9.5	35.19	26.34	36.96	37.00	37.18	35.43	0.01	5.16	11.3
210	-82.1	42.9	9.5	35.16	26.30	36.95	36.99	37.17	35.37	0.01	5.17	11.2

TABLE 5

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
1	-73.5.	36.9.	10.0.	36.25	34.11	37.06	36.99	37.12	35.81	0.10	5.07	36.7.
2	-71.2.	36.9.	10.9.	36.21	33.66	37.06	37.00	37.13	35.80	0.08	5.05	31.0.
3	-69.5.	36.9.	11.7.	36.17	33.30	37.07	37.00	37.13	35.79	0.07	5.05	27.5.
4	-68.0.	36.9.	12.2.	36.14	33.03	37.07	37.00	37.14	35.78	0.07	5.04	25.2.
5	-66.4.	36.9.	12.5.	36.10	32.76	37.08	37.01	37.14	35.75	0.06	5.04	23.2.
6	-64.7.	36.9.	12.6.	36.06	32.50	37.08	37.01	37.15	35.72	0.06	5.03	21.5.
7	-63.3.	36.9.	12.6.	36.03	32.32	37.08	37.01	37.15	35.70	0.05	5.03	20.3.
8	-61.8.	36.9.	12.3.	36.00	32.16	37.08	37.01	37.15	35.66	0.05	5.03	19.3.
9	-60.3.	36.9.	12.0.	35.97	32.00	37.07	37.01	37.15	35.63	0.05	5.02	18.4.
10	-58.9.	36.9.	11.6.	35.93	31.86	37.07	37.01	37.15	35.59	0.04	5.02	17.6.
11	-57.4.	36.9.	11.1.	35.90	31.73	37.07	37.01	37.16	35.55	0.04	5.01	16.9.
12	-56.0.	36.9.	10.6.	35.87	31.61	37.06	37.01	37.16	35.51	0.04	5.01	16.3.
13	-55.1.	36.9.	10.2.	35.85	31.54	37.06	37.01	37.16	35.48	0.03	5.01	15.9.
14	-53.7.	36.9.	9.7.	35.81	31.43	37.05	37.01	37.16	35.43	0.03	5.01	15.3.
15	-53.0.	37.0.	9.5.	35.79	31.36	37.05	37.01	37.16	35.40	0.03	5.01	15.0.
16	-52.1.	37.1.	9.5.	35.76	31.25	37.05	37.00	37.15	35.35	0.03	5.01	14.7.
17	-51.5.	37.2.	9.5.	35.73	31.19	37.04	37.00	37.15	35.32	0.03	5.01	14.4.
18	-50.5.	37.4.	9.5.	35.70	31.09	37.03	36.99	37.15	35.26	0.03	5.02	14.0.
19	-49.9.	37.5.	9.5.	35.67	31.02	37.03	36.99	37.14	35.23	0.03	5.02	13.8.
20	-49.2.	37.7.	9.5.	35.65	30.96	37.02	36.98	37.14	35.19	0.03	5.03	13.6.
21	-48.6.	37.9.	9.5.	35.63	30.90	37.02	36.97	37.14	35.16	0.03	5.03	13.4.
22	-47.8.	38.1.	9.5.	35.60	30.83	37.01	36.96	37.13	35.11	0.03	5.04	13.2.
23	-47.0.	38.4.	9.5.	35.58	30.77	37.00	36.96	37.12	35.08	0.02	5.05	13.0.
24	-46.3.	38.7.	9.5.	35.55	30.70	36.99	36.95	37.11	35.03	0.02	5.06	12.8.
25	-45.8.	38.9.	9.5.	35.53	30.66	36.98	36.94	37.11	35.00	0.02	5.06	12.7.
26	-44.9.	39.3.	9.5.	35.51	30.60	36.97	36.93	37.10	34.97	0.02	5.07	12.5.
27	-44.2.	39.6.	9.5.	35.48	30.54	36.96	36.92	37.09	34.92	0.02	5.08	12.4.
28	-43.3.	40.0.	9.5.	35.46	30.49	36.95	36.91	37.08	34.88	0.02	5.10	12.2.
29	-42.6.	40.4.	9.5.	35.43	30.43	36.94	36.89	37.07	34.84	0.02	5.11	12.1.
30	-42.0.	40.7.	9.5.	35.41	30.39	36.93	36.88	37.06	34.81	0.02	5.12	12.0.
31	11.2.	130.7.	16.5.	35.42	30.10	36.80	36.28	36.88	35.23	0.02	7.95	18.5.
32	17.3.	135.0.	16.5.	35.42	29.94	36.68	36.27	36.72	35.51	0.02	8.08	17.8.
33	21.2.	137.9.	16.5.	35.43	29.85	36.60	36.26	36.62	35.70	0.02	8.17	17.4.
34	24.9.	140.8.	16.5.	35.45	29.76	36.52	36.27	36.55	35.88	0.02	8.26	17.0.
35	28.3.	143.5.	16.5.	35.46	29.69	36.46	36.28	36.49	36.05	0.02	8.35	16.7.
36	31.1.	145.8.	16.5.	35.48	29.65	36.42	36.30	36.47	36.15	0.02	8.42	16.5.
37	31.4.	146.0.	16.5.	35.49	29.62	36.40	36.31	36.47	36.23	0.02	8.43	16.4.
38	32.6.	146.9.	16.5.	35.51	29.59	36.39	36.34	36.47	36.31	0.02	8.45	16.2.
39	33.5.	147.7.	16.5.	35.53	29.58	36.38	36.36	36.48	36.38	0.02	8.48	16.1.
40	33.6.	147.7.	16.5.	35.54	29.56	36.39	36.39	36.49	36.44	0.02	8.48	16.0.
41	33.6.	147.7.	16.5.	35.56	29.55	36.39	36.41	36.51	36.49	0.02	8.48	15.9.
42	33.2.	147.3.	16.5.	35.58	29.54	36.41	36.44	36.54	36.54	0.02	8.47	15.8.
43	32.9.	147.0.	16.5.	35.60	29.54	36.42	36.47	36.56	36.58	0.02	8.46	15.7.

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
44	32.3	146.4	16.5	35.62	29.53	36.44	36.49	36.58	36.61	0.02	8.44	15.7
45	31.9	146.0	16.5	35.64	29.53	36.46	36.51	36.61	36.65	0.02	8.42	15.6
46	31.1	145.2	16.5	35.66	29.53	36.48	36.54	36.64	36.69	0.02	8.40	15.5
47	30.3	144.5	16.5	35.67	29.52	36.50	36.57	36.66	36.73	0.02	8.38	15.5
48	29.6	143.8	16.5	35.69	29.52	36.52	36.58	36.68	36.75	0.02	8.36	15.5
49	28.8	143.2	16.5	35.70	29.52	36.53	36.60	36.69	36.76	0.02	8.34	15.4
50	28.1	142.5	16.5	35.71	29.52	36.55	36.62	36.72	36.79	0.02	8.32	15.4
51	27.2	141.6	16.5	35.73	29.52	36.57	36.64	36.74	36.81	0.02	8.29	15.4
52	27.1	141.5	16.5	35.74	29.52	36.59	36.66	36.76	36.84	0.02	8.28	15.3
53	25.8	140.3	16.5	35.76	29.52	36.61	36.67	36.78	36.86	0.02	8.25	15.3
54	25.6	140.2	16.5	35.77	29.52	36.62	36.69	36.80	36.88	0.02	8.24	15.3
55	24.8	139.4	16.5	35.78	29.52	36.64	36.71	36.82	36.91	0.02	8.22	15.2
56	24.1	138.7	16.5	35.80	29.52	36.66	36.73	36.84	36.93	0.02	8.20	15.2
57	23.1	137.8	16.5	35.81	29.52	36.68	36.74	36.86	36.95	0.02	8.17	15.2
58	22.6	137.3	16.5	35.82	29.52	36.69	36.76	36.87	36.96	0.02	8.15	15.1
59	22.0	136.8	16.5	35.83	29.52	36.71	36.78	36.89	36.98	0.02	8.13	15.1
60	21.6	136.4	16.5	35.84	29.52	36.72	36.79	36.90	37.00	0.02	8.12	15.1
61	-30.2	48.4	9.5	35.82	29.77	36.74	36.81	36.92	36.85	0.02	5.35	10.4
62	-31.6	47.7	9.5	35.81	29.87	36.75	36.82	36.93	36.75	0.02	5.34	10.7
63	-32.8	47.2	9.5	35.79	29.95	36.76	36.83	36.95	36.64	0.02	5.32	10.9
64	-33.9	46.6	9.5	35.77	30.01	36.78	36.84	36.96	36.52	0.02	5.30	11.1
65	-34.5	46.2	9.5	35.75	30.04	36.79	36.84	36.97	36.44	0.02	5.29	11.1
66	-35.0	45.9	9.5	35.73	30.06	36.80	36.85	36.98	36.35	0.02	5.28	11.2
67	-35.2	45.7	9.5	35.72	30.07	36.80	36.85	36.98	36.30	0.02	5.27	11.2
68	-35.6	45.4	9.5	35.70	30.08	36.81	36.85	36.99	36.21	0.02	5.26	11.2
69	-35.8	45.2	9.5	35.68	30.08	36.82	36.86	37.00	36.13	0.02	5.25	11.2
70	-35.9	45.0	9.5	35.66	30.07	36.82	36.86	37.00	36.08	0.02	5.25	11.2
71	-35.9	44.8	9.5	35.64	30.06	36.83	36.86	37.00	36.01	0.02	5.24	11.1
72	-35.9	44.8	9.5	35.61	30.04	36.83	36.86	37.00	35.92	0.02	5.24	11.1
73	-35.8	44.7	9.5	35.60	30.03	36.83	36.86	37.01	35.87	0.02	5.24	11.1
74	-35.8	44.7	9.5	35.58	30.01	36.84	36.85	37.01	35.82	0.02	5.24	11.0
75	-35.6	44.7	9.5	35.57	29.99	36.84	36.85	37.01	35.77	0.02	5.24	11.0
76	-35.4	44.7	9.5	35.55	29.97	36.84	36.85	37.00	35.71	0.02	5.24	10.9
77	-35.2	44.7	9.5	35.53	29.95	36.84	36.85	37.00	35.67	0.02	5.24	10.9
78	-34.9	44.8	9.5	35.50	29.92	36.84	36.84	37.00	35.59	0.02	5.24	10.8
79	-34.7	44.8	9.5	35.48	29.90	36.83	36.84	37.00	35.54	0.02	5.24	10.7
80	-34.4	44.9	9.5	35.47	29.88	36.83	36.84	36.99	35.49	0.02	5.25	10.7
81	-34.2	45.0	9.5	35.45	29.86	36.83	36.83	36.99	35.45	0.02	5.25	10.6
82	-33.9	45.1	9.5	35.43	29.84	36.83	36.83	36.99	35.40	0.02	5.25	10.6
83	-33.6	45.3	9.5	35.42	29.81	36.82	36.82	36.98	35.35	0.02	5.26	10.5
84	-33.2	45.4	9.5	35.40	29.79	36.82	36.82	36.98	35.31	0.02	5.26	10.5
85	-32.9	45.6	9.5	35.38	29.77	36.82	36.81	36.97	35.26	0.02	5.27	10.4
86	-32.5	45.8	9.5	35.36	29.75	36.81	36.80	36.97	35.22	0.02	5.27	10.4

TIME	S.	M.	ÉV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
87	-32.1	46.0	9.5	35.34	29.72	36.81	36.80	36.96	35.17	0.02	5.28	10.3
88	-31.7	46.2	9.5	35.32	29.70	36.80	36.79	36.95	35.12	0.02	5.29	10.3
89	-31.2	46.5	9.5	35.30	29.68	36.79	36.78	36.95	35.07	0.02	5.29	10.2
90	-30.9	46.7	9.5	35.30	29.67	36.79	36.78	36.94	35.06	0.02	5.30	10.2
91	117.3	237.9	24.4	35.36	29.47	36.65	36.16	36.74	35.72	0.02	11.32	17.3
92	122.0	242.2	24.4	35.43	29.40	36.55	36.27	36.61	36.13	0.02	11.45	16.7
93	124.0	244.1	24.4	35.49	29.37	36.50	36.36	36.56	36.41	0.02	11.51	16.5
94	124.4	244.8	24.4	35.56	29.37	36.48	36.46	36.56	36.65	0.02	11.53	16.3
95	123.8	244.5	24.4	35.62	29.39	36.49	36.54	36.59	36.81	0.02	11.52	16.2
96	122.2	243.5	24.4	35.69	29.41	36.51	36.63	36.64	36.96	0.02	11.49	16.1
97	120.2	242.0	24.4	35.75	29.45	36.55	36.71	36.70	37.08	0.02	11.45	16.1
98	117.5	240.0	24.4	35.83	29.49	36.61	36.80	36.78	37.20	0.02	11.38	16.0
99	115.0	238.0	24.4	35.89	29.52	36.66	36.88	36.85	37.29	0.02	11.32	16.0
100	112.1	235.7	24.4	35.95	29.56	36.73	36.96	36.93	37.38	0.02	11.25	16.0
101	110.0	233.9	24.4	36.00	29.60	36.77	37.01	36.99	37.45	0.02	11.19	16.0
102	107.6	232.0	24.4	36.05	29.63	36.83	37.08	37.06	37.52	0.02	11.13	16.0
103	105.0	230.0	24.4	36.11	29.66	36.89	37.14	37.12	37.59	0.02	11.07	16.0
104	102.2	227.7	24.4	36.17	29.70	36.95	37.21	37.20	37.66	0.02	11.00	16.0
105	99.2	225.2	24.4	36.23	29.74	37.02	37.28	37.27	37.73	0.02	10.92	16.0
106	96.0	222.9	24.9	36.30	29.79	37.10	37.36	37.36	37.82	0.02	10.85	16.1
107	90.7	222.9	29.8	36.33	29.81	37.15	37.39	37.41	37.87	0.04	10.87	16.8
108	87.0	222.9	33.1	36.38	29.83	37.20	37.43	37.46	37.92	0.06	10.88	17.2
109	81.0	222.9	38.8	36.42	29.85	37.24	37.47	37.51	37.97	0.08	10.91	18.0
110	78.0	222.9	41.6	36.46	29.87	37.29	37.51	37.55	38.01	0.09	10.92	18.3
111	74.1	222.9	45.2	36.49	29.88	37.32	37.53	37.58	38.04	0.11	10.93	18.8
112	70.7	222.9	48.4	36.53	29.90	37.37	37.57	37.63	38.09	0.12	10.95	19.2
113	66.8	222.9	52.1	36.57	29.91	37.40	37.58	37.66	38.13	0.13	10.96	19.7
114	62.2	222.9	56.4	36.59	29.92	37.43	37.61	37.69	38.15	0.15	10.98	20.2
115	59.8	222.9	58.8	36.63	29.93	37.47	37.66	37.73	38.19	0.16	10.99	20.5
116	56.6	222.9	61.8	36.66	29.94	37.51	37.63	37.76	38.22	0.17	11.00	21.0
117	51.1	222.9	67.0	36.69	29.95	37.53	37.69	37.78	38.25	0.20	11.02	21.5
118	50.8	222.9	67.3	36.71	29.96	37.56	37.73	37.81	38.27	0.20	11.03	21.5
119	47.5	222.9	70.4	36.74	29.96	37.58	37.74	37.83	38.30	0.21	11.04	21.9
120	45.5	222.9	72.4	36.76	29.97	37.61	37.75	37.85	38.32	0.22	11.05	22.2
121	-93.0	36.9	56.9	36.72	30.19	37.59	37.45	37.81	38.19	0.23	5.20	17.2
122	-90.9	36.9	53.9	36.67	30.31	37.54	37.38	37.73	38.06	0.21	5.19	17.4
123	-88.0	36.9	50.6	36.63	30.37	37.49	37.34	37.66	37.95	0.20	5.17	17.2
124	-84.5	36.9	46.8	36.58	30.41	37.44	37.30	37.59	37.82	0.18	5.15	16.9
125	-80.6	36.9	42.7	36.53	30.43	37.39	37.27	37.53	37.69	0.16	5.13	16.5
126	-77.5	36.9	39.6	36.48	30.44	37.36	37.24	37.49	37.58	0.14	5.12	16.1
127	-75.4	36.9	37.5	36.46	30.44	37.33	37.23	37.46	37.51	0.13	5.11	15.8
128	-72.3	36.9	34.4	36.41	30.44	37.30	37.20	37.42	37.40	0.12	5.09	15.4
129	-70.3	36.9	32.5	36.38	30.43	37.28	37.19	37.40	37.32	0.11	5.09	15.1

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TIME   S       M      EV     TB     TS     TH     TQ     TR     TM     SBF   CQ    COND
130   -67.0    36.9   29.4   36.33  30.42  37.24  37.17  37.37  37.21  0.10  5.07  14.6
131   -64.9    36.9   27.4   36.30  30.41  37.23  37.16  37.35  37.13  0.09  5.07  14.3
132   -63.0    36.9   25.6   36.27  30.39  37.21  37.15  37.34  37.05  0.08  5.06  14.0
133   -61.1    36.9   23.9   36.23  30.38  37.19  37.14  37.32  36.97  0.08  5.05  13.8
134   -59.4    36.9   22.3   36.20  30.36  37.18  37.13  37.31  36.90  0.07  5.04  13.5
135   -57.6    36.9   20.8   36.17  30.34  37.16  37.13  37.30  36.81  0.06  5.04  13.2
136   -56.6    36.9   19.9   36.15  30.32  37.15  37.12  37.29  36.76  0.06  5.04  13.0
137   -55.1    36.9   18.6   36.12  30.30  37.14  37.12  37.29  36.69  0.06  5.03  12.8
138   -53.9    36.9   17.6   36.08  30.28  37.13  37.11  37.28  36.61  0.05  5.03  12.6
139   -53.1    36.9   16.9   36.06  30.26  37.13  37.10  37.27  36.56  0.05  5.02  12.4
140   -51.8    36.9   15.9   36.03  30.24  37.12  37.10  37.27  36.49  0.04  5.02  12.2
141   -50.9    36.9   15.2   36.00  30.21  37.11  37.09  37.26  36.41  0.04  5.02  12.0
142   -50.2    36.9   14.6   35.98  30.20  37.10  37.09  37.25  36.36  0.04  5.01  11.9
143   -49.1    36.9   13.8   35.95  30.17  37.10  37.09  37.25  36.30  0.04  5.01  11.7
144   -48.3    36.9   13.2   35.92  30.15  37.09  37.08  37.24  36.22  0.03  5.01  11.6
145   -47.7    36.9   12.7   35.90  30.13  37.08  37.08  37.24  36.18  0.03  5.01  11.5
146   -47.1    36.9   12.3   35.88  30.11  37.08  37.07  37.24  36.13  0.03  5.01  11.3
147   -46.2    36.9   11.6   35.85  30.09  37.08  37.07  37.23  36.07  0.03  5.00  11.2
148   -45.4    36.9   11.1   35.81  30.06  37.07  37.07  37.23  36.00  0.03  5.00  11.0
149   -44.9    36.9   10.7   35.79  30.04  37.06  37.06  37.22  35.95  0.02  5.00  10.9
150   -44.4    36.9   10.3   35.77  30.02  37.06  37.06  37.22  35.91  0.02  5.00  10.8
151   235.1   372.4   36.1   35.87  29.86  36.97  36.60  37.09  36.54  0.02 15.55  19.6
152   237.7   374.7   36.1   35.99  29.80  36.91  36.86  37.02  37.07  0.02 15.62  18.7
153   237.1   374.4   36.1   36.12  29.81  36.92  37.07  37.05  37.44  0.02 15.61  18.2
154   234.6   372.6   36.1   36.25  29.83  36.98  37.26  37.15  37.72  0.02 15.56  17.9
155   231.3   370.0   36.1   36.36  29.87  37.06  37.43  37.26  37.93  0.02 15.48  17.7
156   222.9   369.6   43.3   36.48  29.92  37.15  37.57  37.39  38.11  0.05 15.49  18.5
157   211.3   369.6   54.0   36.61  29.98  37.27  37.72  37.55  38.29  0.09 15.54  19.8
158   202.2   369.6   62.5   36.71  30.02  37.37  37.82  37.66  38.41  0.13 15.57  20.8
159   192.0   369.6   72.0   36.81  30.06  37.47  37.93  37.79  38.53  0.17 15.61  21.9
160   180.4   369.6   82.8   36.92  30.11  37.59  38.04  37.92  38.66  0.22 15.66  23.2
161   171.0   369.6   91.6   37.01  30.15  37.69  38.13  38.02  38.76  0.25 15.70  24.3
162   161.5   369.6  100.5   37.10  30.21  37.80  38.22  38.14  38.86  0.29 15.74  25.3
163   154.5   369.6  107.0   37.17  30.25  37.87  38.28  38.21  38.93  0.32 15.77  26.1
164   144.4   369.6  116.4   37.26  30.31  37.97  38.36  38.31  39.02  0.37 15.81  27.3
165   135.1   369.6  125.1   37.35  30.37  38.07  38.43  38.40  39.10  0.41 15.85  28.4
166   129.0   369.6  130.8   37.40  30.41  38.13  38.47  38.46  39.16  0.44 15.88  29.2
167   121.4   369.6  137.9   37.47  30.45  38.20  38.57  38.53  39.22  0.47 15.91  30.0
168   112.4   369.6  146.3   37.54  30.51  38.29  38.63  38.61  39.29  0.51 15.95  31.1
169   107.7   369.6  150.7   37.58  30.54  38.34  38.68  38.65  39.33  0.53 15.97  31.6
170   100.1   369.6  157.7   37.65  30.60  38.42  38.67  38.72  39.39  0.56 16.01  32.7
171    93.5   369.6  163.9   37.70  30.64  38.48  38.76  38.77  39.44  0.59 16.04  33.4
172    88.6   369.6  168.5   37.73  30.66  38.52  38.80  38.80  39.46  0.61 16.06  33.9
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TIME    S.       M.      EV.    TB    TS    TH    TO    TR    TM     SBF    CO    COND
173    81.5.   369.6.  175.2. 37.79 30.71 38.58 38.77 38.85 39.52  0.65  16.09  35.1.
174    76.7.   369.6.  179.7. 37.82 30.73 38.62 38.86 38.88 39.54  0.67  16.11  35.4.
175    73.8.   369.6.  182.4. 37.86 30.76 38.66 38.89 38.92 39.57  0.68  16.12  35.8.
176    69.2.   369.6.  186.7. 37.90 30.79 38.71 38.92 38.95 39.60  0.70  16.14  36.3.
177    64.7.   369.6.  191.0. 37.93 30.82 38.75 38.90 38.98 39.63  0.72  16.16  37.1.
178    60.5.   369.6.  194.9. 37.96 30.84 38.79 38.94 39.01 39.66  0.74  16.18  37.6.
179    53.1.   369.6.  202.0. 38.00 30.86 38.82 38.97 39.04 39.68  0.77  16.21  38.4.
180    50.0.   369.6.  204.9. 38.02 30.88 38.85 38.95 39.06 39.70  0.78  16.23  39.0.
181  -180.4.    36.9.  136.1. 37.92 31.36 38.72 37.98 38.84 39.54  0.81   5.78  32.0.
182  -176.0.    36.9.  130.7. 37.83 31.51 38.54 37.80 38.58 39.41  0.76   5.73  33.0.
183  -168.5.    36.9.  122.9. 37.74 31.57 38.36 37.67 38.34 39.26  0.68   5.66  32.8.
184  -158.7.    36.9.  113.2. 37.65 31.56 38.21 37.57 38.15 39.13  0.61   5.58  31.7.
185  -148.4.    36.9.  103.2. 37.57 31.49 38.05 37.49 37.98 38.99  0.53   5.50  30.1.
186  -139.9.    36.9.   95.2. 37.49 31.41 37.93 37.43 37.85 38.86  0.46   5.43  28.6.
187  -131.5.    36.9.   87.5. 37.41 31.29 37.82 37.38 37.74 38.73  0.39   5.36  26.9.
188  -125.3.    36.9.   82.0. 37.35 31.19 37.74 37.34 37.67 38.62  0.34   5.32  25.6.
189  -116.4.    36.9.   73.7. 37.29 31.10 37.66 37.32 37.61 38.51  0.30   5.28  23.9.
190  -108.4.    36.9.   66.4. 37.23 31.03 37.60 37.29 37.56 38.40  0.27   5.24  22.4.
191  -101.5.    36.9.   59.9. 37.16 30.96 37.53 37.27 37.51 38.28  0.23   5.21  21.2.
192   -97.3.    36.9.   56.0. 37.12 30.93 37.50 37.25 37.48 38.20  0.22   5.19  20.4.
193   -91.8.    36.9.   50.9. 37.06 30.87 37.45 37.24 37.45 38.07  0.19   5.17  19.4.
194   -88.5.    36.9.   47.8. 37.02 30.84 37.42 37.23 37.43 37.99  0.18   5.15  18.9.
195   -85.4.    36.9.   45.1. 36.98 30.81 37.39 37.22 37.42 37.90  0.17   5.14  18.3.
196   -82.6.    36.9.   42.5. 36.94 30.78 37.37 37.21 37.40 37.81  0.15   5.13  17.8.
197   -80.0.    36.9.   40.2. 36.89 30.75 37.34 37.21 37.39 37.73  0.14   5.12  17.3.
198   -77.7.    36.9.   38.1. 36.85 30.72 37.32 37.20 37.38 37.64  0.13   5.11  16.9.
199   -75.0.    36.9.   35.7. 36.81 30.68 37.30 37.19 37.37 37.55  0.12   5.10  16.4.
200   -73.1.    36.9.   34.1. 36.76 30.65 37.29 37.19 37.36 37.45  0.12   5.09  16.1.
201   -71.9.    36.9.   33.1. 36.73 30.62 37.27 37.18 37.36 37.40  0.11   5.09  15.8.
202   -69.9.    36.9.   31.3. 36.70 30.59 37.26 37.18 37.35 37.32  0.10   5.08  15.5.
203   -68.3.    36.9.   30.0. 36.65 30.56 37.25 37.18 37.35 37.23  0.10   5.07  15.1.
204   -67.2.    36.9.   29.1. 36.63 30.54 37.24 37.17 37.34 37.17  0.09   5.07  14.9.
205   -65.5.    36.9.   27.6. 36.59 30.51 37.23 37.17 37.34 37.10  0.09   5.06  14.6.
206   -64.2.    36.9.   26.6. 36.55 30.48 37.22 37.17 37.33 37.01  0.08   5.06  14.4.
207   -63.2.    36.9.   25.8. 36.52 30.46 37.21 37.16 37.33 36.96  0.08   5.06  14.2.
208   -61.8.    36.9.   24.6. 36.49 30.43 37.20 37.16 37.33 36.89  0.08   5.05  13.9.
209   -60.7.    36.9.   23.7. 36.45 30.39 37.19 37.16 37.32 36.80  0.07   5.05  13.7.
210   -59.9.    36.9.   23.1. 36.42 30.37 37.19 37.15 37.32 36.75  0.07   5.05  13.5.
```

TABLE 6

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
1	0.4.	36.9.	9.5.	36.29	34.75	37.06	36.97	37.11	35.81	0.19	5.17	14.
2	0.3.	36.9.	10.0.	36.29	34.74	37.06	36.97	37.12	35.81	0.18	5.15	14.
3	0.3.	36.9.	10.0.	36.29	34.73	37.06	36.97	37.12	35.81	0.17	5.15	14.
4	-0.2.	36.9.	10.8.	36.29	34.71	37.06	36.97	37.12	35.81	0.17	5.15	14.
5	-0.3.	36.9.	10.9.	36.29	34.70	37.06	36.98	37.12	35.81	0.17	5.15	14.
6	-0.6.	36.9.	11.3.	36.29	34.68	37.07	36.98	37.12	35.81	0.17	5.14	14.
7	-0.8.	36.9.	11.6.	36.29	34.67	37.07	36.98	37.12	35.81	0.17	5.14	14.
8	-1.1.	36.9.	12.1.	36.29	34.65	37.07	36.98	37.12	35.81	0.17	5.14	14.
9	-1.3.	36.9.	12.3.	36.29	34.64	37.07	36.98	37.13	35.81	0.17	5.14	14.3
10	-1.4.	36.9.	12.6.	36.29	34.63	37.07	36.98	37.13	35.81	0.16	5.14	14.2
11	-1.5.	36.9.	12.8.	36.29	34.62	37.07	36.98	37.13	35.81	0.16	5.14	14.2
12	-1.7.	36.9.	13.0.	36.29	34.61	37.07	36.98	37.13	35.81	0.16	5.14	14.2
13	-1.7.	36.9.	13.1.	36.29	34.59	37.07	36.98	37.13	35.81	0.16	5.14	14.2
14	-1.8.	36.9.	13.3.	36.29	34.59	37.07	36.98	37.13	35.81	0.16	5.13	14.2.
15	-1.8.	36.9.	13.3.	36.28	34.58	37.07	36.98	37.13	35.81	0.16	5.13	14.1.
16	-1.9.	36.9.	13.5.	36.28	34.57	37.07	36.99	37.13	35.81	0.16	5.13	14.1.
17	-2.0.	36.9.	13.7.	36.28	34.56	37.08	36.99	37.13	35.81	0.16	5.13	14.0.
18	-2.0.	36.9.	13.7.	36.28	34.55	37.08	36.99	37.13	35.81	0.15	5.13	14.0.
19	-2.1.	36.9.	13.9.	36.28	34.54	37.08	36.99	37.13	35.81	0.15	5.13	13.9.
20	-2.1.	36.9.	14.0.	36.28	34.52	37.08	36.99	37.13	35.81	0.15	5.13	13.9.
21	-2.1.	36.9.	14.1.	36.28	34.52	37.08	36.99	37.13	35.81	0.15	5.13	13.8.
22	-2.2.	36.9.	14.2.	36.28	34.51	37.08	36.99	37.14	35.81	0.15	5.13	13.8.
23	-2.2.	36.9.	14.3.	36.27	34.50	37.08	36.99	37.14	35.81	0.15	5.12	13.8.
24	-2.2.	36.9.	14.4.	36.27	34.49	37.08	36.99	37.14	35.80	0.15	5.12	13.7.
25	-2.2.	36.9.	14.5.	36.27	34.48	37.08	36.99	37.14	35.80	0.15	5.12	13.6.
26	-2.2.	36.9.	14.5.	36.27	34.47	37.08	36.99	37.14	35.80	0.15	5.12	13.6.
27	-2.2.	36.9.	14.6.	36.27	34.46	37.08	36.99	37.14	35.80	0.15	5.12	13.6.
28	-2.2.	36.9.	14.7.	36.27	34.45	37.08	36.99	37.14	35.80	0.15	5.12	13.5.
29	-2.3.	36.9.	14.7.	36.27	34.44	37.08	36.99	37.14	35.80	0.14	5.12	13.5.
30	-2.3.	36.9.	14.8.	36.27	34.44	37.08	36.99	37.14	35.80	0.14	5.12	13.5.
31	72.6.	123.8.	16.5.	36.30	34.36	37.02	36.68	37.05	36.13	0.10	7.81	19.9.
32	73.2.	124.0.	16.5.	36.34	34.33	36.97	36.69	36.98	36.33	0.09	7.81	19.5.
33	73.6.	124.2.	16.5.	36.37	34.31	36.93	36.71	36.93	36.53	0.09	7.81	19.0.
34	73.9.	124.3.	16.5.	36.42	34.30	36.89	36.74	36.90	36.73	0.09	7.81	18.6.
35	74.0.	124.4.	16.5.	36.46	34.30	36.89	36.78	36.90	36.85	0.08	7.81	18.4.
36	73.9.	124.4.	16.5.	36.49	34.31	36.89	36.80	36.91	36.93	0.08	7.81	18.3.
37	73.7.	124.4.	16.5.	36.53	34.33	36.89	36.84	36.93	37.04	0.09	7.81	18.2.
38	73.6.	124.4.	16.5.	36.57	34.34	36.91	36.89	36.96	37.13	0.09	7.81	18.0.
39	73.3.	124.3.	16.5.	36.61	34.37	36.93	36.94	37.00	37.23	0.09	7.81	18.0.
40	72.7.	124.2.	16.5.	36.65	34.39	36.96	36.98	37.03	37.29	0.09	7.81	18.0.
41	72.3.	124.0.	16.5.	36.71	34.43	37.01	37.05	37.10	37.40	0.09	7.81	17.9.
42	71.8.	123.9.	16.5.	36.72	34.44	37.02	37.06	37.11	37.41	0.10	7.81	18.0.
43	71.7.	123.9.	16.5.	36.76	34.46	37.05	37.10	37.15	37.47	0.10	7.81	17.9.

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
44	71.2.	123.8.	16.6.	36.80	34.49	37.09	37.15	37.20	37.54	0.10	7.81	18.0.
45	59.0.	123.8.	28.4.	36.83	34.49	37.12	37.15	37.23	37.58	0.19	7.89	22.5.
46	58.0.	123.8.	29.3.	36.86	34.47	37.15	37.19	37.26	37.62	0.19	7.90	22.4.
47	48.1.	123.8.	39.5.	36.89	34.44	37.18	37.20	37.29	37.66	0.26	7.97	25.7.
48	43.7.	123.8.	44.2.	36.92	34.39	37.21	37.23	37.32	37.71	0.28	7.99	26.6.
49	40.1.	123.8.	48.0.	36.94	34.35	37.24	37.25	37.35	37.75	0.31	8.01	27.2.
50	35.4.	123.8.	53.2.	36.96	34.31	37.25	37.26	37.36	37.77	0.33	8.04	28.4.
51	33.1.	123.8.	55.7.	36.97	34.28	37.27	37.27	37.38	37.79	0.34	8.05	28.7.
52	29.1.	123.8.	60.3.	36.99	34.23	37.29	37.28	37.40	37.81	0.36	8.07	29.4.
53	26.9.	123.8.	62.8.	37.00	34.20	37.30	37.30	37.41	37.83	0.37	8.08	29.6.
54	24.6.	123.8.	65.5.	37.02	34.14	37.33	37.31	37.43	37.86	0.38	8.09	29.7.
55	23.0.	123.8.	67.4.	37.03	34.11	37.34	37.32	37.44	37.87	0.39	8.09	29.8.
56	20.9.	123.8.	69.9.	37.04	34.07	37.35	37.33	37.45	37.89	0.39	8.10	30.0.
57	19.4.	123.8.	71.8.	37.05	34.03	37.36	37.34	37.46	37.90	0.40	8.11	30.1.
58	18.0.	123.8.	73.4.	37.06	34.00	37.37	37.35	37.48	37.92	0.40	8.11	30.1.
59	16.5.	123.8.	75.3.	37.07	33.97	37.38	37.36	37.49	37.93	0.41	8.12	30.2.
60	15.3.	123.8.	76.8.	37.08	33.91	37.40	37.37	37.50	37.95	0.41	8.12	29.9.
61	-52.8.	36.9.	68.5.	37.08	33.93	37.40	37.30	37.50	37.93	0.42	5.39	25.2.
62	-51.9.	36.9.	67.3.	37.05	33.97	37.38	37.20	37.46	37.87	0.41	5.39	26.0.
63	-46.7.	36.9.	61.9.	37.02	33.99	37.35	37.18	37.41	37.80	0.38	5.35	24.7.
64	-41.8.	36.9.	56.9.	36.99	34.01	37.31	37.16	37.37	37.71	0.34	5.32	23.5.
65	-39.0.	36.9.	54.0.	36.97	34.02	37.29	37.15	37.35	37.67	0.33	5.30	22.7
66	-36.5.	36.9.	51.4.	36.96	34.03	37.28	37.14	37.34	37.64	0.31	5.28	22.1.
67	-34.4.	36.9.	49.3.	36.94	34.05	37.26	37.13	37.32	37.58	0.30	5.27	21.6.
68	-31.9.	36.9.	46.7.	36.92	34.06	37.25	37.13	37.30	37.54	0.28	5.26	20.9.
69	-29.5.	36.9.	44.2.	36.91	34.07	37.24	37.12	37.30	37.50	0.26	5.24	20.2.
70	-27.5.	36.9.	42.1.	36.89	34.08	37.23	37.12	37.29	37.46	0.25	5.23	19.6.
71	-27.3.	36.9.	41.9.	36.88	34.09	37.22	37.11	37.28	37.42	0.25	5.23	19.6.
72	-25.7.	36.9.	40.2.	36.87	34.10	37.22	37.11	37.28	37.38	0.24	5.22	19.2.
73	-24.8.	36.9.	39.3.	36.85	34.11	37.21	37.11	37.27	37.33	0.24	5.21	18.9.
74	-23.8.	36.9.	38.3.	36.84	34.11	37.20	37.11	37.27	37.30	0.23	5.20	18.7.
75	-22.8.	36.9.	37.2.	36.82	34.12	37.20	37.10	37.26	37.26	0.22	5.20	18.4.
76	-21.7.	36.9.	36.1.	36.81	34.12	37.20	37.10	37.26	37.23	0.22	5.19	18.0.
77	-21.3.	36.9.	35.7.	36.80	34.12	37.19	37.10	37.26	37.20	0.22	5.19	17.9.
78	-20.8.	36.9.	35.3.	36.79	34.12	37.19	37.10	37.26	37.16	0.21	5.19	17.8.
79	-20.2.	36.9.	34.6.	36.78	34.12	37.19	37.10	37.25	37.13	0.21	5.18	17.5.
80	-19.6.	36.9.	34.1.	36.77	34.12	37.18	37.10	37.25	37.09	0.21	5.18	17.4.
81	-19.2.	36.9.	33.7.	36.76	34.12	37.18	37.10	37.25	37.08	0.20	5.18	17.2.
82	-18.9.	36.9.	33.4.	36.75	34.12	37.18	37.10	37.25	37.05	0.20	5.18	17.1.
83	-18.4.	36.9.	32.9.	36.74	34.11	37.18	37.09	37.25	37.02	0.20	5.17	16.9.
84	-18.1.	36.9.	32.6.	36.73	34.11	37.18	37.09	37.25	36.99	0.20	5.17	16.8.
85	-17.5.	36.9.	32.1.	36.72	34.11	37.18	37.09	37.25	36.97	0.20	5.17	16.6.
86	-17.2.	36.9.	31.8.	36.71	34.11	37.17	37.09	37.25	36.95	0.19	5.17	16.5.

TIME	S.	M.	EV.	TB	TS	TH	TO	TR	TM	SBF	CO	COND
87	-16.9.	36.9.	31.5.	36.70	34.10	37.17	37.09	37.24	36.91	0.19	5.17	16.4.
88	-16.6.	36.9.	31.3.	36.69	34.10	37.17	37.09	37.24	36.88	0.19	5.17	16.3.
89	-16.3.	36.9.	31.0.	36.68	34.10	37.17	37.09	37.24	36.87	0.19	5.16	16.2.
90	-16.0.	36.9.	30.7.	36.68	34.10	37.17	37.09	37.24	36.85	0.19	5.16	16.1.
91	147.9.	222.9.	43.0.	36.74	34.05	37.15	37.03	37.22	37.14	0.17	11.00	23.5.
92	149.0.	222.9.	41.9.	36.82	34.04	37.15	37.15	37.22	37.43	0.17	11.00	22.2.
93	145.6.	222.9.	45.2.	36.89	34.06	37.18	37.25	37.26	37.62	0.19	11.02	22.7.
94	138.5.	222.9.	52.0.	36.97	34.07	37.22	37.34	37.32	37.80	0.23	11.06	24.3.
95	127.8.	222.9.	62.5.	37.05	34.06	37.29	37.43	37.41	37.96	0.30	11.13	26.8.
96	118.8.	222.9.	71.5.	37.11	34.05	37.34	37.50	37.48	38.06	0.35	11.18	28.8.
97	108.5.	222.9.	81.9.	37.18	34.02	37.40	37.56	37.55	38.16	0.41	11.24	30.9.
98	97.4.	222.9.	93.1.	37.24	33.98	37.47	37.63	37.63	38.25	0.47	11.30	33.0.
99	91.2.	222.9.	99.6.	37.28	33.94	37.52	37.67	37.68	38.31	0.51	11.34	34.1.
100	85.2.	222.9.	105.8.	37.31	33.92	37.56	37.70	37.72	38.36	0.55	11.37	35.1.
101	74.7.	222.9.	116.7.	37.38	33.86	37.63	37.76	37.80	38.44	0.61	11.43	36.7.
102	69.2.	222.9.	122.5.	37.39	33.84	37.65	37.77	37.82	38.46	0.64	11.46	37.8.
103	65.7.	222.9.	126.3.	37.43	33.80	37.71	37.81	37.87	38.51	0.66	11.48	38.0.
104	59.2.	222.9.	133.1.	37.47	33.76	37.75	37.84	37.91	38.55	0.69	11.52	38.9.
105	52.5.	222.9.	140.3.	37.49	33.74	37.78	37.86	37.93	38.57	0.73	11.55	40.1.
106	48.2.	222.9.	144.9.	37.51	33.71	37.81	37.88	37.96	38.59	0.74	11.57	40.7.
107	44.2.	222.9.	149.2.	37.56	33.65	37.86	37.92	38.01	38.64	0.76	11.59	40.6.
108	40.6.	222.9.	153.2.	37.56	33.64	37.87	37.92	38.02	38.65	0.78	11.61	41.4.
109	40.0.	222.9.	153.8.	37.58	33.61	37.90	37.95	38.04	38.67	0.78	11.61	41.0.
110	34.7.	222.9.	159.7.	37.60	33.58	37.92	37.96	38.06	38.69	0.80	11.63	41.8.
111	32.1.	222.9.	162.5.	37.62	33.54	37.95	37.98	38.09	38.71	0.81	11.64	41.8.
112	30.3.	222.9.	164.6.	37.63	33.52	37.97	37.99	38.10	38.72	0.82	11.65	42.0.
113	27.0.	222.9.	168.3.	37.65	33.48	38.00	38.01	38.13	38.75	0.83	11.66	42.2.
114	25.5.	222.9.	169.9.	37.66	33.46	38.01	38.02	38.14	38.76	0.84	11.66	42.2.
115	23.5.	222.9.	172.2.	37.67	33.44	38.03	38.03	38.15	38.77	0.84	11.67	42.4.
116	21.9.	222.9.	174.0.	37.69	33.42	38.05	38.04	38.16	38.78	0.85	11.68	42.4.
117	20.0.	222.9.	176.2.	37.70	33.40	38.07	38.05	38.18	38.79	0.86	11.68	42.5.
118	18.7.	222.9.	177.6.	37.71	33.38	38.08	38.06	38.19	38.80	0.86	11.69	42.6.
119	17.5.	222.9.	179.0.	37.72	33.36	38.09	38.07	38.20	38.81	0.86	11.69	42.6.
120	16.4.	222.9.	180.2.	37.73	33.35	38.11	38.08	38.21	38.82	0.87	11.70	42.6.
121	-106.9.	36.9.	124.7.	37.67	33.64	38.03	37.52	38.09	38.74	0.92	5.90	35.8.
122	-100.1.	36.9.	116.8.	37.61	33.83	37.90	37.38	37.90	38.63	0.90	5.87	37.2.
123	-92.3.	36.9.	108.3.	37.55	33.93	37.78	37.30	37.75	38.54	0.84	5.81	37.0.
124	-86.2.	36.9.	101.8.	37.51	33.98	37.70	37.25	37.65	38.47	0.78	5.75	36.1.
125	-79.4.	36.9.	94.8.	37.47	33.99	37.61	37.21	37.55	38.40	0.69	5.67	34.6.
126	-72.0.	36.9.	87.4.	37.42	33.96	37.52	37.19	37.47	38.31	0.59	5.57	32.3.
127	-68.2.	36.9.	83.6.	37.40	33.94	37.48	37.18	37.43	38.26	0.54	5.51	30.9.
128	-59.4.	36.9.	75.2.	37.34	33.88	37.41	37.17	37.38	38.15	0.44	5.42	27.8.
129	-53.1.	36.9.	69.1.	37.32	33.87	37.38	37.16	37.36	38.09	0.40	5.37	25.9.

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TIME    S       M       EV     TB    TS    TH    TO    TR    TM     SBF   CO    COND
130   -46.8    36.9    62.9  37.30 33.87 37.36 37.16 37.34 38.04  0.36  5.33  24.0
131   -43.9    36.9    60.0  37.27 33.88 37.33 37.15 37.33 37.97  0.34  5.31  23.2
132   -40.8    36.9    56.7  37.25 33.89 37.32 37.15 37.32 37.93  0.32  5.29  22.3
133   -38.9    36.9    54.7  37.24 33.90 37.31 37.15 37.32 37.90  0.31  5.28  21.8
134   -37.5    36.9    53.3  37.22 33.91 37.30 37.15 37.32 37.84  0.30  5.27  21.5
135   -34.9    36.9    50.5  37.20 33.93 37.29 37.15 37.31 37.80  0.28  5.26  20.7
136   -33.9    36.9    49.5  37.18 33.93 37.28 37.15 37.31 37.76  0.28  5.25  20.5
137   -32.6    36.9    48.1  37.17 33.94 37.27 37.15 37.31 37.71  0.27  5.24  20.1
138   -32.4    36.9    47.9  37.15 33.95 37.27 37.15 37.31 37.67  0.27  5.24  20.1
139   -30.8    36.9    46.3  37.13 33.95 37.26 37.15 37.31 37.63  0.26  5.23  19.7
140   -30.7    36.9    46.2  37.11 33.96 37.26 37.15 37.31 37.59  0.26  5.23  19.7
141   -29.5    36.9    45.0  37.10 33.96 37.25 37.15 37.30 37.55  0.25  5.23  19.3
142   -28.9    36.9    44.4  37.07 33.96 37.25 37.15 37.30 37.48  0.25  5.22  19.2
143   -28.3    36.9    43.8  37.07 33.96 37.25 37.14 37.30 37.47  0.24  5.22  19.0
144   -27.8    36.9    43.3  37.04 33.97 37.24 37.14 37.30 37.41  0.24  5.22  18.8
145   -27.3    36.9    42.8  37.04 33.96 37.24 37.14 37.30 37.40  0.24  5.21  18.7
146   -27.2    36.9    42.7  37.02 33.96 37.24 37.14 37.30 37.37  0.24  5.21  18.6
147   -26.6    36.9    42.1  37.01 33.96 37.23 37.14 37.30 37.33  0.24  5.21  18.5
148   -26.0    36.9    41.5  37.00 33.96 37.23 37.14 37.30 37.31  0.23  5.21  18.3
149   -25.6    36.9    41.2  36.98 33.96 37.23 37.14 37.29 37.27  0.23  5.21  18.2
150   -25.1    36.9    40.7  36.96 33.96 37.22 37.13 37.29 37.24  0.23  5.20  18.0
151   270.4   369.6    68.2  37.03 33.93 37.23 37.31 37.31 37.50  0.23 15.67  27.9
152   259.6   369.6    79.0  37.19 33.92 37.31 37.58 37.42 37.98  0.30 15.74  28.8
153   245.1   369.6    93.2  37.30 33.93 37.39 37.74 37.54 38.25  0.38 15.82  31.3
154   226.4   369.6   111.7  37.43 33.92 37.51 37.90 37.69 38.49  0.50 15.94  34.7
155   204.0   369.6   133.9  37.56 33.92 37.66 38.06 37.87 38.71  0.64 16.08  38.8
156   188.3   369.6   149.6  37.66 33.91 37.76 38.15 37.99 38.84  0.74 16.18  41.6
157   170.2   369.6   167.7  37.76 33.90 37.88 38.25 38.12 38.97  0.85 16.29  44.6
158   157.0   369.6   180.9  37.83 33.88 37.97 38.33 38.22 39.05  0.92 16.36  46.7
159   143.2   369.6   194.9  37.90 33.85 38.07 38.42 38.31 39.13  0.99 16.44  48.5
160   131.3   369.6   206.9  38.00 33.87 38.19 38.52 38.43 39.24  1.09 16.54  50.1
161   124.6   369.6   213.4  38.05 33.91 38.26 38.57 38.50 39.29  1.17 16.61  51.6
162   112.4   369.6   224.8  38.11 34.03 38.34 38.53 38.57 39.35  1.33 16.77  56.0
163   101.5   369.6   234.6  38.17 34.16 38.40 38.62 38.61 39.38  1.49 16.93  59.0
164    89.5   369.6   244.9  38.22 34.34 38.45 38.61 38.65 39.40  1.70 17.14  64.4
165    78.2   369.6   254.4  38.26 34.54 38.49 38.58 38.68 39.41  1.95 17.39  71.0
166    64.9   369.6   265.2  38.30 34.81 38.52 38.51 38.68 39.41  2.35 17.80  81.1
167    44.7   369.6   281.1  38.32 35.25 38.52 38.37 38.66 39.37  3.59 19.03 102.6
168    22.0   369.6   300.3  38.34 35.61 38.50 38.38 38.61 39.29  3.77 19.21 123.8
169    18.4   369.6   303.3  38.35 35.66 38.49 38.38 38.58 39.27  3.74 19.19 127.4
170    18.0   369.6   303.6  38.36 35.67 38.48 38.38 38.56 39.26  3.73 19.17 127.8
171    18.5   369.6   303.0  38.37 35.67 38.48 38.38 38.55 39.26  3.71 19.15 128.0
172    18.6   369.6   302.9  38.38 35.68 38.48 38.37 38.54 39.26  3.71 19.15 128.3
```

TIME	S	M	EV	TB	TS	TH	TO	TR	TM	SBF	CO	COND
173	18.5	369.6	303.0	38.39	35.67	38.48	38.39	38.53	39.25	3.70	19.14	127.5
174	18.9	369.6	302.6	38.40	35.69	38.48	38.30	38.54	39.26	3.70	19.14	132.6
175	18.5	369.6	302.9	38.41	35.70	38.48	38.30	38.54	39.26	3.70	19.14	132.9
176	16.4	369.6	304.9	38.42	35.68	38.48	38.40	38.53	39.25	3.71	19.16	128.1
177	17.8	369.6	303.6	38.43	35.71	38.48	38.30	38.54	39.26	3.70	19.14	133.5
178	17.2	369.6	304.2	38.44	35.71	38.48	38.30	38.54	39.27	3.70	19.15	134.1
179	14.9	369.6	306.3	38.44	35.70	38.48	38.40	38.53	39.26	3.72	19.17	129.3
180	16.2	369.6	305.1	38.45	35.72	38.49	38.30	38.54	39.27	3.71	19.16	134.9
181	-174.8	36.9	177.4	38.37	35.86	38.34	37.47	38.32	39.19	3.51	8.48	128.6
182	-167.4	36.9	170.9	38.27	35.70	38.14	37.33	38.04	39.11	3.06	8.04	122.4
183	-149.9	36.9	154.5	38.19	35.54	37.96	37.21	37.82	39.02	2.61	7.58	108.7
184	-137.8	36.9	143.1	38.13	35.44	37.84	37.15	37.68	38.96	2.31	7.28	99.6
185	-116.3	36.9	122.5	38.04	35.32	37.67	37.08	37.51	38.86	1.87	6.84	84.4
186	-102.3	36.9	108.9	37.99	35.25	37.57	37.05	37.41	38.79	1.59	6.57	75.0
187	-90.7	36.9	97.6	37.95	35.19	37.48	37.03	37.34	38.72	1.36	6.34	67.0
188	-81.1	36.9	88.4	37.91	35.14	37.41	37.01	37.29	38.66	1.17	6.14	60.4
189	-68.3	36.9	76.1	37.86	35.04	37.34	37.05	37.24	38.57	0.81	5.78	50.0
190	-59.1	36.9	67.2	37.83	35.00	37.31	37.06	37.23	38.53	0.66	5.63	44.3
191	-52.2	36.9	60.6	37.80	34.95	37.28	37.08	37.23	38.44	0.56	5.54	39.6
192	-49.0	36.9	57.5	37.78	34.94	37.27	37.09	37.24	38.40	0.53	5.50	37.7
193	-46.4	36.9	55.1	37.75	34.93	37.26	37.10	37.24	38.35	0.50	5.47	36.1
194	-43.5	36.9	52.2	37.73	34.91	37.25	37.11	37.25	38.29	0.47	5.44	34.5
195	-42.4	36.9	51.2	37.71	34.91	37.25	37.11	37.26	38.24	0.46	5.43	33.7
196	-41.5	36.9	50.4	37.68	34.90	37.25	37.12	37.26	38.20	0.45	5.42	33.1
197	-40.7	36.9	49.7	37.66	34.88	37.24	37.12	37.27	38.15	0.44	5.42	32.6
198	-40.6	36.9	49.6	37.64	34.87	37.24	37.13	37.28	38.10	0.44	5.42	32.3
199	-40.0	36.9	49.1	37.62	34.86	37.24	37.13	37.28	38.06	0.43	5.41	31.8
200	-39.4	36.9	48.7	37.59	34.84	37.24	37.13	37.28	38.01	0.43	5.40	31.2
201	-38.9	36.9	48.2	37.58	34.82	37.24	37.13	37.29	37.97	0.41	5.39	30.7
202	-38.5	36.9	48.0	37.55	34.80	37.24	37.14	37.29	37.92	0.41	5.38	30.2
203	-38.1	36.9	47.8	37.53	34.77	37.24	37.14	37.29	37.88	0.40	5.37	29.7
204	-37.6	36.9	47.5	37.51	34.75	37.24	37.14	37.29	37.84	0.39	5.36	29.2
205	-37.2	36.9	47.2	37.49	34.72	37.24	37.14	37.30	37.80	0.38	5.36	28.6
206	-36.8	36.9	47.0	37.48	34.71	37.24	37.14	37.30	37.79	0.37	5.35	28.4
207	-36.4	36.9	46.8	37.45	34.67	37.24	37.14	37.30	37.72	0.37	5.34	27.7
208	-36.0	36.9	46.6	37.43	34.65	37.24	37.14	37.30	37.69	0.36	5.34	27.3
209	-35.6	36.9	46.4	37.41	34.62	37.23	37.14	37.30	37.66	0.35	5.33	26.8
210	-35.2	36.9	46.1	37.39	34.60	37.23	37.14	37.30	37.62	0.35	5.32	26.4

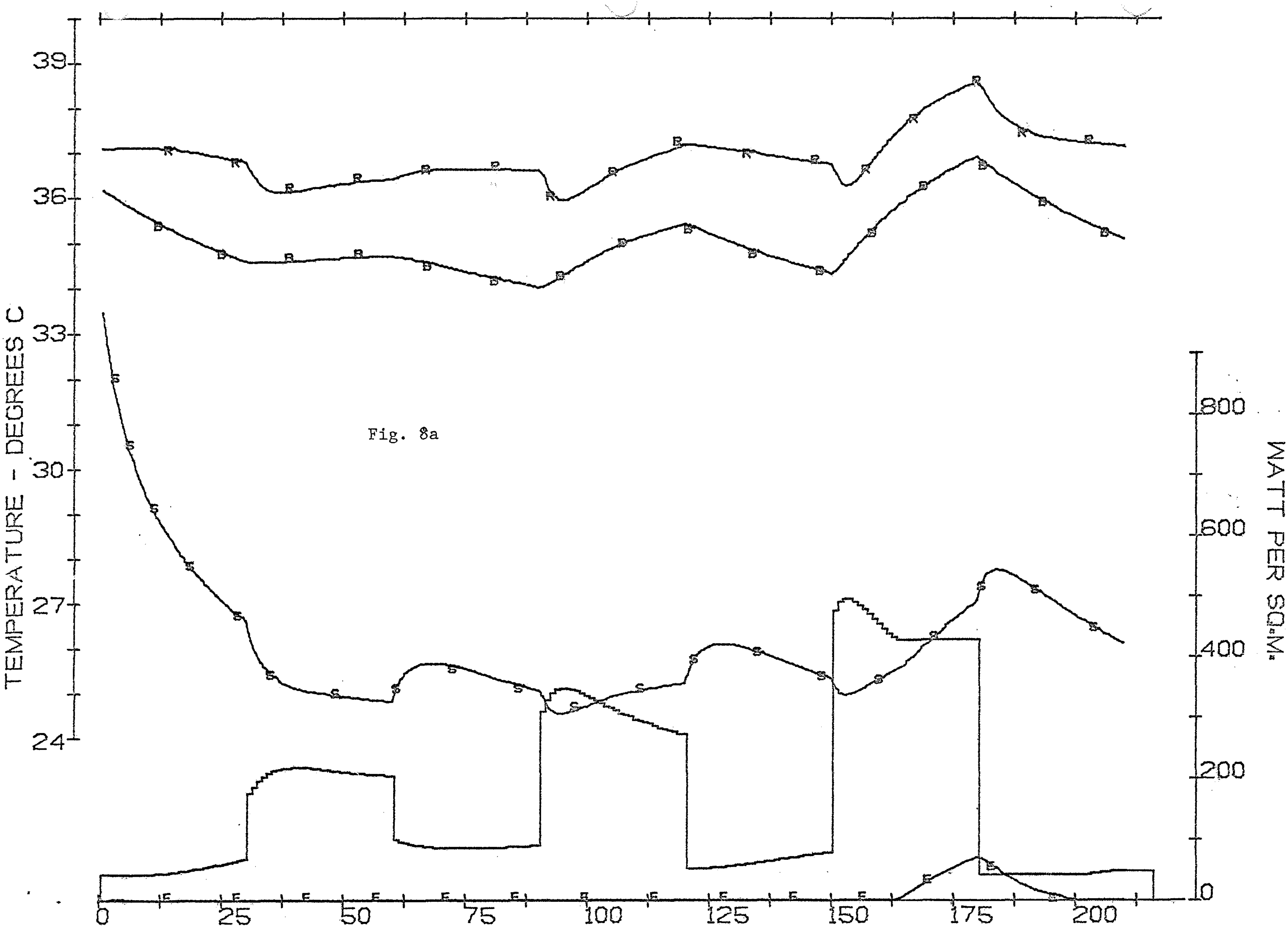
Some of the values obtained in the simulation runs are also presented in graphical form together with experimental data obtained from subject PM who was closest to the values adopted for surface area and maximum aerobic capacity. All of the graphs in Fig. 8 refer to the 10°C environment, Fig. 9 and Fig. 10 refer to the 20°C and the 30°C environment respectively. The format of the figures is similar to that used in presenting the experimental data in preceding parts of this report.

Sub-figure a gives for the simulation run the rectal temperature and the computed average body temperature, the mean weighted skin temperature, the time course of oxygen consumption, and of sweat evaporation.

Sub-figure b gives the same data as obtained in an individual experimental run.

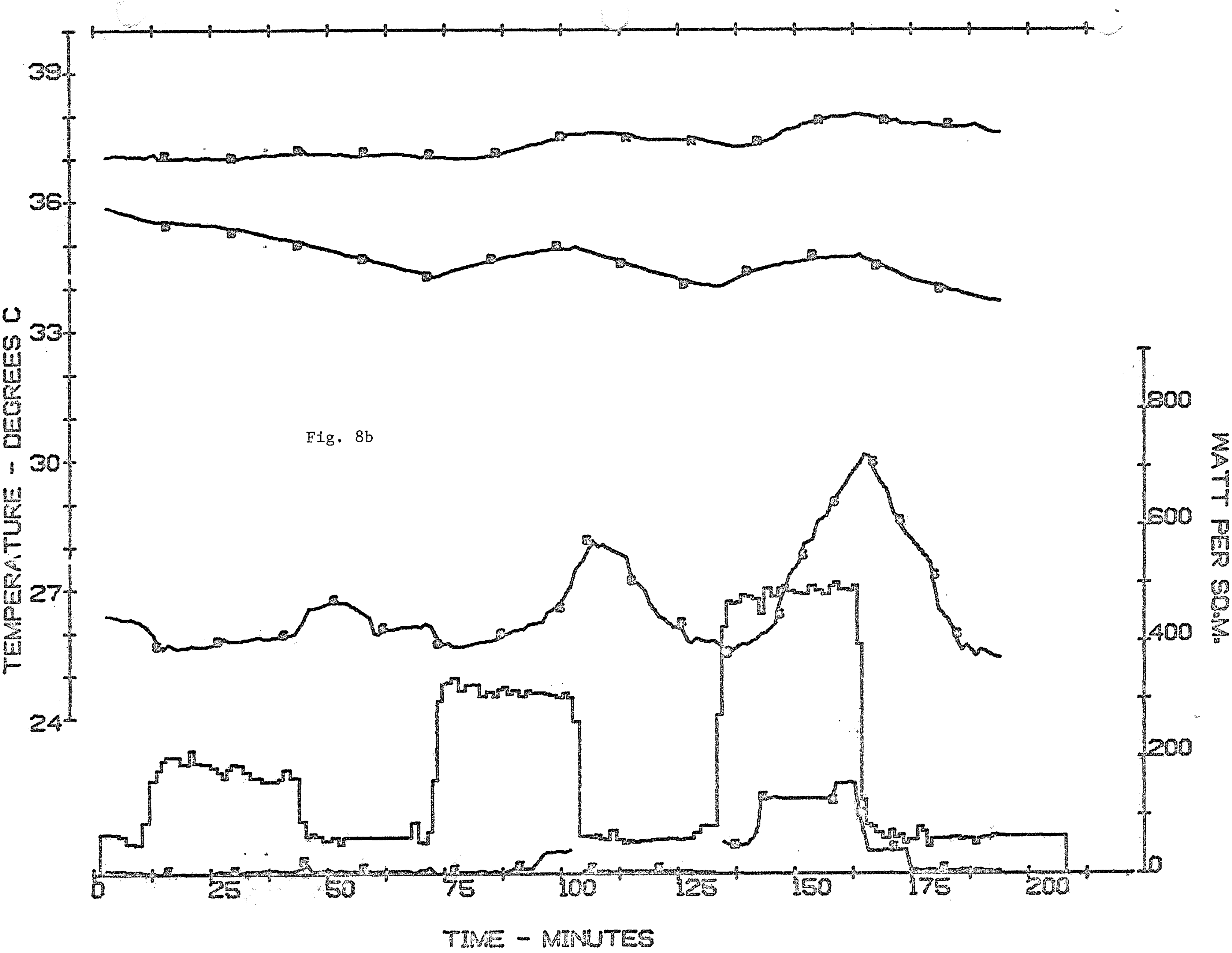
Sub-figure c gives the time course of the rectal temperature, the central blood temperature, the computed average body temperature, and the temperature of the working muscle in the leg.

Sub-figure d gives the time course of measured rectal temperature, oesophageal temperature, muscle temperature in the thigh, and the computed average body temperature in an individual experimental run.



39
36
33
30
27
24
TEMPERATURE - DEGREES C
800
600
400
200
0
WATT PER SQ.M.
0
25
50
75
100
125
150
175
200
TIME - MINUTES
R
B
S
E

Fig. 8a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36
33
30
27
24
TEMPERATURE - DEGREES C
800
600
400
200
0
WATT PER SQ.M.
0
25
50
75
100
125
150
175
200
TIME - MINUTES

Fig. 8b

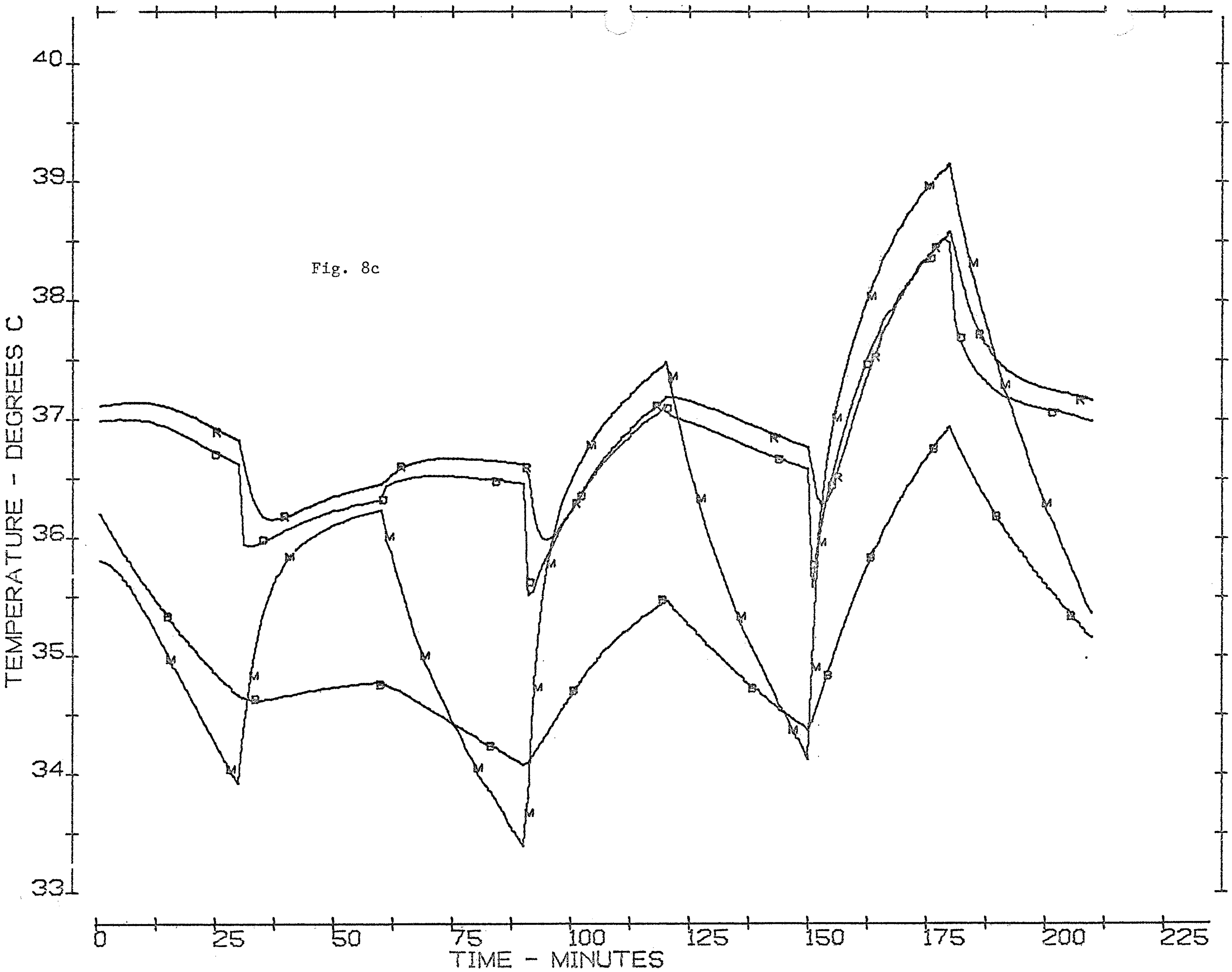
Fig. 8c
TEMPERATURE - DEGREES C
TIME - MINUTES
33
34
35
36
37
38
39
40
0
25
50
75
100
125
150
175
200
225
R
D
M
B

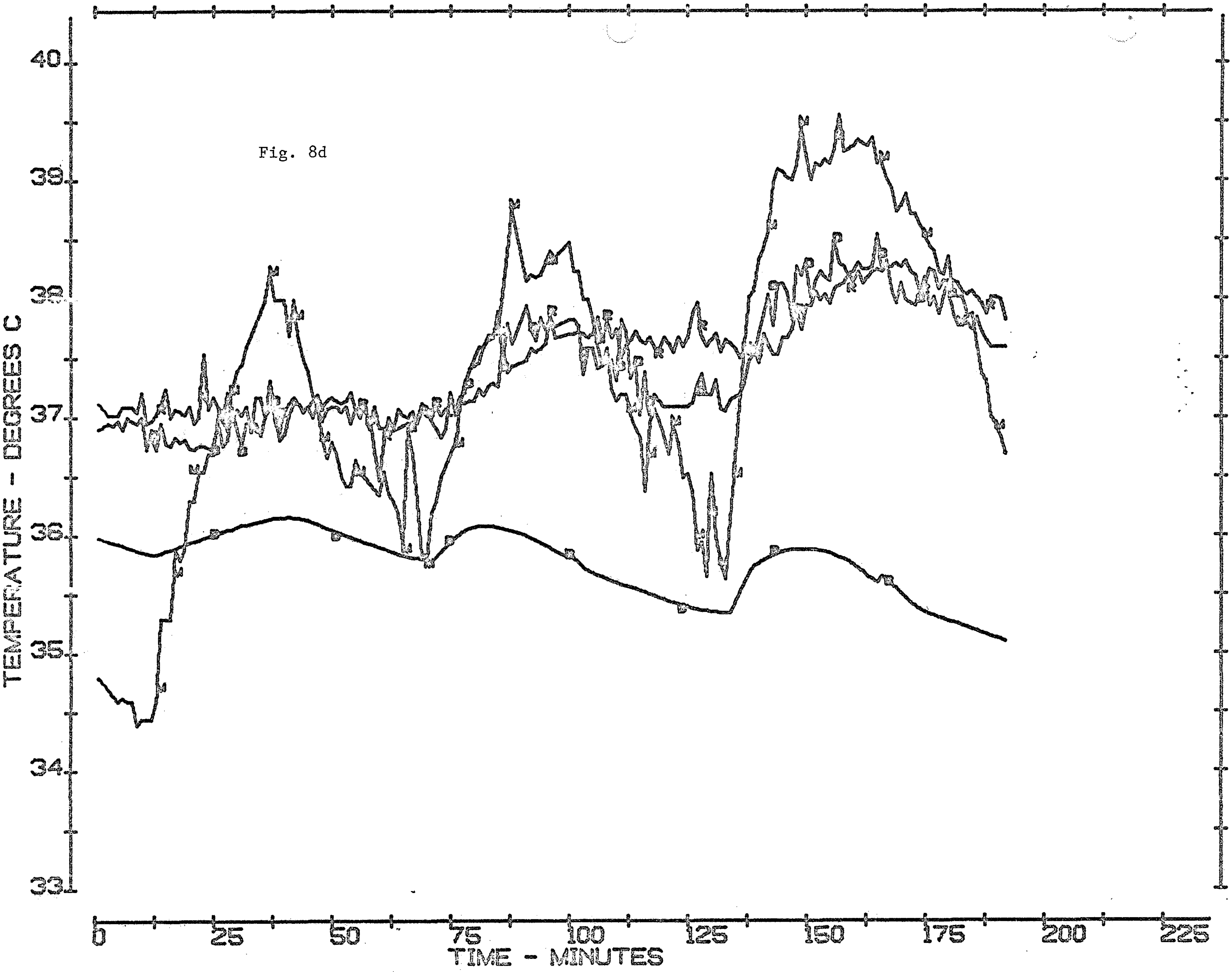

Fig. 8d
TEMPERATURE - DEGREES C
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39
38
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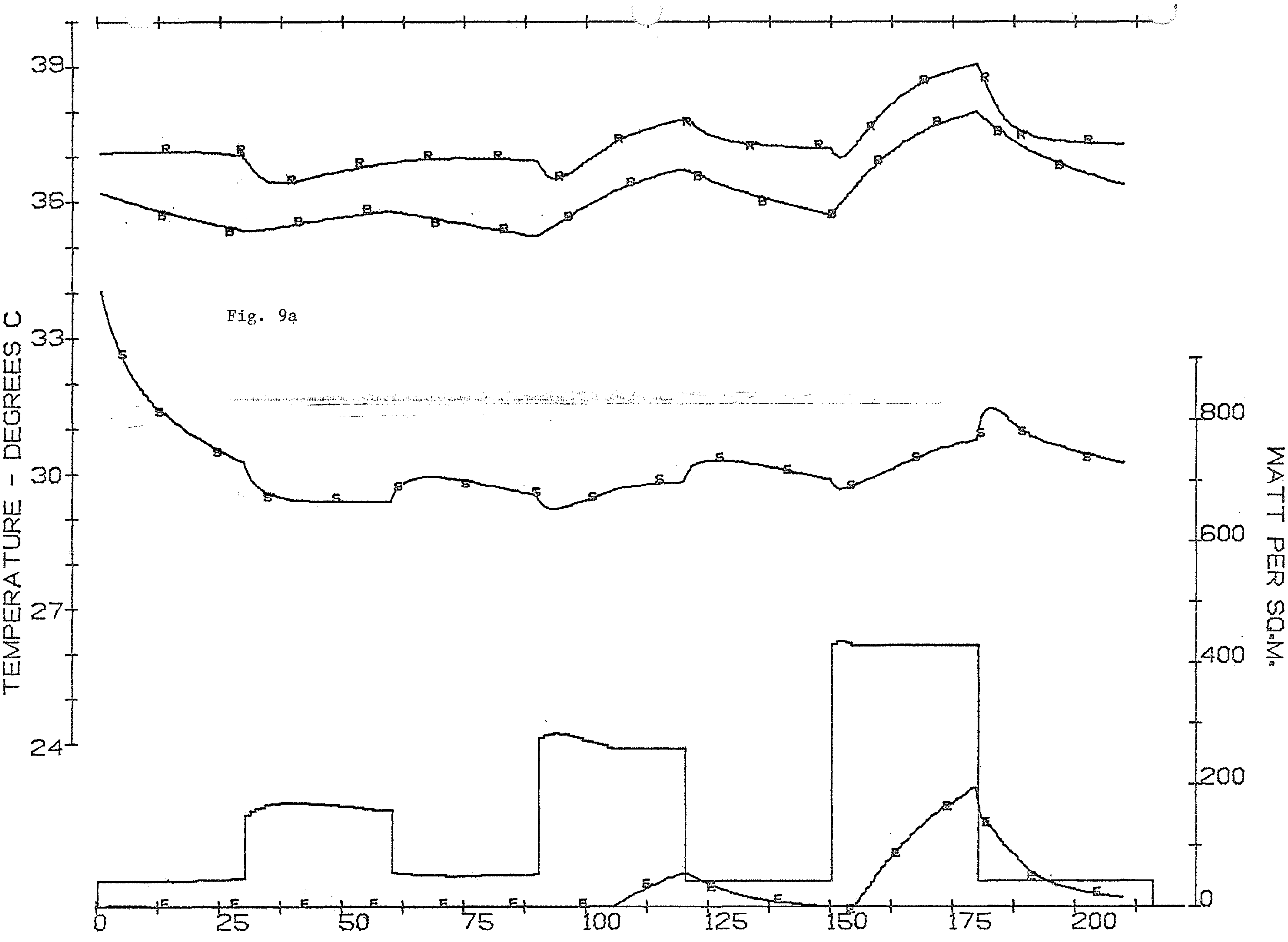
36
35
34
33
0
25
50
75
100
125
150
175
200
225
TIME - MINUTES


39
36
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27
24
TEMPERATURE - DEGREES C
800
600
400
200
0
WATT PER SQ.M.
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25
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75
100
125
150
175
200
TIME - MINUTES
R
B
S
E

Fig. 9a

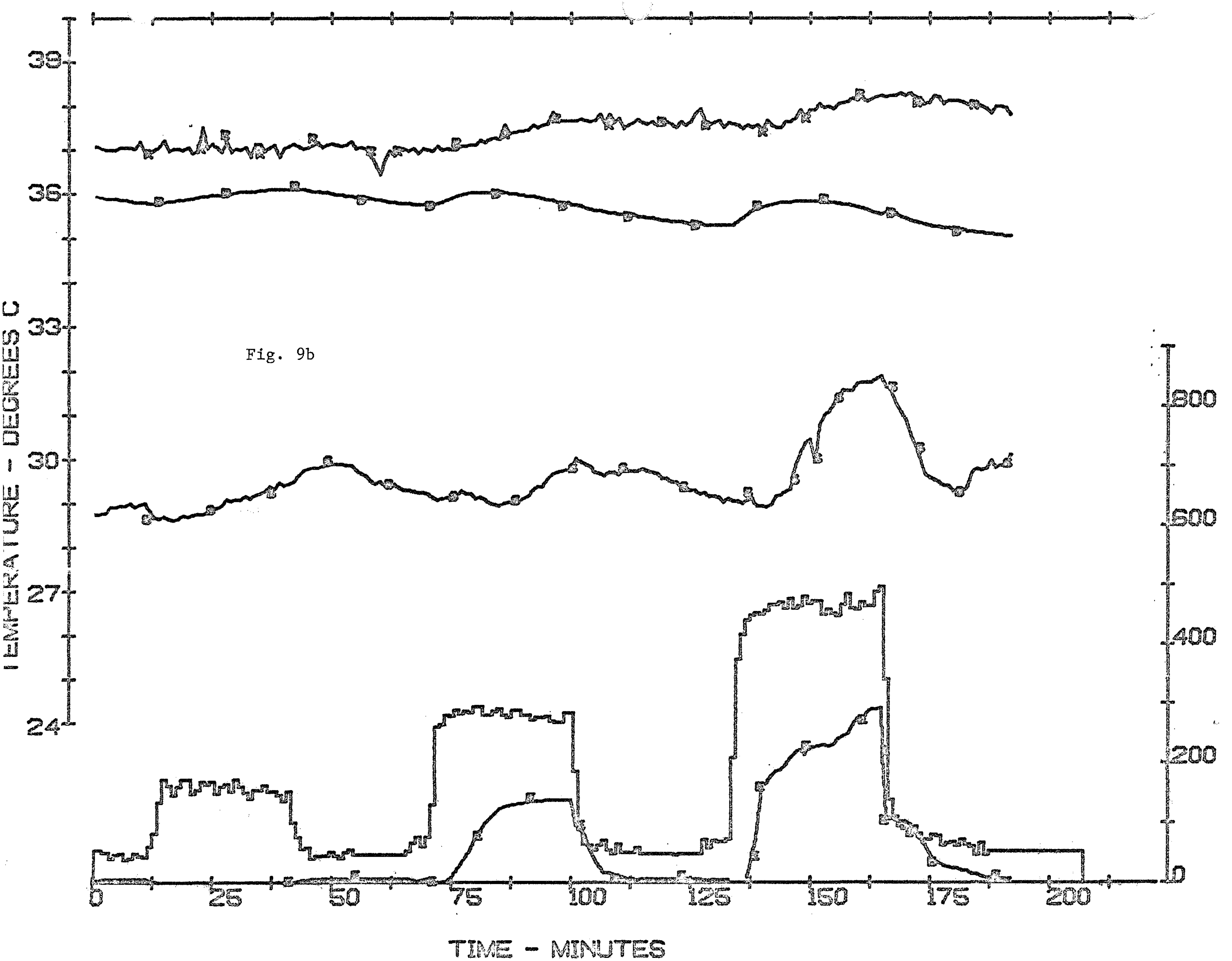
TEMPERATURE - DEGREES C
39
36
33
30
27
24
WATT PER SQ.M.
800
600
400
200
0
0
25
50
75
100
125
150
175
200
TIME - MINUTES

Fig. 9b

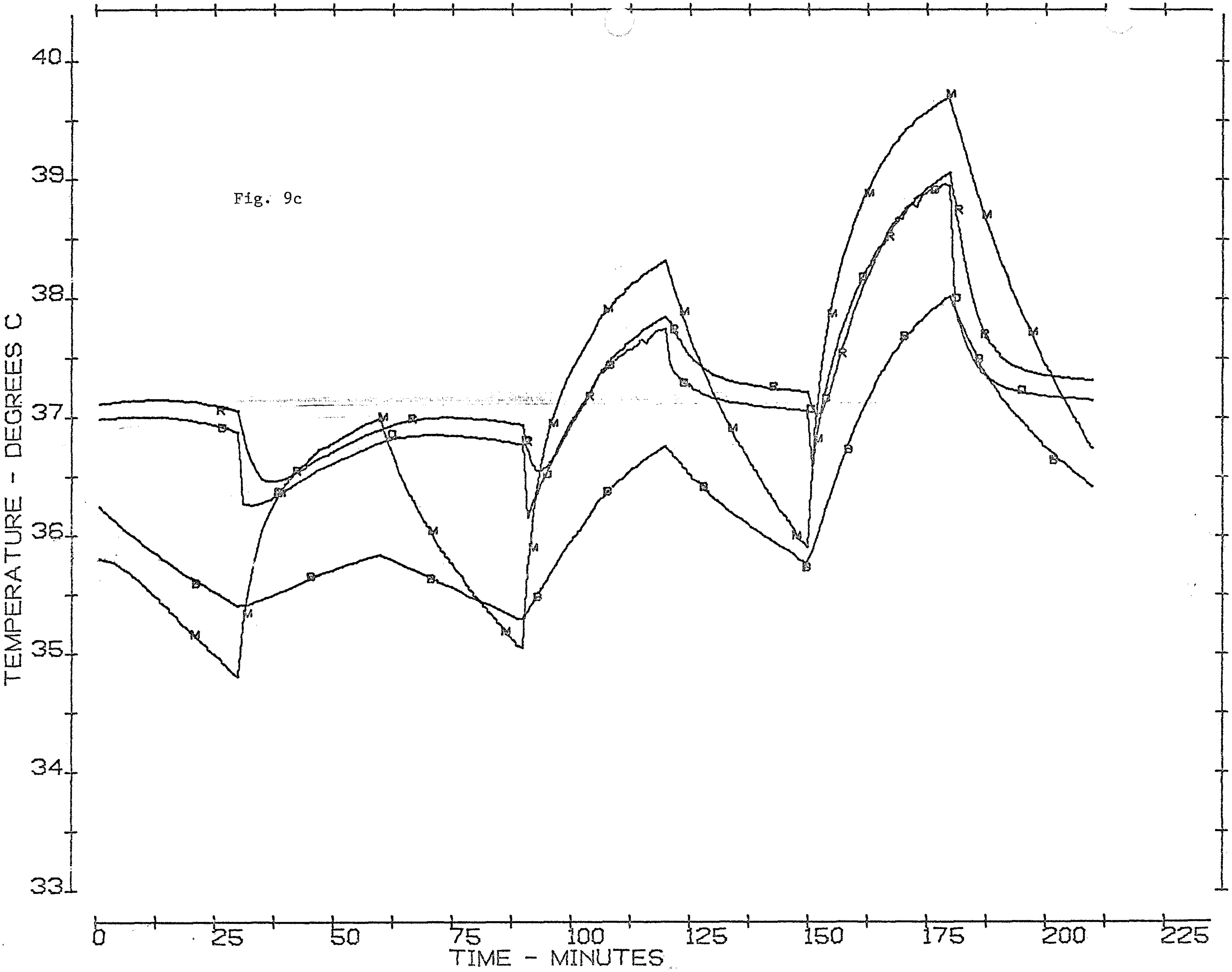

Fig. 9c
TEMPERATURE - DEGREES C
TIME - MINUTES
33
34
35
36
37
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39
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75
100
125
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175
200
225
M
R
B
D

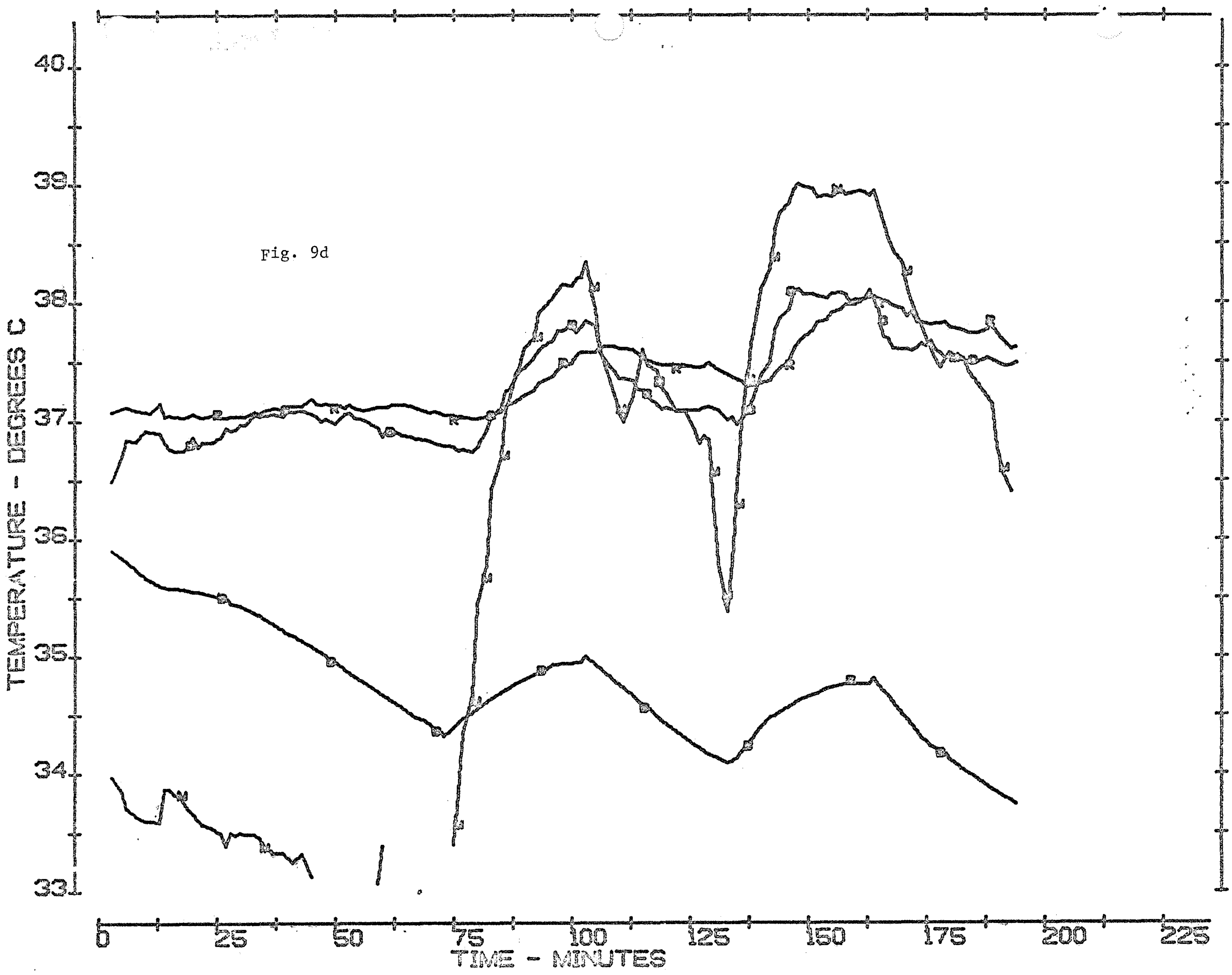
Fig. 9d
TEMPERATURE - DEGREES C
TIME - MINUTES
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39
38
37
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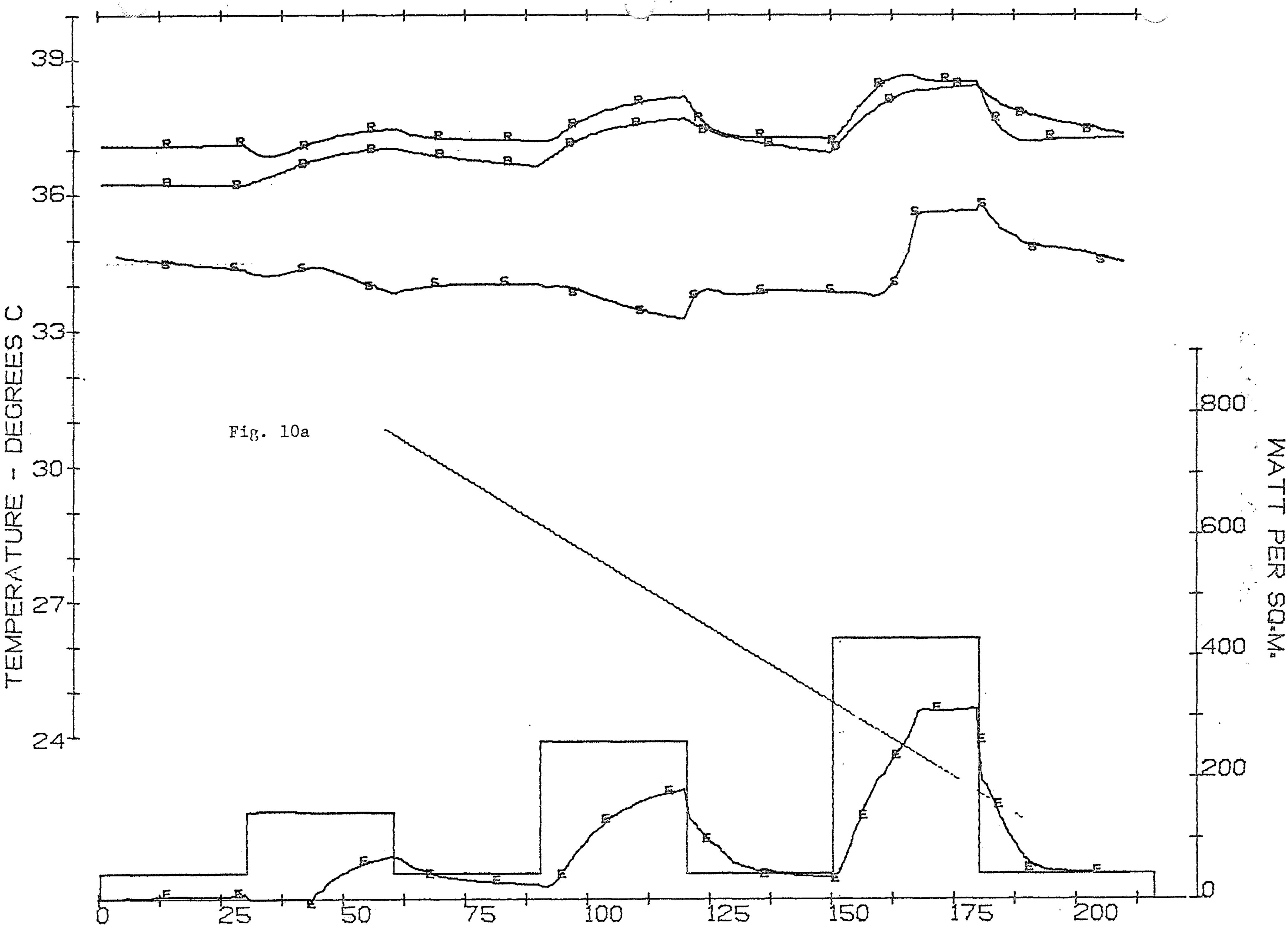
39
36
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27
24
TEMPERATURE - DEGREES C
R
B
S
E
800
600
400
200
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WATT PER SQ.M.
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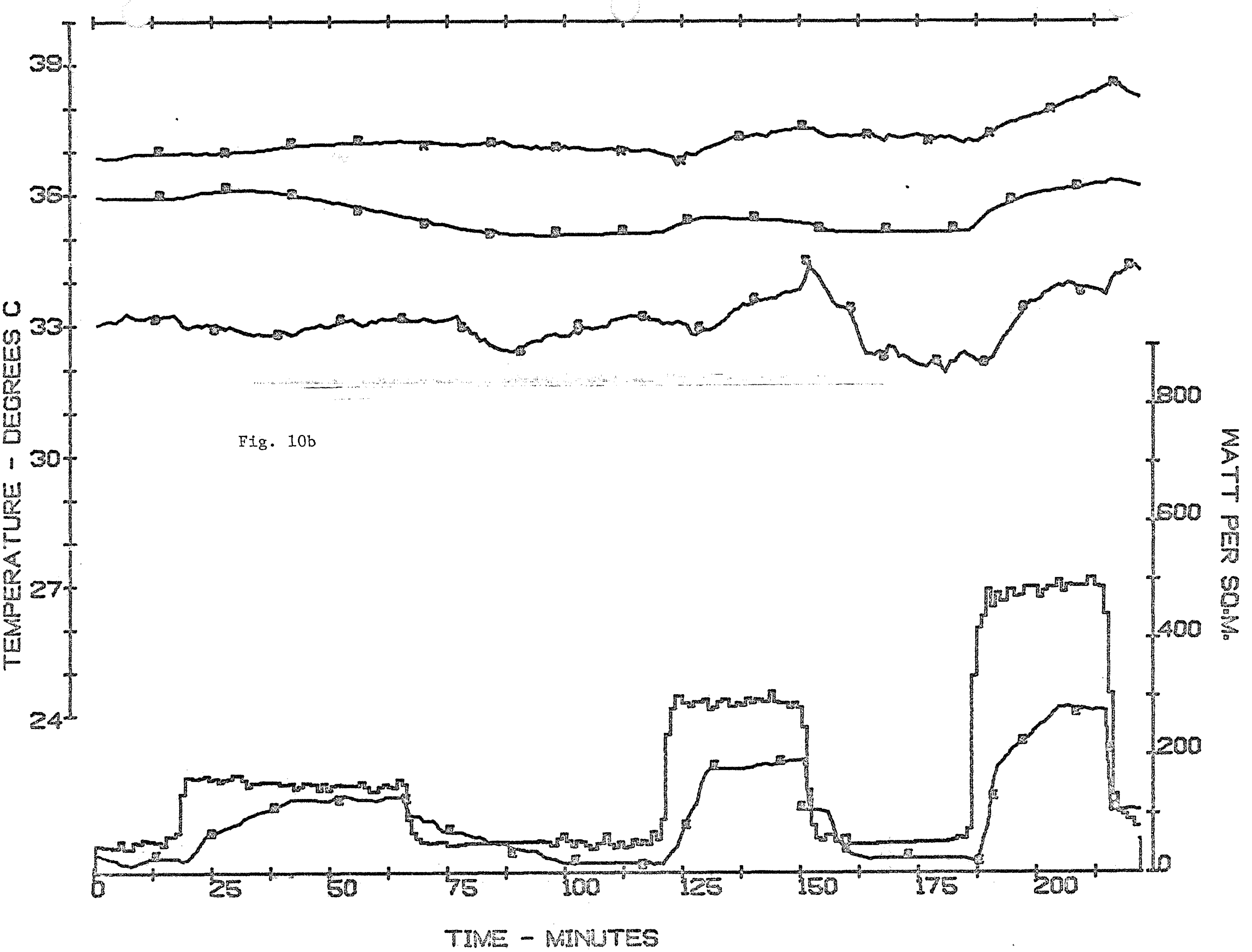
75
100
125
150
175
200
TIME - MINUTES

Fig. 10a


TEMPERATURE - DEGREES C
39
36
33
30
27
24
WATT PER SQ.M.
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600
400
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25
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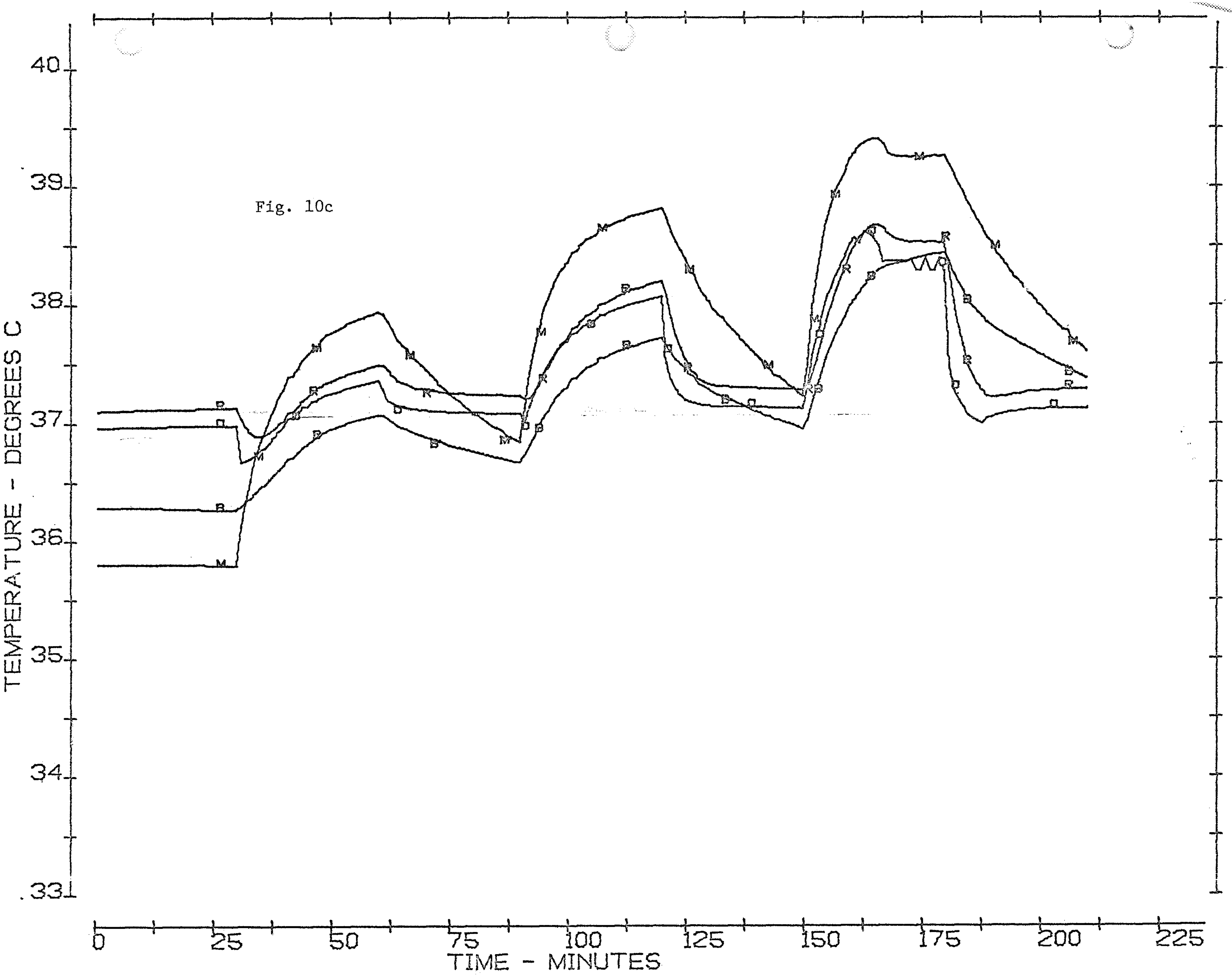
75
100
125
150
175
200
TIME - MINUTES

Fig. 10b



40
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TEMPERATURE - DEGREES C
0
25
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75
100
125
150
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200
225
TIME - MINUTES
M
R
D
B

Fig. 10c

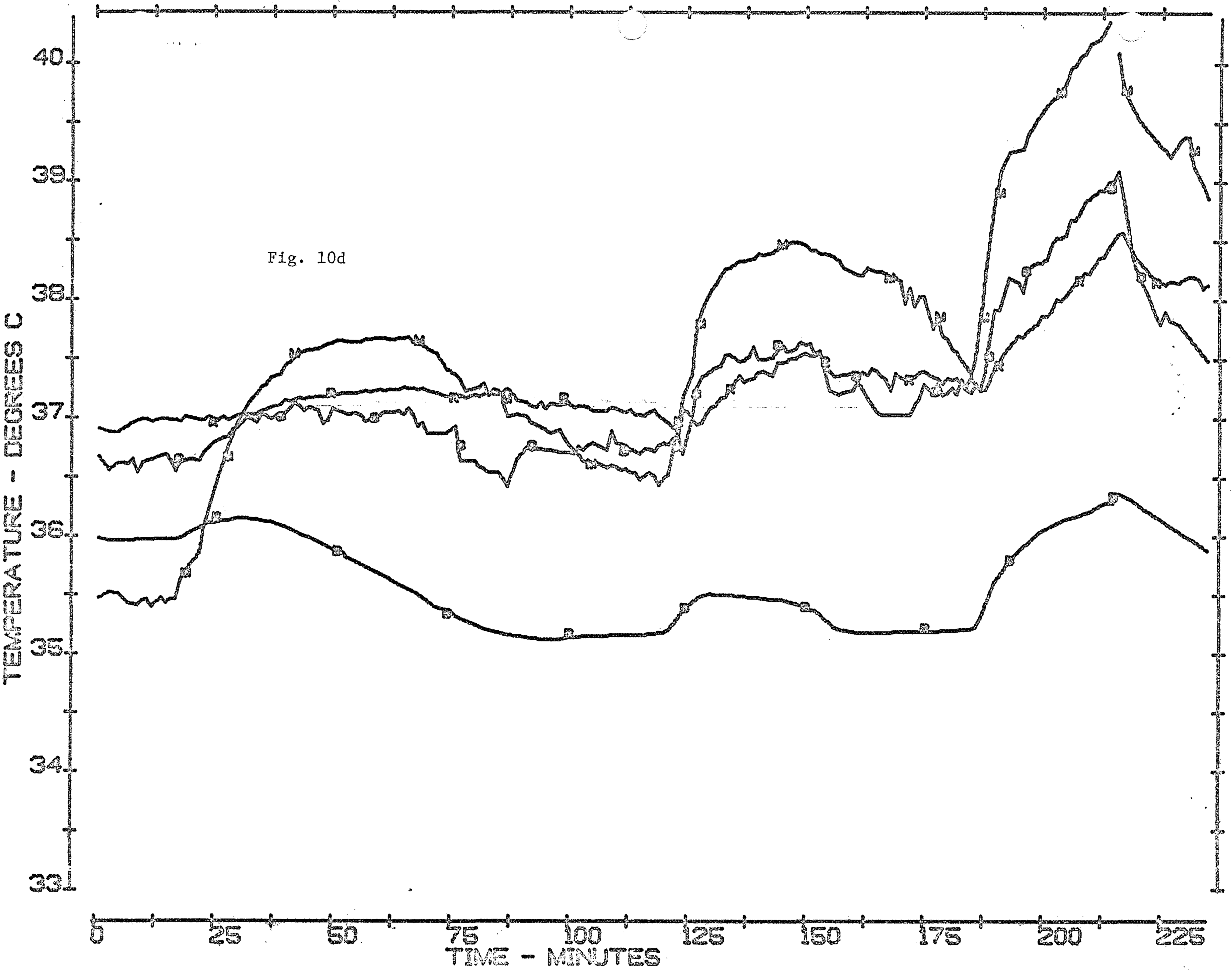

Fig. 10d
TEMPERATURE - DEGREES C
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125
150
175
200
225
TIME - MINUTES

Discussion

The mathematical model of thermoregulation presented and demonstrated in this report represents a considerable improvement over the earlier versions as developed in this laboratory. It is capable of predicting in very considerable detail the response to be expected in a very wide range of environmental conditions and levels of activity. It is not by any means perfect and it really represents a stage of development, on which we expect to build further.

The weakest point of the model as it stands now is to be found in the prediction of resting or low level activity at very low ambient temperatures. We feel that this essential weakness is due to inadequacies in the representation of the role of the circulatory system in the convective transport of heat within the body. One immediately recognizable shortcoming is the manner in which the blood flow to the working muscles is represented. In the model we have assumed an immediate onset of muscle blood flow in the working muscle, proportional to the work load. In fact, the muscle works anaerobically for a short while before an adequate blood supply starts. This has important consequences for the onset of exercise in the cold. In the present form the model predicts an immediate and sharp drop in internal temperature following the onset of exercise in the cold, due to blood returning from cold muscles. The initially anaerobic metabolic activity in the working muscle allows the muscle to heat up considerably, even in cold environments, before a substantial amount of blood perfuses it. In reality we then do not see as marked a sudden drop in internal temperature as the model predicts. Another aspect of the circulatory contribution to internal convective heat transport which is inadequately represented is the dynamic vasoconstrictive response. We have not placed upper limits on the circulatory capacity, but from comparisons of experimental runs and simulation runs it seems that sets of conditions which cause the model to require skin blood flow rates in excess of 3 liters/minute caused the subjects to reach unacceptable conditions often associated with nausea and dizziness. In the development of the present model, as well as in our attempts to achieve good agreement of predicted and experimental values at all times during a dynamically changing set of conditions, it became very clear that in a system as complex as the present system has become the quantitative value of the controller coefficients became less and less important. There are so many multiple pathways for incoming signals as well as for the outgoing commands, that a relative change in any one of the coefficients has only a very slight effect and the effect of such a relative change is immediately counteracted by the combined changes in all the other variables. On the other hand if a new pathway is added or if one is omitted, the effect on the performance of the system tends to be more pronounced. Thus a qualitative change in the control system or the controlled system is much more important, making the simulation more of a useful tool for the investigator.

In conclusion, it is our hope that the model presented here will be useful in the evaluation of the effect of physiological thermoregulation in complex environments in practical applications, and that at the same time it will be able to make a contribution to the advancement of knowledge in the area of thermoregulation by providing workers in this area with a working model on which to test new challenges to the concepts which we have built into it.