ON THE STIMULUS CONTROL OF POST-REINFORCEMENT PAUSES ON MULTIPLE SCHEDULE OF REINFORCEMENT

BY

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Suad Kaylani

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Chapter I

Introduction

Although an organism's behavior is continuous, yet experimental investigation necessitates the breakdown of behavior into specific units in order to facilitate its analysis. Analysis of an organism's behavior aids us in arriving at laws which contribute to the understanding of the entire behavioral process. Thus, experimental studies deal with specific controlled operants, each of which produces the proper stimulus conditions for the control of the subsequent operant.(1)

Skinner(2) identifies operant behavior as operating on the physical environment to produce certain consequences. In this kind of behavior, a reinforcer is contingent upon a response, thus, strengthening it, or making its occurrence more probable. Furthermore, the fact that behavior is usually reinforced intermittently, rather than consistently, contributes not only to greater stability of behavior but also to its greater resistance to extinction with time. Consequently, it is important to differentiate between various schedules of reinforcement which, according to Skinner, may be divided into two main classes, namely: schedules which are regulated according to time and those which are controlled by the organism itself. The first class includes schedules of fixed interval (FI) and variable interval (VI). Thus, FI5 means that reinforcement is delivered to the organism after the lapse of 5 minutes; while VI10 would

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(1) Findley, J. An experimental outline for building and exploring multi-operant behavior repertoires. J. exp. anal. Behav., 1962, suppl. to Vol. 5, No. 1, p. 113.
See also Skinner, B.F. Science and human behavior. New York: Macmillan, 1953, p. 93.

(2) Skinner, op.cit., pp. 62-66.

mean that reinforcement is delivered after the first response after an average of 10 minutes, irrespective of the number of responses performed during this particular period of time. These schedules are characterized by low rates of responding. The second class involves the fixed ratio (FR) and the variable ratio (VR) schedules of reinforcement. On fixed ratio schedules reinforcements are given after a certain number of responses have been emitted. Thus on FR15, for example, every 15th response is reinforced, while, for example, VR15 means that reinforcement is given on the average after every 15 responses. These schedules are characterized by high response rates.(3)

A random combination of two or more of the above-mentioned simple schedules would give us a complex schedule of reinforcement. Examples of such complex schedules are: mixed, multiple, and chained. After a presentation of the simple fixed ratio schedule, a discussion of each of these three complex schedules will then follow. All throughout this presentation, experiments studying the effects of various factors on the post-reinforcement pause length will be mentioned.

A fixed ratio schedule, not too large in size, can take control immediately after continuous reinforcement. Under the new schedule, a high response rate is generated for a short period of time. The rate may then decline slowly and be followed by an extinction-like curve. With further training, the high rate of responding generally produced by the FR schedule is generated and maintained.

Sample records of animals' behavior are presented by Ferster and

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(3) Ibid., pp. 99-104.

Skinner to illustrate and support the finding that, as the fixed ratio is increased, the subsequent post-reinforcement pause increases in length. The length of this pause may vary, extending over a period from a few seconds to several minutes, or for any intermediate time.(4) Though long pauses follow large ratios, they do not disappear directly upon the introduction of a smaller ratio, nor do they reappear directly when the small ratio is increased.(5)

A further consideration of the simple fixed ratio schedule would lead to a discussion of Skinner's experiment in 1938 which marshalled more evidence on the length of the pause following short and long ratios. More specifically, two groups of rats were conditioned on FR16. Then, progressively longer ratios were used. Each rat was run three sessions on one of the following ratios: FR48, FR96, or FR192, chosen at random. Skinner concluded that the rats showed discrimination between the short and the long ratios. The results of this experiment supported other findings that longer pauses follow longer ratios.(6)

A more recent experiment carried out by Boren in 1953 utilized the same kind of schedule. Six groups of animals (36 rats) were trained on a fixed ratio schedule. One of these groups (6 rats) was chosen to test the effect of FR on the rate of responding. The schedule started with FR2 and was gradually increased to FR7, FR14, FR25, and finally FR35. Then the schedule was switched back to FR14 and FR2.(7) Boren reported that the

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(4) Ferster, C., and Skinner, B.F. Schedules of reinforcement. New York: Appleton-Century-Crofts, Inc., 1957, pp. 42-53.

(5) Ibid., pp. 54-57.

(6) Skinner, B.F. The behavior of organisms. New York: Appleton-Century-Crofts, Inc., 1938, pp. 286-287.

(7) Boren, J.J. Response rate and resistance to extinction as functions of the fixed ratio. Unpublished doctoral dissertation, Microfilm, Columbia Univ., 1953, p. 6.

pauses were influenced by the size of the fixed ratio. The mean break, (i.e. post-reinforcement pause) was plotted as a function of each ratio. The resultant curve was positively accelerated, i.e., with increasing fixed ratios, pauses became longer. When the ratios were lowered again to FR2 and FR14, the pauses lasted for a longer time than they had initially.(8)

Some of the factors responsible for the post-reinforcement pause length in a fixed ratio schedule were discussed by Boren in a simple and concise way. He pointed out that post-reinforcement "breaks" occur because the animal needs time to consume the reinforcement. However, this cannot be the only factor, for otherwise breaks would be equal irrespective of the size of the ratios. Hence, he takes into consideration three other factors which contribute to the formation of the longer breaks after long ratios and shorter breaks following short ratios. First, in a fixed ratio schedule, responses following a reinforcement are not reinforced (an S^{Δ} condition). With the number of unreinforced responses in the longer ratios being greater than in the smaller ratios, a longer pause is produced following the longer ratio. Second, in a longer fixed ratio, the animal emits a larger number of responses than in a shorter one. Therefore, a longer ratio is more fatiguing and requires a longer rest period after reinforcement. Third, following a high rate of responding, reinforcement is delivered and is followed by a period of unreinforced responses. In the case of small FR schedules, where there is more similarity between the stimulus condition of the pause and the reinforcement (because the animal makes few responses after a pause before the next reinforcement), by the

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(8) Ibid., pp. 14-15.

manifested itself. The animal after reinforcement made a few responses, paused, and resumed responding exhibiting a "ragged" pattern of behavior until reinforced again. Upon the occurence of "strain" in behavior, the average rate of responding was lower and the average pause after reinforcement was longer.(11) This pattern of behavior called "strain" was attributed to two possible factors. First, "strain" may have resulted because of the use of a large ratio schedule that included too few reinforcements to maintain a high rate of responding. Second, the schedule might have been raised too abruptly without the animal being prepared.(12)

In reconsidering the complex schedules more elaborately, a definition of each is necessary.

(a) Multiple schedule (mult). This schedule may consist of two or more components, or simple schedules, which usually alternate at random. Reinforcement is presented after every component of the schedule. Each component is paired with a different exteroceptive stimulus (e.g. light) which is terminated with the completion of the component. For example, in a multiple FR15FI5, a red light may be paired with FR15, the completion of which is followed by reinforcement; while another key color (green light) could be paired with FI5.

(b) Mixed schedule (mix). Another complex schedule similar to the multiple except that all of its components are accompanied by the same stimulus.(13)

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(11) Boren, op.cit., pp. 6-7.

(12) Ibid., pp. 26-27.

(13) Ferster and Skinner, op.cit., p.5.

(c) Chained schedules (chain). "A schedule in which responding under one stimulus on a given schedule is reinforced by the production of a second stimulus in the presence of which a response is reinforced on a second schedule with food, water etc. Resembles a multiple schedule except that the reinforcement of the first component is simply the production of the stimulus of the second component."(14)

A further consideration of the post-reinforcement pause length as a function of the size of the ratio would lead us to an experiment (on the mixed schedule) cited in Schedules of reinforcement. A bird was trained on a mixed FR60FR360. The schedules were presented in such a way that, when only two of the longer ratios occurred for every ten of the shorter ratios (having a low mean ratio), the animal showed very little pausing. However, when the longer ratios were increased in number in relation to the shorter ratios, longer pauses after reinforcement resulted. This led to the conclusion that the appearance of pauses on mixed schedules depends on the average of the ratios. Thus, pauses vary with the different sizes of the components making up the schedule.(15)

In a long series of experiments using chained schedules of reinforcement, Findley aimed at analyzing behavior through the study of multi-operant behavior rather than the thorough analysis of specific bits of behavior.(16) Some of these experiments are presented here for their relevance to this thesis.

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(14) Ibid., p. 724.

(15) Ibid., pp. 580-590.

(16) Findley, op.cit., p. 114.

In an experiment utilizing a rat, a pigeon, and a monkey, Findley employed a procedure consisting of five progressively increasing ratios accompanied by a green light, and then presented the same ratios in a decreasing order, pairing them this time with a red light. The purpose of this experiment was to see whether the animals would pause uniformly prior to the different ratios. The experiment followed the procedure whereby each ratio produced both a reinforcement and the condition for either a larger or a smaller ratio.

The general result was that, with increasing ratios under the green light pauses became longer, while with decreasing ratios under the red light, pauses became shorter. Much variability in behavior, however, was exhibited from ratio to ratio. Thus, the five ratios were decreased to three and were presented in the following manner for one of the organisms, namely, the bird: with the red light, ratios were 33, 132, and 528, while with the green light, the reverse order of 528, 132, and 33 was scheduled. Results obtained from this and other animals indicated that longer pauses preceded the long ratios and shorter pauses preceded the short ratios. The results of these two experiments led Findley to conclude that a pause is a function of both the preceding as well as the subsequent ratios.(17) The latter conclusion was supported by a recent study which was conducted on four albino rats. As a result of using different sizes of ratios in a multiple schedule, it was suggested that, the shorter ratio in a multiple FRFR has a certain threshold level. When this threshold is exceeded, the shorter pauses follow the shorter ratios and the longer pauses follow the longer ratios. However, when the ratio

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(17) Ibid., pp. 131-132.

is below this threshold level, the longer pauses follow the shorter ratios and the shorter pauses follow the longer ratios. In multiple FR3FR31, for example, the majority of the shorter pauses followed the longer ratios, and in a multiple FR27FR73, most of the shorter pauses followed the shorter ratios.(18)

Findley trained a bird and a monkey on a procedure where the ratios in the presence of a light were 33, 132, and 528, while under a green light, ratios of equal sizes were used: 132, 132, and 132. His aim was to find more evidence supporting his contention that the pause was not solely a function of the size of the preceding ratio. The result obtained from sample records of behavior indicated that the pause after 132, with the red light, was much longer than the uniform pauses after each of the 132 fixed ratios with the green light.

Upon completion of the experiments dealing with increasing ratios, the writer suggested that the behavior exhibited during a ratio was controlled by stimuli coming from within the organism itself. A preceding ratio and a reinforcement might have acted as discriminative stimuli which controlled the performance of the next ratio.(19)

However, Skinner,(20) in an experiment on a pigeon, using a multiple schedule, suggested that each of a set of performances exhibited by the animal could be brought under exteroceptive stimulus control. Thus, when a green light was paired with FR60, a high rate of responding was generated; while

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(18) Salman, M. Determinants of post-reinforcement pauses on fixed ratio schedules. Unpublished M.A. thesis, Amer. Univ. Beirut, 1962, pp. 30-34.

(19) Findley, op.cit., pp. 132-133.

(20) Skinner, B.F. The experimental analysis of behavior. Amer. Scientist, 1957, 45, 343-371. (Reprinted in Skinner, B.F. Cumulative record. New York: Appleton-Century-Crofts, Inc., 1959, p. 109.

when the schedule was FI6min., with the key color being red, a pause and a scallop developed. The typical performance of the animal consistently followed this pattern of behavior. However, it should be noted that Skinner changed the stimulus and the schedule at the same time, thus, making it difficult to attribute the control of the pause length to either one of two possible sources - the stimulus condition during the pause, or the aftereffects of the previously completed schedule, cf. Findley, above.

By examining the figures presented in Ferster and Skinner, based on experiments utilizing multiple schedules of reinforcement, no consistent pattern of behavior could be observed. In these experiments, the scallop developed during the interval schedule when the animal was previously run on a fixed ratio schedule as mentioned in the experiment on the pigeon by Skinner. However, Ferster and Skinner mention that the more fixed ratios were run preceding a fixed interval, the more pronounced the scallop became. Thus, the source of control might have been the behavior of the organism itself rather than the stimuli present during the schedule. Furthermore, when an interval was followed by another interval, a scallop developed at times, while at other times a constant rate of responding occurred throughout the segment, even though a change in the stimulus occurred.(21) All these inconclusive results throw doubt on whether the control of the post-reinforcement pause length lies with the preceding stimuli or those prevailing during the pause.

Further research on the stimulus control, using a rat, was done by Salman where an exteroceptive stimulus (red and green lights) was paired with the longer of the two or more components of the multiple

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(21) Ferster and Skinner, op.cit., pp. 504-510.

schedule.[22] Though this problem was given a minor part in this experiment, yet an interesting result was reported. It was found that, "when a particular stimulus condition is made to prevail, for a considerable period of time during a pre-reinforcement run which normally controls short pauses, that stimulus continues to be effective in its control even when it is made to correlate with a pre-reinforcement run that normally controls long pauses."[23]

This interesting and challenging result again points to the importance of the stimulus present during the preceding ratio in the control of post-reinforcement pause length in a multiple schedule.

Thus, although it is normally accepted that the stimulus conditions under which a response occurs has the major control over that response there is suggestive evidence that post-reinforcement pauses are not so much affected by the prevailing stimulus as by the stimulus conditions present at reinforcement. The present study was designed to throw light on this point.

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(22) Salman, op.cit., pp. 24-25.

(23) Ibid., p. 24.

Chapter II

Method

Subjects

Six experimentally naive albino locally bred rats were used. Four rats identified as Ky2, Ky3 (males), Ky21, and Ky22 (females) were 188 days old at the start of experimentation. These four animals were run daily for a period of two and a half months. The remaining animals, two male rats, Ky23 and Ky24, were 292 days old at the beginning of experimentation which lasted for two months in order to check further the results obtained and the procedures followed with the first set of four animals.

Apparatus

A 2-bar Skinner box, Grason-Stadler type E3125B modified for liquid reinforcement was used as the experimental chamber. It was approximately 11.5 in. long, 9.25 in. wide and 7.5 in. high. The floor consisted of steel rods spaced .5 in. apart. The Skinner box was shielded by a sound reducing, light-tight outer box. A one way transparent opening in the outer box permitted a clear view of the animal inside. The box was equipped with a blower to circulate the air and provide a masking sound for extraneous noises and disturbances. Illumination was provided by a 6 watt light. A red, a green, and a white light were situated on the same wall as the two horizontal bars. These lights were put into use whenever needed. The two bars were spaced from each other by $1\frac{3}{8}$ in. end to end. Only the bar to the left was used in the experiment. This bar was 2 in. long and 3 in. above the floor, and required a force of about 20 grams to activate it.

To the right of the bar, between it and the non-functional bar, there was the dipper which provided the reinforcement. The dipper was immersed in a reinforcing substance in a magazine outside the Skinner box, and provided 0.1cc. of 12 per cent sucrose solution by weight, or of water, for 3 sec. at the appropriate times.

The various stimulus conditions used were programmed by electrical circuits located in a nearby room separate from the experimental room in which the box was placed. A cumulative recorder, counter, and timers provided records of the responses. Bar pressing responses besides producing the reinforcements, set into action the automatic scheduling and the magnetic counter. The graphic recorder gave a cumulative record of responses.

General procedure

The general procedure followed with all six rats was to train every animal to bar press, for 30-minute experimental sessions every day. A reinforcement of 0.1 cc. of 12 per cent sucrose solution by weight was used.

Every animal's behavior was first shaped by successive approximations, i.e., by reinforcing any response that involved approaching the bar or pressing it.

Every animal was started on continuous reinforcement. A simple FR schedule was adopted which was gradually increased till, after three sessions, FR15 was reached. After two more experimental sessions on this schedule, post-reinforcement pauses were recorded. The schedule was then switched to an alternating multiple FR15FR15 schedule by the introduction of an exteroceptive stimulus (white, red and green lights) which was paired with the second ratio. After three sessions the schedule was changed to multiple FR15FR45 for four sessions. From this point onwards, the experi-

mental procedure varied from one animal to another, and these specific procedural variations will be described shortly.

For 7 days before the experiment began, the S's were handled and adapted to a 23½ hour food and water deprivation rhythm, with ½ hour of ad libitum feeding and water, plus a 5-minute period of handling, each day.

When the experiment began all animals were food and water deprived for 22½ hours a day. After each hourly experimental session an animal was taken to its own cage where it was immediately given food and water for a period of 30-minutes. However, the feeding time often exceeded the 30-minutes period because the animal frequently held a pellet in its mouth at the end of this period. Finally, the animal was weighed daily following feeding.

Data obtained from animal Ky21 were excluded from this thesis because the rat was very slow in responding throughout the experiment and yielded poor results with whatever procedure was applied to it.

Specific procedures

The specific procedural variations for every one of the five animals utilized in this thesis were as follows:-

1. Rat Ky2:

a. Phase I. The multiple schedule was changed from FR15FR45 to FR30FR90, with the exteroceptive stimulus (light) being paired with the FR90. After five sessions, the reinforcement was changed from 12 per cent sucrose solution by weight to water because behavior was rather ragged and "strain" was exhibited in the daily records of the animal. Water did not help to improve the animal's performance, thus, after two sessions,

the original reinforcing substance was used again. Upon the completion of 15 sessions, when behavior was stable, a test period for the effect of the exteroceptive stimulus on the post-reinforcement pause length was run. Both ratios were run in dark for two experimental sessions.

b. Phase II. The multiple schedule FR30FR90 was continued, light being paired with the longer ratio. This lasted for 12 sessions during which behavior exhibited by the animal stabilized. The animal underwent another test, light being paired with both ratios.

c. Phase III. This last phase served as a check on the effect of the light. There were eleven more sessions with the reinforcement schedule mult.FR30FR90, light being paired with FR90. Finally, the animal went through a third test period, where light was again paired with both ratios for two experimental sessions.

The total number of sessions amounted to 74.

2. Rat Ky3:

a. Phase I. The multiple schedule was changed from FR15FR45 to FR30FR90, with the exteroceptive stimulus (light) being paired with the FR90. During the first six sessions, this animal's behavior showed "strain", particularly in the long ratios. Then, the 12 per cent sucrose solution was replaced by water as a reinforcer for two experimental sessions, during which the animal's behavior deteriorated. Thus, the 12 per cent sucrose solution was restored as a reinforcement. During the last two sessions of which a total of 19 sessions included in this phase, the animal was responding at a very high rate without much pausing.

b. Phase II. To produce clear cut pauses after the runs, the animal was prefed 2 cc. of 12 per cent sucrose solution before every

experimental session, keeping the same size of multiple schedule FR30FR90, with the light being paired with the FR90. Prefeeding served to lower the animal's rate of responding. In addition, behavior became less ragged, except in some instances at the end of the sessions. After 12 sessions, a test was undertaken. The light was paired with both ratios for two experimental sessions.

c. Phase III. Upon the completion of 14 more sessions, the animal's behavior stabilized and a second test followed. Both ratios were run in the absence of light for two experimental sessions.

The total number of sessions performed by this animal was 74.

3. Rat Ky22:

a. Phase I. The multiple schedule was increased from FR15FR45 to FR30FR90, the light still being paired with the longer ratio. The animal's rate of responding on this schedule was low and behavior was ragged with long pauses. After six sessions, the reinforcing substance was changed from 12 per cent sucrose solution to water. Performance did not improve. Thus, water was replaced, after two sessions, by the 12 per cent sucrose solution. The animal was then run on the multiple schedule FR30FR90 for 14 more sessions. Responding was very poor with much "strain" and, as a consequence, very few reinforcements were delivered.

b. Phase II. The schedule was lowered to multiple FR15FR45 because the previous schedule was high and strenuous for the animal. The animal was run on the multiple FR15FR45 for 12 sessions till the behavior stabilized. Performance improved greatly from the previous phase. In this phase, a test was included for the effect of the exteroceptive stimulus on the post-reinforcement pause length. Both ratios were run in the absence of light for 2 experimental sessions.

c. Phase III. After the first test, the animal was run again on the schedule mult.FR15FR45, light being paired with the long ratio FR45, for 14 sessions. Then, the animal went through a further test for the effect of the exteroceptive stimulus, but this time light was paired with both ratios for two experimental sessions.

The total number of sessions performed by this animal was 76.

4. Rats Ky23 and Ky24:

After running both of these animals on a mixed schedule FR15FR15 for a period of five sessions, the schedule was then switched to a multiple FR15FR45 for 31 more sessions. Throughout the experiment, the exteroceptive stimulus (white, red and green lights) was paired with the long ratio, while only the green light (i.e. dark) was kept on during the short ratio. However, following both ratios, there was complete darkness during the delivery of reinforcements for 3 seconds. During the 31 sessions, each of which lasted for 30 minutes (only for animal Ky23), the house light was off for both animals.* After the first five sessions, subject Ky24 was run for one hour per experimental session, for a total of 22 sessions. This variation in procedure had to be undertaken because of the animal's high rate of responding during the first 30-minutes. However, during the last five sessions, the animal stopped responding during the second 30-minutes. Thus, it was run again 30-minutes per session, for the remainder of the experiment. After 22 sessions, a test for the effect of the exteroceptive stimulus on the post-reinforcement pause length was performed,

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*The house light was kept on with the other four animals during the so-called dark period, while all of the three key colors were off.

light being paired with both ratios for one experimental session. Then, upon the completion of 7 more sessions, another test was undertaken where light was paired with both ratios for two experimental sessions.

Table 1

Summary of procedures of the five animals

Animal No.	Phase	Schedule	Reinforcement	No. of Sessions	Tests
Ky2	I	Mult.FR30FR90	12% sucrose	5	
		"	Water	2	
		"	12% sucrose	13	
		"	"	2	Dark on both ratios
	II	"	"	12	
		"	"	2	Light on both ratios
	III	"	"	11	
		"	"	2	Light on both ratios
Ky3	I	"	"	6	
		"	Water	2	
		"	12% sucrose	19	
	II	"	" (Prefed 2 cc.)	12	
		"	"	2	Light on both ratios
	III	"	"	14	
		"	"	2	Dark on both ratios
Ky22	I	"	12% sucrose	6	
		"	Water	2	
		"	12% sucrose	14	
	II	Mult.FR15FR45	"	12	
		"	"	2	Dark on both ratios
	III	"	"	14	
		"	"	2	Light on both ratios
Ky23 and Ky24		"	"	22	
		"	"	1	Light on both ratios
		"	"	8	
		"	"	2	Dark on both ratios

Chapter III

Results

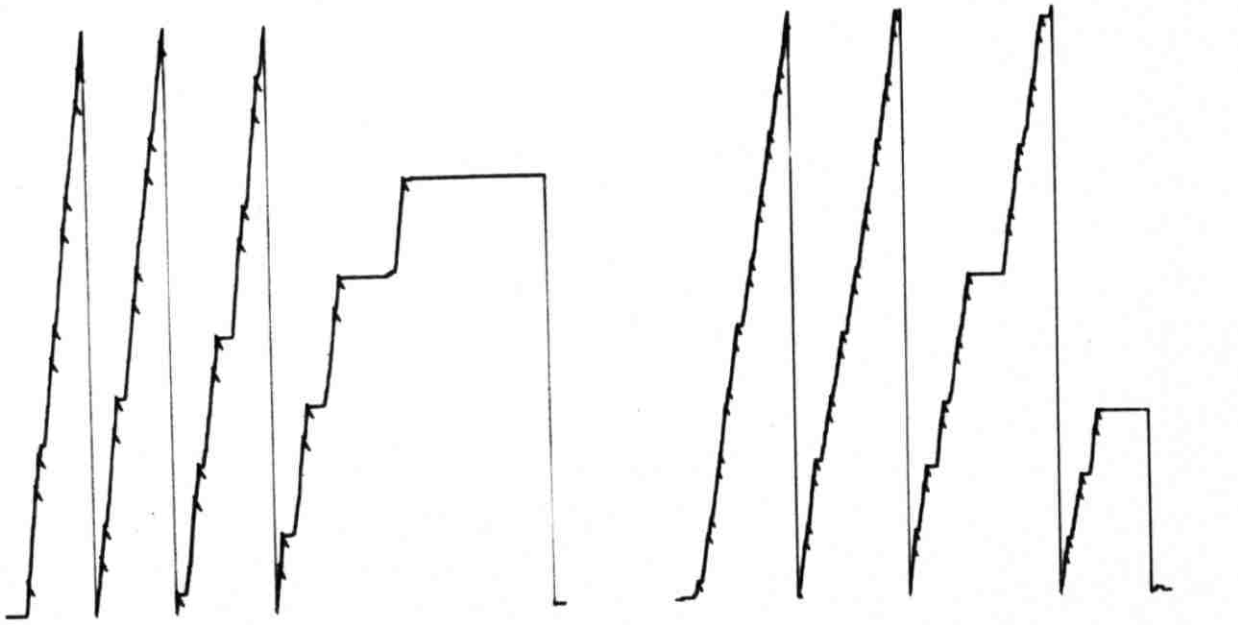
The main results of this experiment will be presented under three separate headings. These are: (1) a presentation of sample cumulative records of the animals' daily behavior, (2) results of tests for the effect of the exteroceptive stimulus on the mean post-reinforcement pause length, and (3) a within-session tracing of the development of post-reinforcement pause length.

1. Sample cumulative records of animals' daily behavior.

Representative sample records of the animals' daily behavior are presented in figure 1. The general trend exhibited by all animals shows that long pauses followed short ratios and short pauses followed long ratios. However, this trend of behavior was exhibited less consistently by animal Ky22, as shown in fig. 1(c), where pauses of different lengths occurred after the short as well as the long ratios. Nevertheless, the majority of the longer pauses followed the short ratios. Furthermore, the animals' behavior sometimes contained pauses of variable length in the midst of the long ratios.

Figure 1 shows that pauses were usually followed by a high rate of responding which lasted till the delivery of the reinforcement. However, a ragged, but a more regular pattern of behavior than that referred to as "strain" was sometimes exhibited by all animals. This pattern appeared frequently during the long ratios, as shown in fig. 1, particularly toward the end of the experimental sessions.

(a) 35th Session on mult. FR30FR90 (Rat Ky24) (c) 18th Session on mult. FR15FR45 (Rat Ky22)



(b) 34th Session on mult. FR30FR90 (Rat Ky3) preferred acc. of sucrose solution (d) 15th Session on mult FR15FR45 (Rat Ky23)

Figure 1

Representative sample records of the animals' daily behavior

2. Results of tests for the effect of the exteroceptive stimulus on the mean post-reinforcement pause length.

Effects of the exteroceptive stimulus on the mean post-reinforcement pause length are summarized in Table 2 and presented graphically in figs. 2 through 6. Every figure consists of two curves representing the daily mean post-reinforcement pause lengths after the long (broken lines) and the short (solid lines) ratios respectively. An equal number of reinforcements in plotting the means over all the daily sessions was chosen in the case of each animal. The specific number of reinforcements will be described shortly.

As the figures clearly show, curves representing mean pauses after the long ratios are more stable than those following the short ratios. Every figure contains data on two or more test days for the effect of the exteroceptive stimulus on the post-reinforcement pause length. On these test days either light or dark was paired with both ratios for two successive daily test sessions. However, only the first test sessions are shown in the figures, as our interest was in the immediate effects of changing the exteroceptive ratios-correlated stimulus uncontaminated, (as far as possible), by the recovery effects (which did occur on the second test days).

In general, the results obtained in this experiment were as follows:

When light was paired with both ratios, the post-reinforcement pause length was reduced after the short ratio for all animals with the exception of animal Ky24 where practically no change occurred. Smaller changes occurred in the post-reinforcement pause length after the long ratio times. Although these latter changes are small, they gain in

Table 2

Tests for the effect of the exteroceptive stimulus on the mean post-reinforcement pause length.

Test	Animal No.	Pause after the short ratio in sec.		Pause after the long ratio in sec.	
		Average mean Pause*	Test mean Pause	Average mean Pause*	Test mean Pause
Dark paired with both ratios					
Test 1	Ky2	15.96	12.36	4.8	7.68
Test 2	Ky3	16.38	11.88	4.5	5.04
Test 1	Ky22	14.1	10.2	7.8	9.66
Test 2	Ky23	7.44	6.6	5.7	4.68
Test 2	Ky24	3.9	3.7	3.4	3.6
Light paired with both ratios					
Test 2	Ky2	22.62	11.32	5.22	5.28
Test 3	Ky2	15.36	11.04	5.1	6.12
Test 1	Ky3	14.2	7.62	4.6	4.92
Test 2	Ky22	10.26	8.7	7.98	6.66
Test 1	Ky23	14.58	7.4	5.34	4.86
Test 1	Ky24	4.7	4.8	4.1	3.6

* Average mean is the average of the last 3 pre-test sessions.

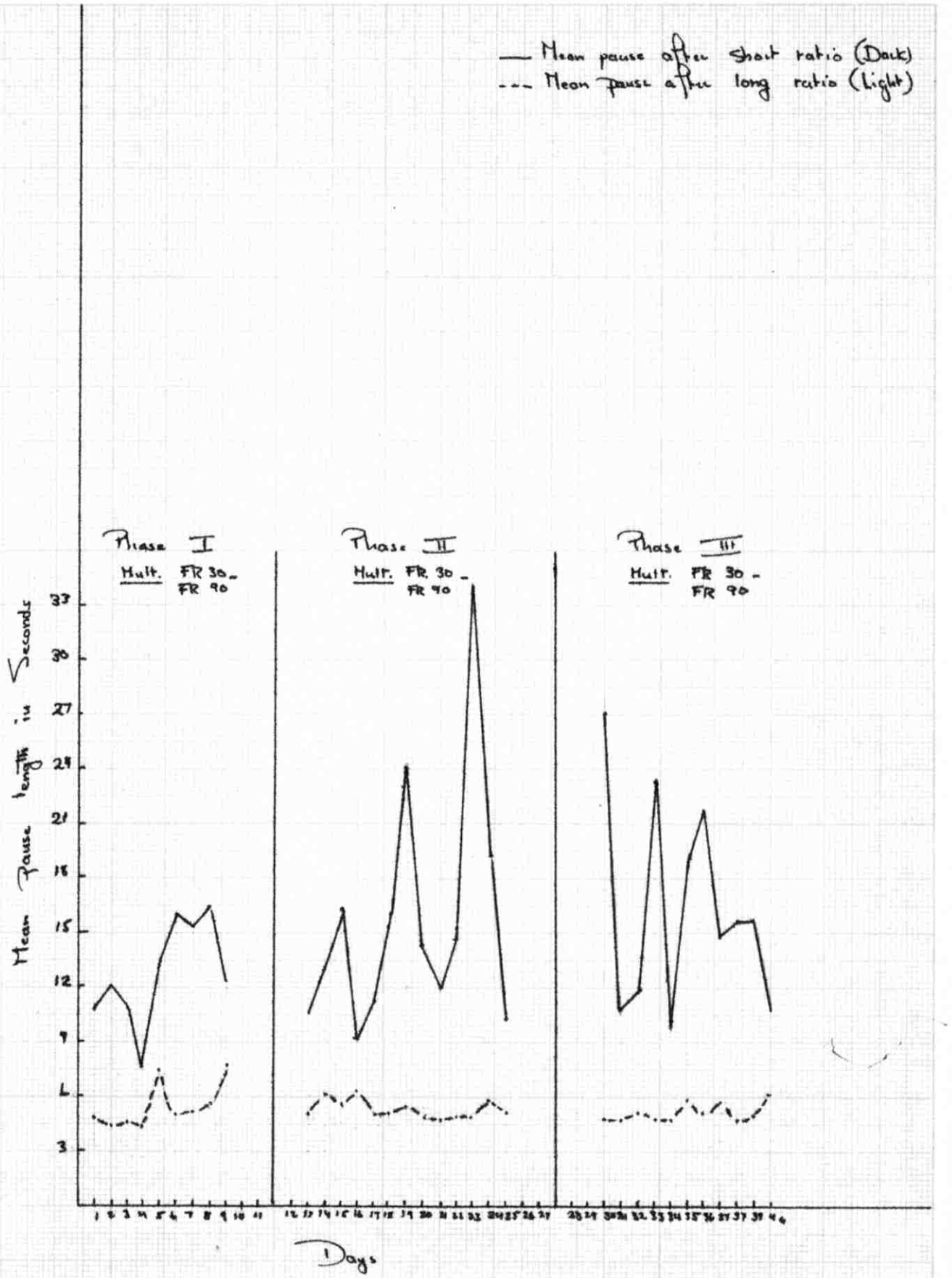


Figure 2. Daily mean post-reinforcement pauses produced by animal Icy 2

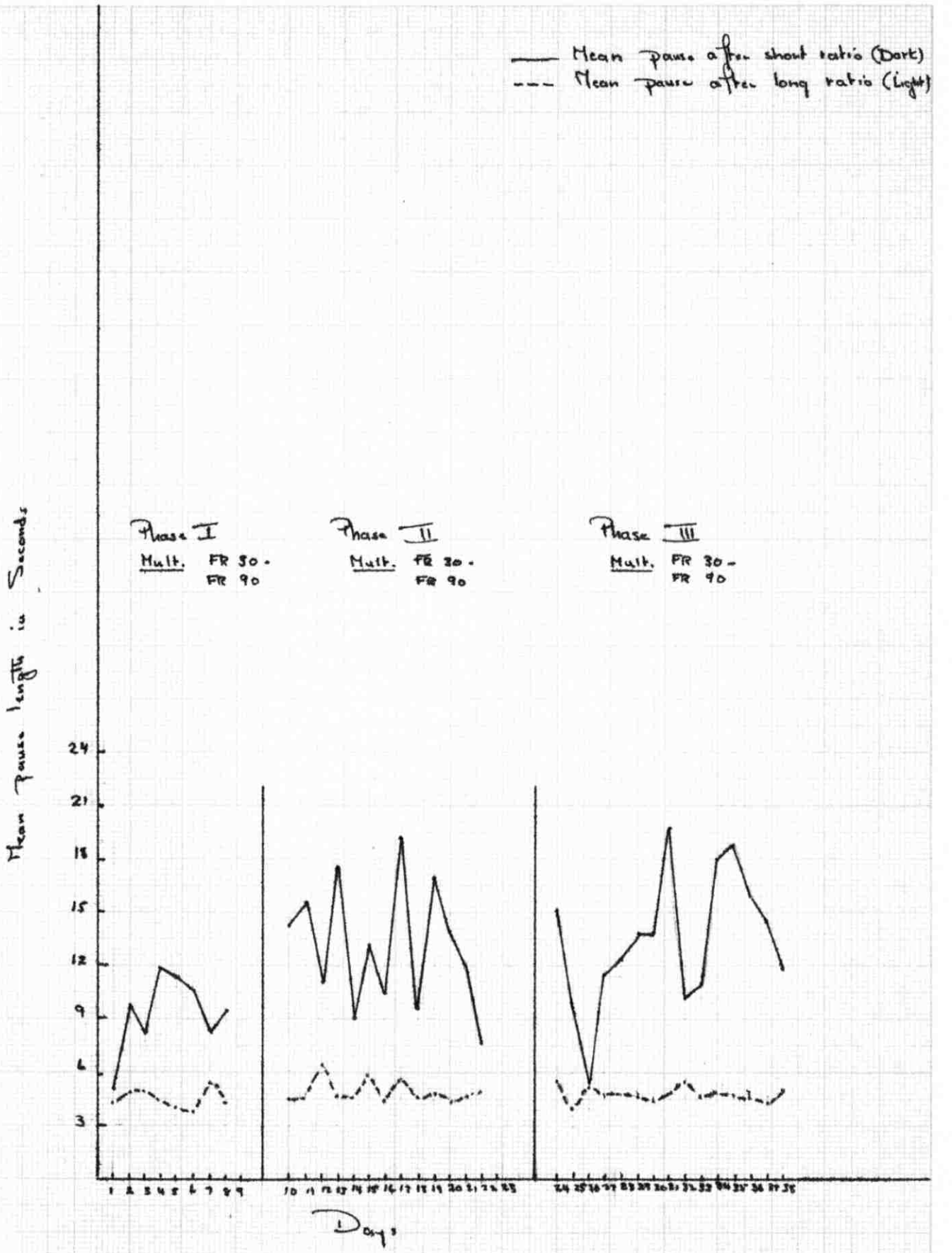


Figure 3. Daily mean Post-reinforcement pauses produced by animal Icy 3

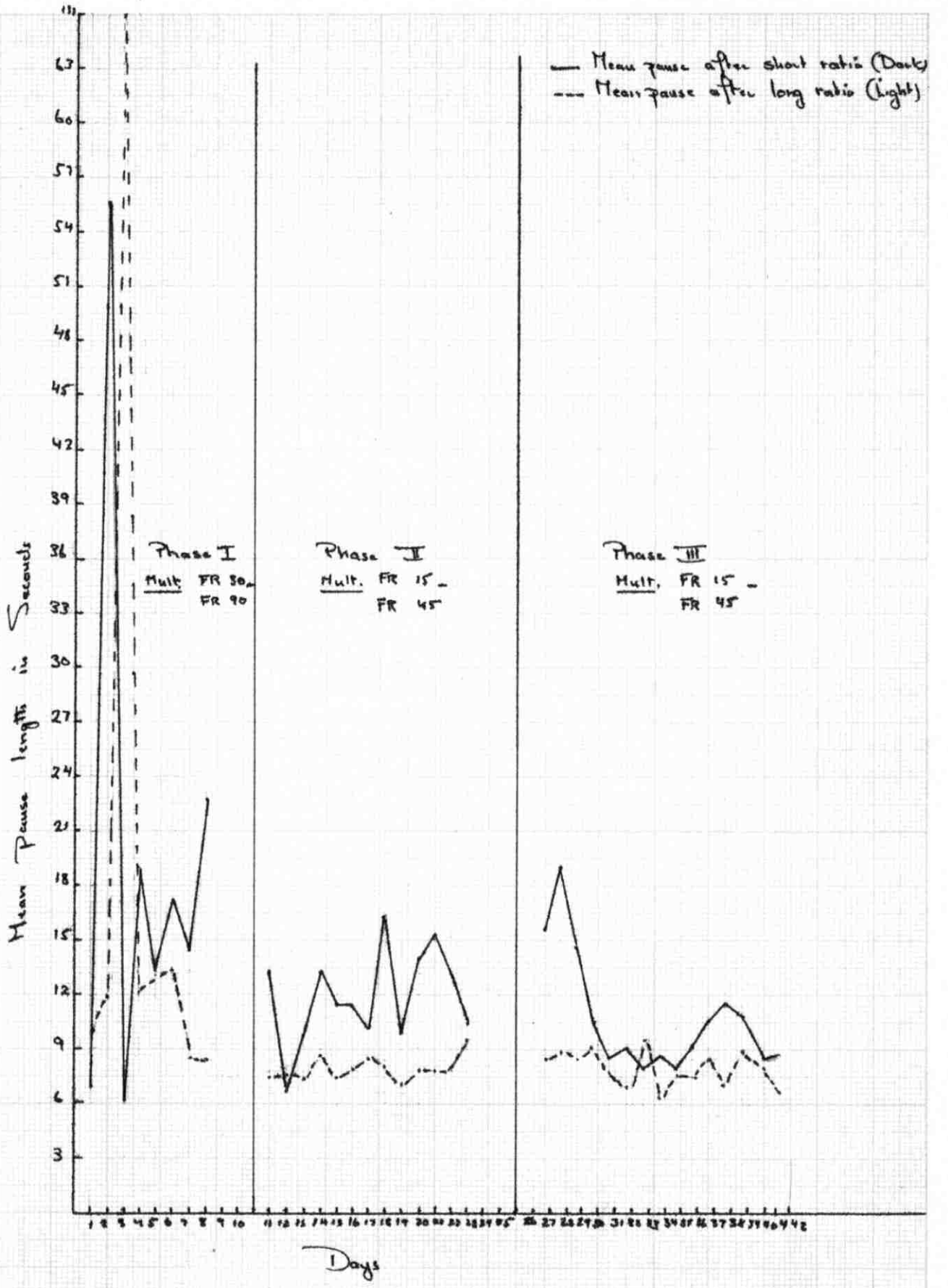


Figure 4. Daily mean post-reinforcement pauses produced by animal Ky 22

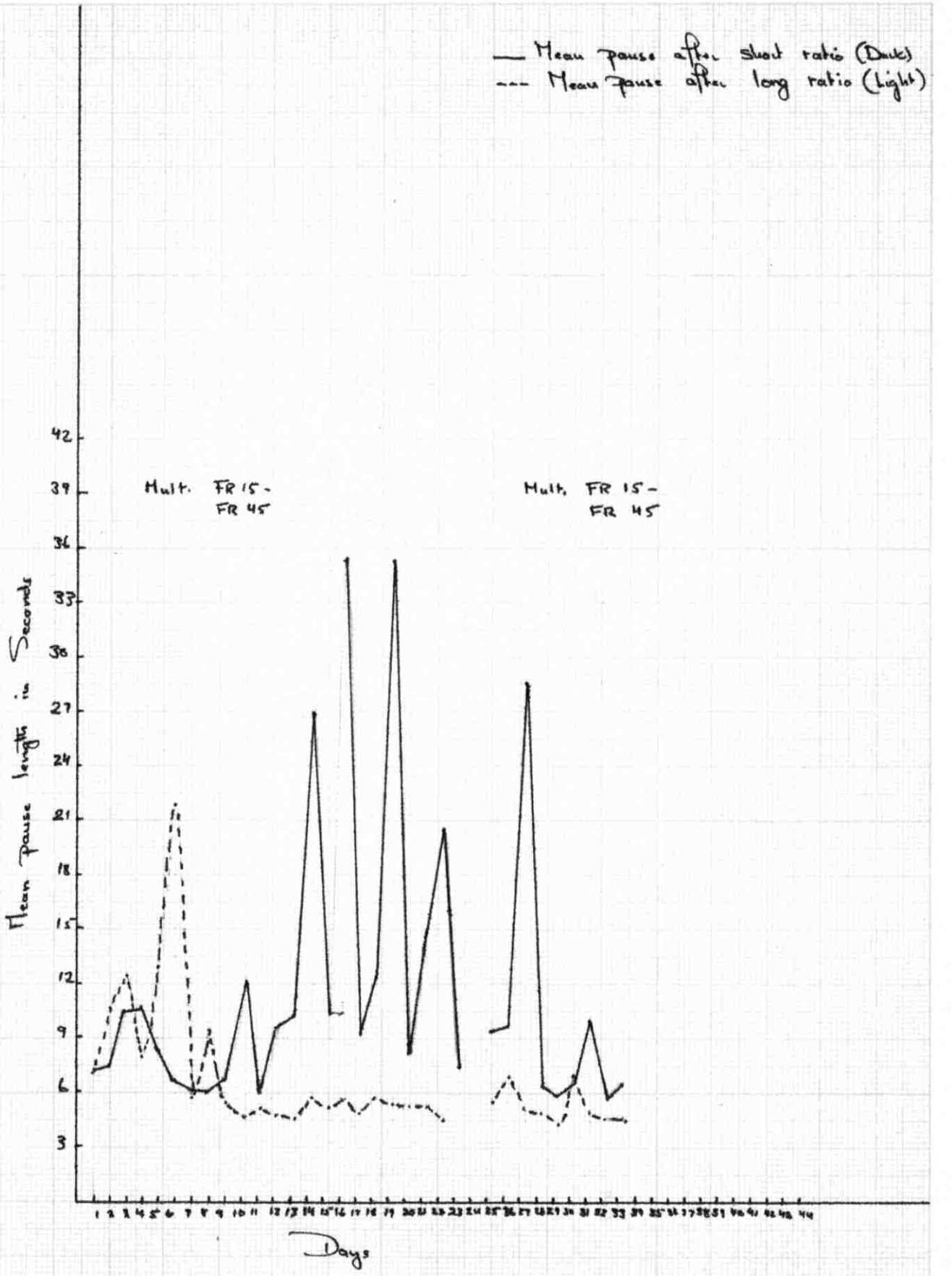


Figure 5. Daily mean post-reinforcement pauses produced by animal Ky 23

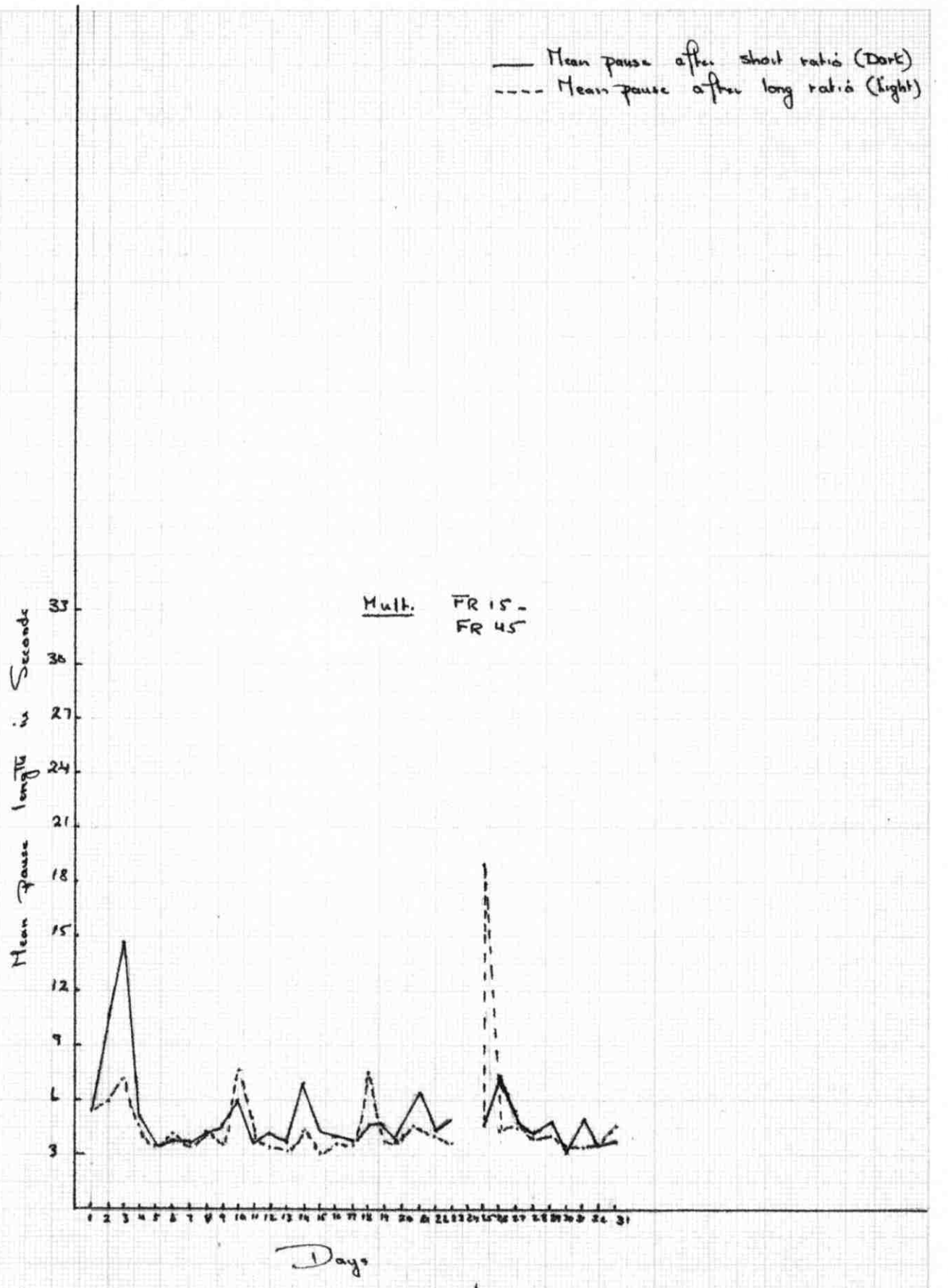


Figure 6. Daily mean post-reinforcement pauses produced by animal ICy 24

importance due to the stability of the daily mean curves. For example, in the case of animals Ky22, Ky23, and Ky24, there was a decrease in the post-reinforcement pause length following the long ratios varying from .48 sec. to 1.32 sec., as shown in Table 2 and figs. 2-6. However, in the case of animal Ky2, there was an increase of 1.02 sec. in the post-reinforcement pause length in one test, but practically no change in the other (.06 sec.). Also, a small increase (.32 sec.) occurred in the case of animal Ky3.

When dark was paired with both ratios, the post-reinforcement pause length increased after the long ratio, in the case of all animals, except animal Ky23, where a mean decrease of 1.02 sec. occurred, as shown in Table 2 and figs. 2-6. Although the largest difference between the average pause over the 3 pre-test sessions and the test mean pause was only 2.88 sec., the changes were large relative to the stability of the daily mean pauses before the test. The post-reinforcement pause lengths after the short ratio were reduced for animals Ky2, Ky3, Ky22, and Ky23. However, practically no change occurred in the pause length of animal Ky24, as shown in Table 2.

Now that a general account of the results has been presented, a further consideration of specific detailed results of each animal will be discussed separately.

Rat Ky2.

Phase I. As may be seen in figure 2, Phase I shows the mean pause for the last ten sessions of training on multiple FR30FR90 before the first test session based in every case on the first 16 pauses after each of the short and the long ratios. Thus, the means later are based on a total of

32 reinforcements per session though the number of reinforcements ranged from 32 to 60 from one session to another.

The animal was run on an alternating multiple schedule FR30FR90 with the FR30 segment run in "dark". A test for the effect of the exteroceptive stimulus was performed by pairing dark with both ratios. Table 2 and figure 2 show a rise in the mean pause length after the long ratio from 4.8 sec. over the 3 pre-test sessions to 7.68 sec. on the test session. At the same time a decrease occurred in the mean pause length after the short ratio from an average 15.96 sec. to 12.36 sec.

Phase II. Mean pauses after the short and the long ratios were plotted for 12 more sessions with the same schedule. A test was then performed, where light was paired with both ratios for two experimental sessions. Table 2 shows that the mean pause length after the short ratio became shorter, dropping from an average of 22.62 sec. over the 3 pre-test days to a mean of 11.32 sec. on the test day. The mean pause length after the long ratio remained almost the same (5.22 sec. to 5.28 sec.).

Phase III. In an attempt to stabilize pauses after the short ratios the experiment was extended for ten more sessions, keeping the same multiple schedule FR30FR90. This phase contains the third test for the effect of the light. Again light was paired with both ratios and the previous finding confirmed. The mean pause following the short ratio was reduced from an average of 15.36 sec. over the 3 pre-test sessions to a mean of 11.04 sec. on the test session. There was however, a corresponding small rise in the mean pause after the long ratio from an average of 5.1 sec. to 6.12 sec.

More variability in pause behavior was exhibited after the short than after the long ratios, as shown by the curves in all three phases.

Also, the mean pauses after reinforcements following the shorter ratios were uniformly longer than those following the longer ratios.

Rat Ky3.

Phase I. The animal was on a multiple FR30FR90 schedule. Though behavior appears to be stable, as shown in figure 3, yet the daily records contained ragged behavior during the long ratios. The mean pause curves were based on the first 17 reinforcements after each of the short and the long ratios. The average number of reinforcements received per session was around 40 reinforcements.

Phase II. The animal was prefed 2 cc. of 12 per cent sucrose solution by weight before each daily run. As a result, longer pauses appeared, while "strain" decreased in some experimental sessions but not in others.

The first test for the effect of the exteroceptive stimulus on the post-reinforcement pause length was performed by pairing light with both ratios. Table 2 and figure 3 show that the pause after the short ratio became shorter, and accordingly the curve of the mean pause after the short ratio dropped from an average of 14.2 sec. over the 3 pre-test days to a mean of 7.62 sec. on the test day. A very small increase (.32 sec.) occurred in the mean pause after the long ratio. However, two very long pauses after each the long and the short ratios were omitted while computing the mean pause length in one of the 3 pre-test sessions, because it was assumed that something must have gone wrong at that particular time.

Phase III. The animal was still prefed and run on a multiple schedule FR30FR90. Figure 3, phase III contains the second test for the

effect of the exteroceptive stimulus. The light was removed from both ratios. Table 2 shows that a rise occurred in the mean pause length from an average of 4.5 sec. to a mean of 5.04 sec. from the 3 pre-test days to the test days, after the long ratio; while a drop occurred in the mean pause length after the short ratio from an average of 16.38 sec. over the 3 pre-test days to a mean of 11.88 sec. on the test session.

Figure 3 shows that the curves for the mean pauses after the long ratios were more stable than those after the short ratios in all three phases. Also, the mean post-reinforcement pauses after the shorter ratios were uniformly longer than those following the longer ratios.

Rat Ky22.

Phase I. Figure 4 shows much variability in behavior after both the long and the short ratios at first for this animal. The multiple schedule FR30FR90 was too large and very strenuous for the animal. The mean pauses after both short and the long ratios were computed on the basis of 5 reinforcements each, for the animal did not receive more than ten reinforcements per experimental session.

Phase II. The schedule was reduced to a multiple FR15FR45. Variability in behavior was reduced and the animal responded throughout the whole experimental session. The first 16 pauses after both the short and the long ratios were used in plotting the curves in Phase II figure 4. The average number of reinforcements was about 40 per session.

A test for the effect of the exteroceptive stimulus was included in this phase, where dark was paired with both ratios for two experimental sessions. Table 2 shows a rise in the mean pause length after the long ratio from an average of 7.8 sec. over the 3 pre-test sessions to a mean of 9.66 sec. on the test session. The mean pause after the short ratio dropped from an average of 14.1 sec. to a mean of 10.2 sec. over the same

period.

Phase III. The multiple schedule FR15FR45 was continued for 12 more sessions after which a second test was performed. Light was paired with both ratios for two experimental sessions. The results in Table 2 and figure 4 indicate small changes occurring in the length of the pauses. The average pause length after the short ratio decreased from an average of 10.26 sec. to an average of 8.7 sec. from the last 3 pre-test to the test session, and the average mean pause length after the long ratio changed from 7.98 sec. to 6.66 sec. similarly.

Rats Ky23 and Ky24.

These animals were run on alternating multiple schedule FR15FR45 throughout. The mean pauses after the long and short ratios were computed from pauses after the first 22 reinforcements after each ratio for both animals. In the case of animal Ky23, the number of reinforcements ranged from 44 to 58, while in the case of animal Ky24 from 22 to 85 per session.

After 22 sessions, a test for the effect of the exteroceptive stimulus on the post-reinforcement pause length was performed. Light was being paired with both ratios for one experimental session. For animal Ky23, the pause after the short ratio was reduced in length from an average of 14.58 sec. over the 3 pre-test sessions to a mean of 7.4 sec. on the test session. Also a very small decrease occurred in the pause length after the long ratio from an average of 5.34 sec. to 4.86 sec. For animal Ky24, very minor changes occurred in the mean pause length after each of the ratios. Practically no change occurred in the mean pause length after the short ratios.

There was a small decrease in the pause length after the long ratio from an average of 4.1 sec. over the 3 pre-test sessions to a mean of 3.6 sec. on the test day.

The animals were kept on the same schedule for 8 more sessions. Another test was performed where dark was paired with both ratios for two experimental sessions. The changes in the pause lengths were very small. In the case of animal Ky23, the pause after the long ratio was decreased from an average mean of 5.7 sec. to a mean of 4.68 sec. Also, a decrease occurred in the pause length after the short ratio from an average mean of 7.44 sec. to a mean of 6.6 sec. However, in the case of animal Ky24, practically no changes occurred in the pause length after either of the two ratios. The pause after the long ratio increased in length from an average of 3.4 sec. to a mean of 3.6 sec., and decreased after the short ratio from 3.9 sec. to 3.7 sec. from the last 3 pre-test sessions to the test session.

3. Development of post-reinforcement pauses within sessions.

As stated earlier, at least two tests for the effect of the exteroceptive stimulus on post-reinforcement pause length were carried out with every animal. On one of these tests both ratios were run in light, while the other consisted of pairing dark with both ratios. In the case of animal Ky2, three tests were carried out, two with light and one with dark paired with both ratios.

On every test session, and for the 3 preceding sessions, cumulative records of post-reinforcement pauses after the respective ratios in the multiple schedules were constructed. These cumulative records are shown in figures 7-50, Appendix I. This was done in order to follow more

accurately the development of the post-reinforcement pauses after each ratio within sessions.[1] Further more, in order to show more clearly the differences due to the stimulus change, figures 51-61 were plotted showing pauses after the critical ratio,[2] for each animal. These latter figures will be presented at the end of this section.

In general, the results confirm those presented above where the mean post-reinforcement pause lengths were computed from only part of the data from each session. Though all post-reinforcement pauses, rather than a certain specific number, were plotted in the cumulative daily sessions, the change due to the effect of the exteroceptive stimulus on the post-reinforcement pause length was the same in both cases.

However, a close study of the development of the post-reinforcement pause lengths (within sessions) of each animal uncovers details which cannot be detected on the basis of comparisons of means.

Light paired with both ratios.

Rat Ky2.

Figures 7 - 10 show that the post-reinforcement pause length increased less after the short ratio during the test session (fig. 10), as compared to the pre-test sessions (figs. 7 - 9). However, no change in pause length occurred after the long ratio during the test session as compared to the pre-test sessions.

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[1] This method of data presentation also overcomes the gross instability of mean pauses after the short ratios from day to day. Pauses after the shorter ratios in mixed schedules have been shown to increase abruptly within sessions (Patrikiou, V. Motivational effects on pause lengths during mixed schedules of reinforcement. Unpublished M.A. thesis, 1963, Amer. Univ. Beirut, pp.29-81), and the point at which this occurs naturally affects the mean pause on any day.

[2] Critical ratio is that ratio in which case there occurred a change in the stimulus conditions between the day before the test and the test day.

The results of the other test for this animal in figs. 11-14 are more or less similar, and show that the post-reinforcement pause length after the shor ratio during the test session was generally shorter as compared to the 3 pre-test sessions, and did not show the accelerating pattern of increasing pauses so markedly. Concerning the post-reinforcement pause length after the long ratio, some raggedness occurred during the test session as compared to pre-test sessions, after the 11th reinforcement. If it were not for this long pause between the 11th and 12th reinforcements, the post-reinforcement pause length would not have changed till after the 21st reinforcement. However, this last change affords no comparison with any of the three sessions preceding the test, as the number of reinforcements in each of them was less than 20.

Rat Ky3.

Results of this animal are shown in figures 15 through 18. The cumulative curve of post-reinforcement pauses after the short ratio was depressed throughout the test session (fig. 18), as compared to the pre-test sessions (figs.15-17). However, the post-reinforcement pauses did not change much during the test session following the long ratio as compared to the pre-test sessions although by the 17th reinforcement long pauses began to occur.

Rat Ky22.

Figures 19-22 show that the over all post-reinforcement pausing after the short ratio during the test session (fig. 22), was shorter than during the pre-test sessions (figs. 19-21). This decrease occurred in spite of the fact that during one of the pre-test sessions, fig. 21, more than half of the pauses were actually shorter than those during the test

session. Furthermore, the post-reinforcement pause length after the long ratio was shorter on the test day as compared to the 3 pre-test sessions.

Rat Ky23.

Figures 23-26 show that the post reinforcement pause length was less after the short ratio during the test session (fig. 26), than in the pre-test sessions (fig.23-35). This decrease occurred in spite of the fact that up to the 14th reinforcement, pauses in fig. 24 were uniformly shorter than those during the test session.

Rat Ky24.

Figures 27-30 show the cumulative post reinforcement pauses after the long and the short ratios during the test session (fig. 30), and the 3 sessions before it (figs. 27-29). Whereas in all three pre-test sessions long pauses occurred towards the end of the session after the short ratio, they did not occur when this ratio was run in the light - the same stimulus condition as the long ratio. Pauses after this latter ratio remained fairly constant overmost of the sessions.

Dark paired with both ratios.

Rat Ky2.

Figures 31-34 show that, up to the 13th reinforcement, almost no change occurred in the post-reinforcement pause length after the long ratio during the test session (fig. 34), as compared to the pre-test sessions (figs. 31-33). From the 14th reinforcement onwards, an increase in the pause length occurred during the test as compared to pre-test sessions. However, the pause length was less during the test session after the short ratio, than the pre-test sessions. This decrease occurred

in spite of the fact that, up to the 15th reinforcement in fig. 33, the pauses were shorter than those during the test session.

Rat Ky3.

Figures 35-38 show that the post reinforcement pause length after the long ratio increased during the test session (fig. 38), as compared to the pre-test sessions (figs. 35-37), except for a decrease on the 15th reinforcement which occurred as a result of a long pause in fig. 36. However, the pause length after the short ratio was shorter during the test session than the pre-test sessions.

Rat Ky22.

Figures 39-42 show that the over all post-reinforcement pausing after the long ratio increased during the test session (fig. 42), as compared to the pre-test sessions (figs. 39-41). Whereas the cumulative curve of the post-reinforcement pause after the short ratio was depressed during the test as compared to the pre-test sessions.

Rat Ky23.

Figures 43-46 show that the post-reinforcement pause length after the long ratio was shorter from the 11th up to the 32nd reinforcement during the test session (fig. 46), than the pre-test sessions (figs. 43-45). Also, the pause length after the short ratio was less during the test session than the pre-test sessions.

Rat Ky24.

Figures 47-50 show that the over all post-reinforcement pause after the long ratio increased during the test session (fig. 50), as

compared to the pre-test sessions (figs. 47-49). Furthermore, there was a slight increase in the pause length after the short ratio, up to the 15th reinforcement during the test as compared to the pre-test sessions after which almost no change was further observed in pause length.

Pauses after the critical ratio.

The results stated earlier under the present section suggest that a change in the stimulus conditions during a ratio influenced the post-reinforcement pause length following that ratio. In order to investigate this problem further, graphs were plotted showing pauses after the critical ratio for every animal. Every graph contains two curves representing pauses for the day before the test and test day. These graphs are shown in figures 51-61.

Figures 51-56 show comparisons of post-reinforcement pause lengths after the short ratios (critical ratio) between the day before the test (dark) and the test day (light). These figures show clearly that the post-reinforcement pause length on the test day was depressed in comparison to the pre-test day. Furthermore, the pause length became gradually shorter on the test day, particularly towards the end of the session, as compared to the pre-test day.

Figures 57-61 show comparisons of post-reinforcement pause lengths after the long ratios (critical ratio) between the day before the test (light) and the test day (dark). These figures show clearly that the post-reinforcement pause length on the test day increased in comparison to the pre-test day. Furthermore, the pause length became gradually longer on the dest day, particularly towards the end of the session, as compared to the pre-test day.

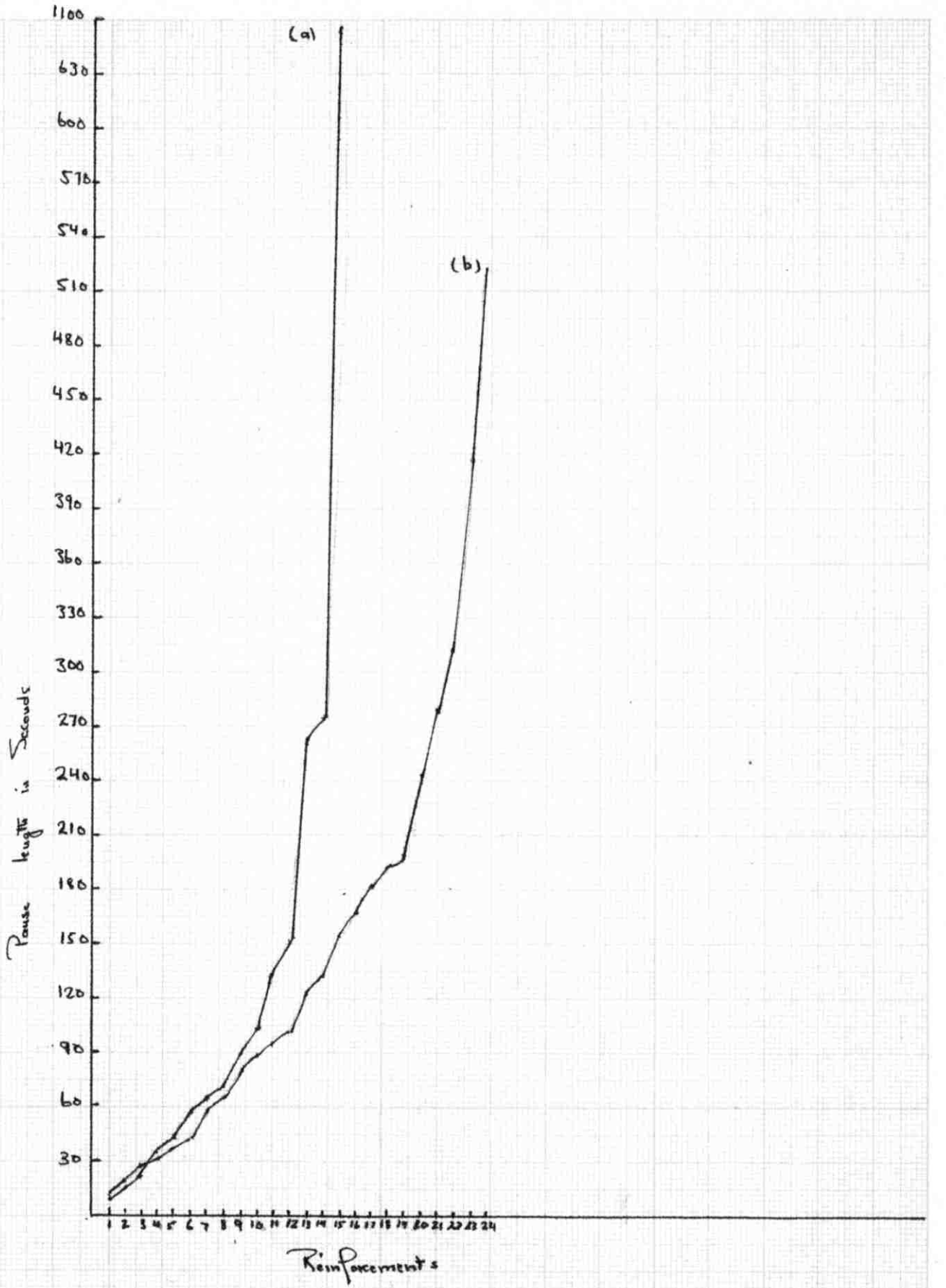

Figure 51. Cumulative records of animal Ky 2 after the short ratio. (a) Pause on pre-test day (Dark). (b) Pause on Test day (light)

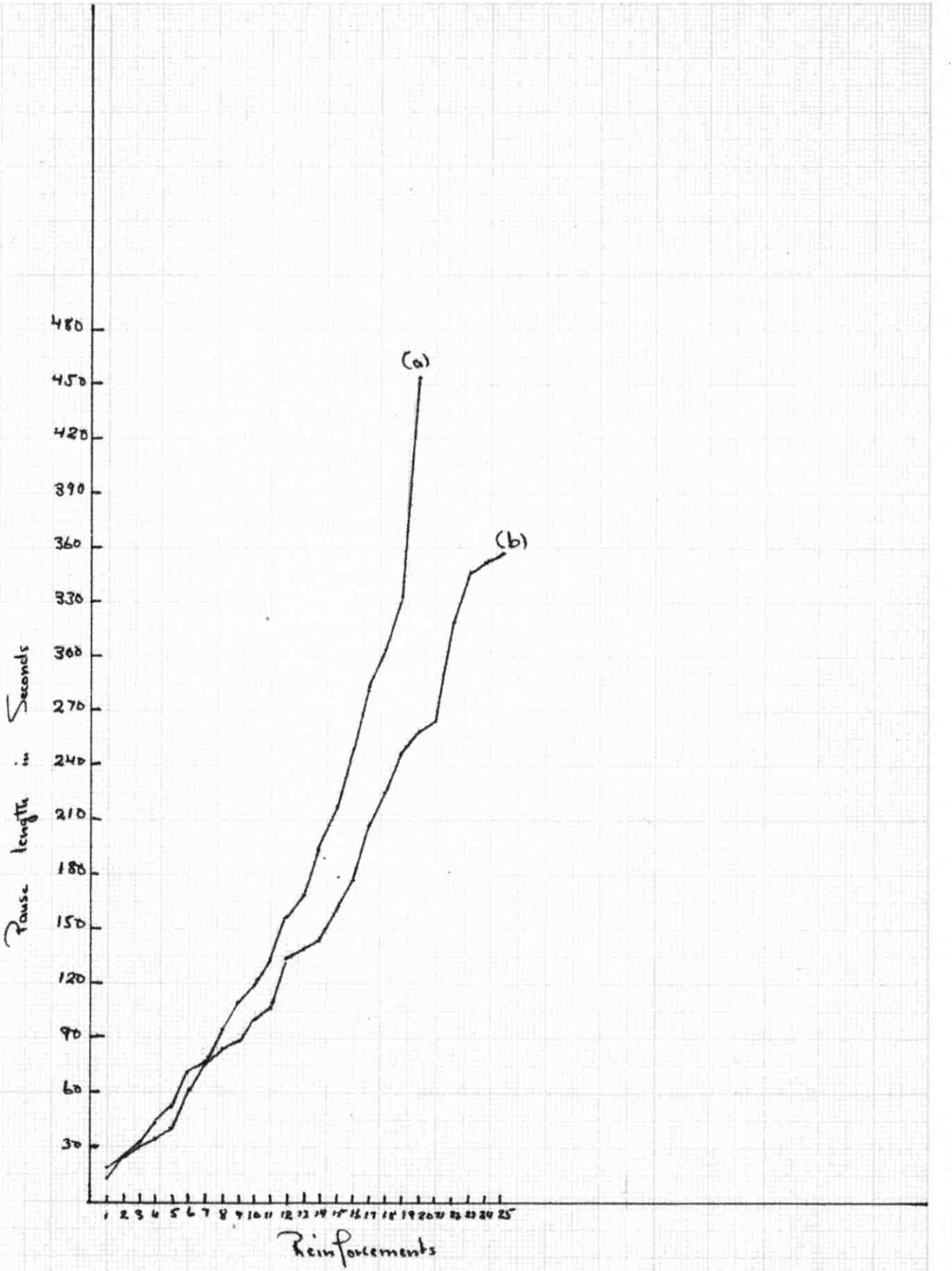

Figure 52. Cumulative records of animal Ky2 after the short ratio. (a) pause on pre-test day (Dark). (b) pause on test day (Light).

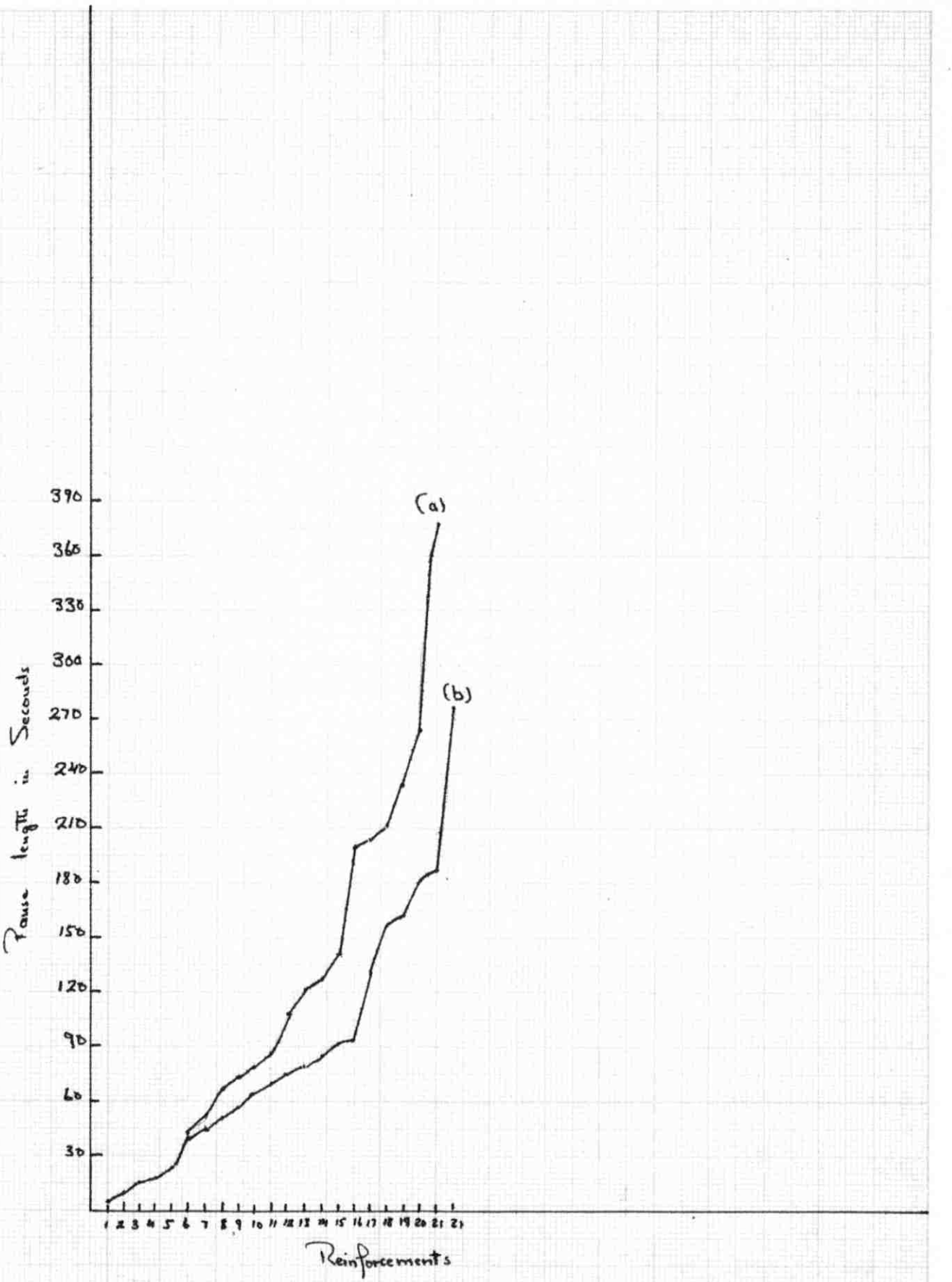

Figure 53. Cumulative records of animal Ky 3 after the short ratio. (a) Pause on pre-Test day (Dark). (b) Pause on Test day (light).

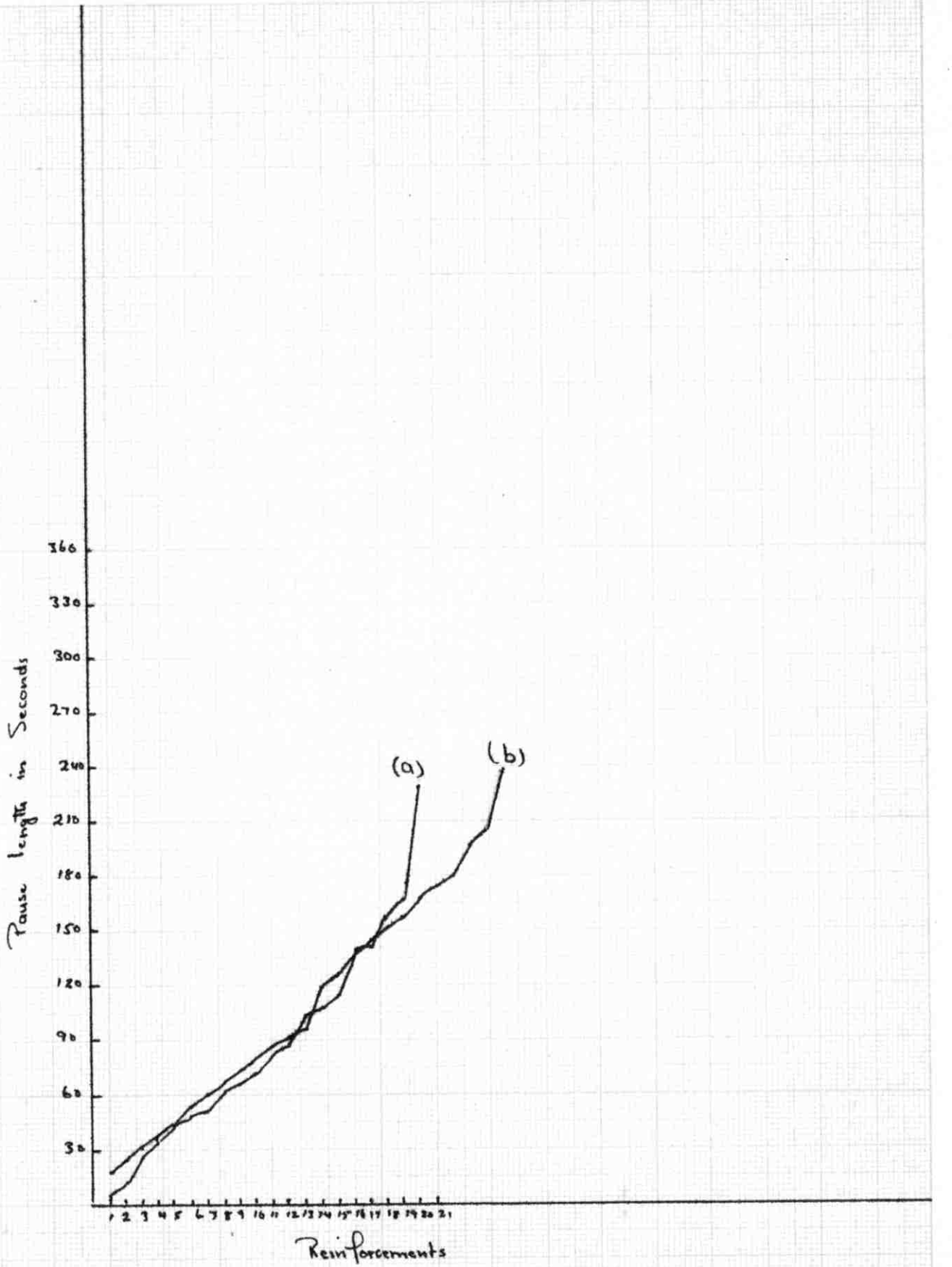

Figure 54. Cumulative records of animal Ky 22 after the short ratio. (a) Pause on pre-Test day (Dark). (b) Pause on Test day (Light).

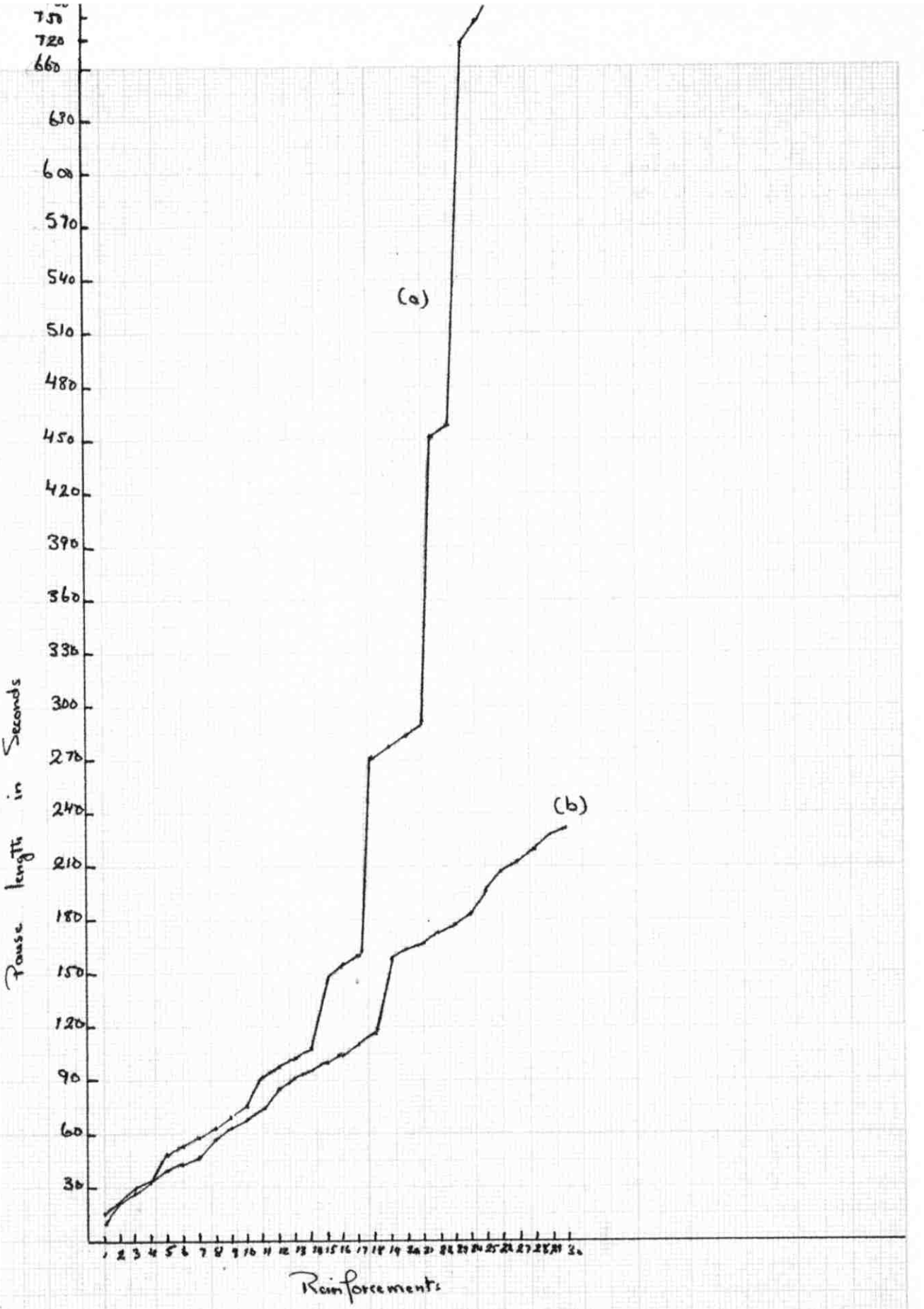

Figure 55. Cumulative records of animal Ky 23 after the short ratio. (a) Pause on pre-Test day (Dark). (b) Pause on Test day (Light)

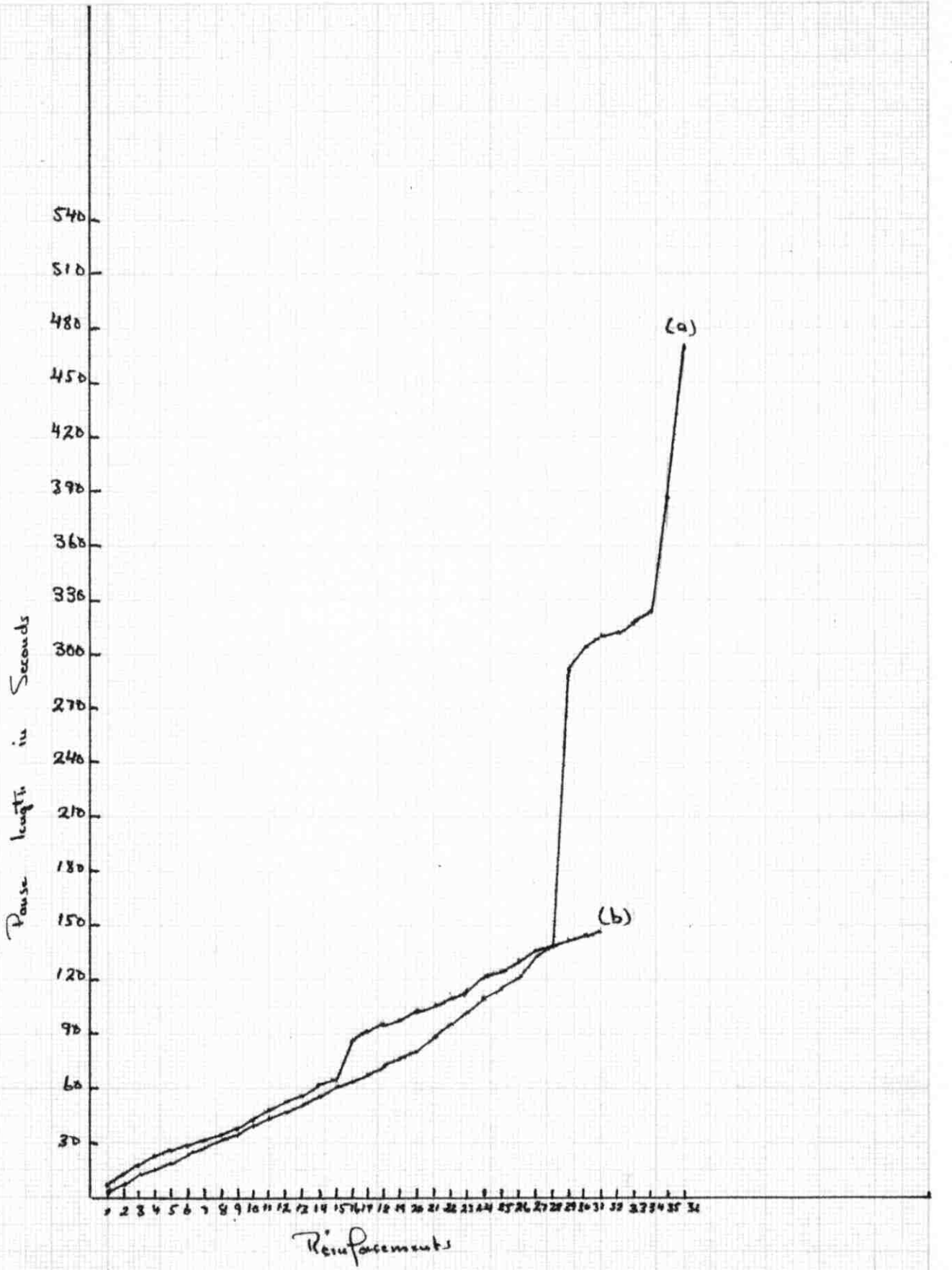

Figure 56. Cumulative records of animal 164 24 after the short ratio. (a) Pause on pre-test day (Dark). (b) Pause on the Test day (light).

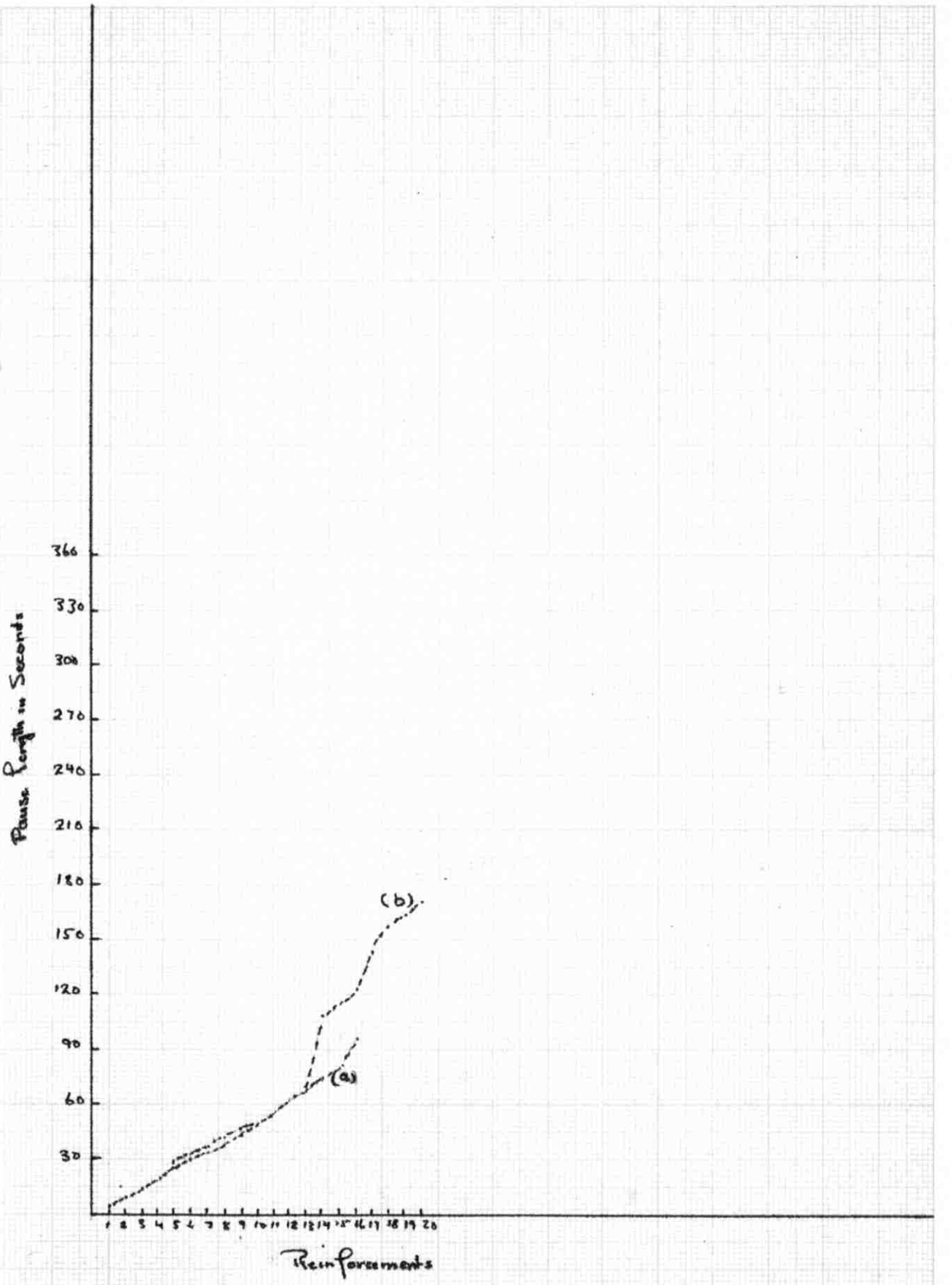

Figure 57. Cumulative records of animal Ky 2 after the long ratio. (a) pause on pre-Test day (b) pause on Test day (Dark)

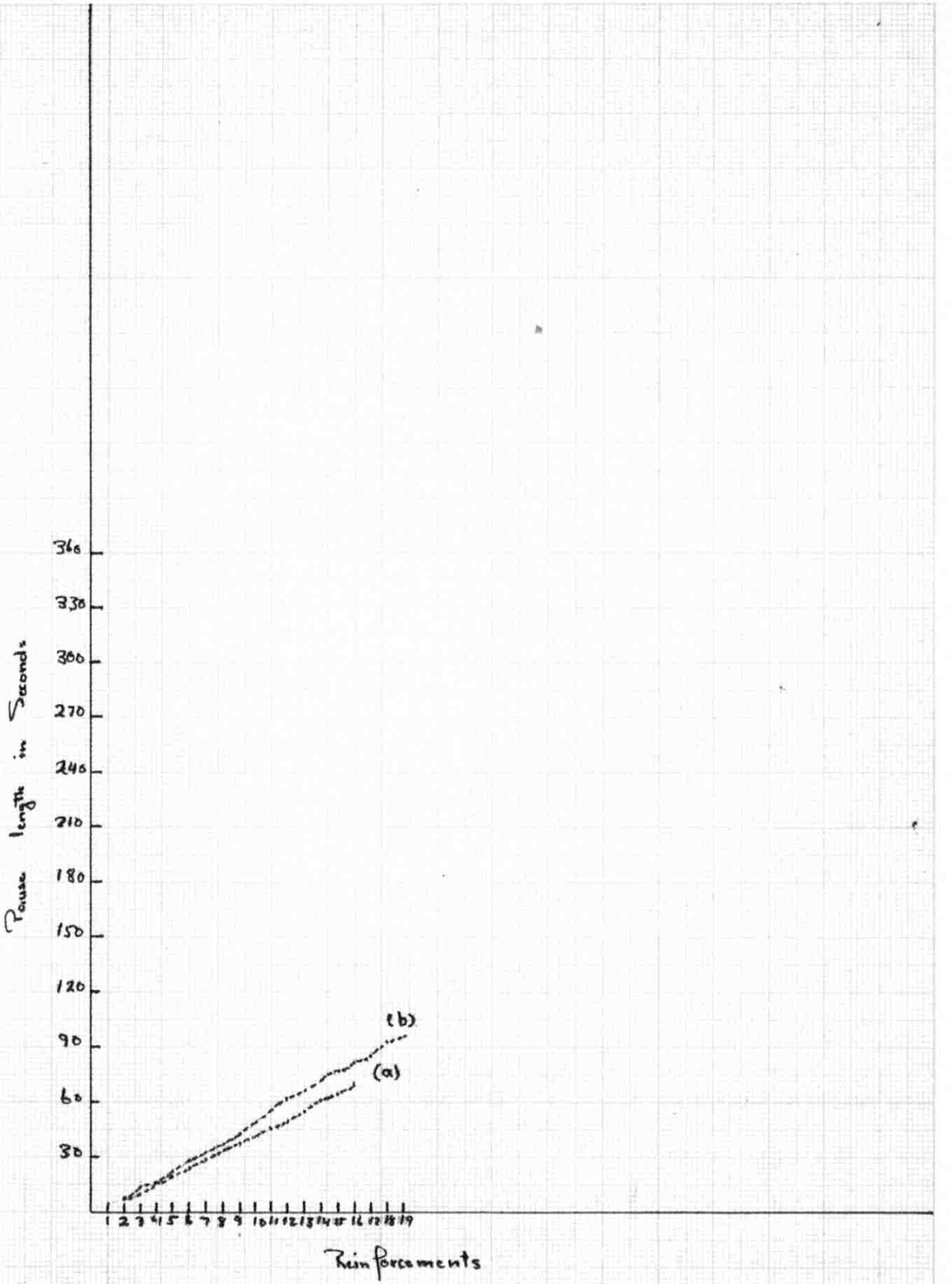

Figure 58. Cumulative records of animal Ky 3 after the long ratio. (a) Pause on pre-test day (light). (b) Pause on test day (dark)

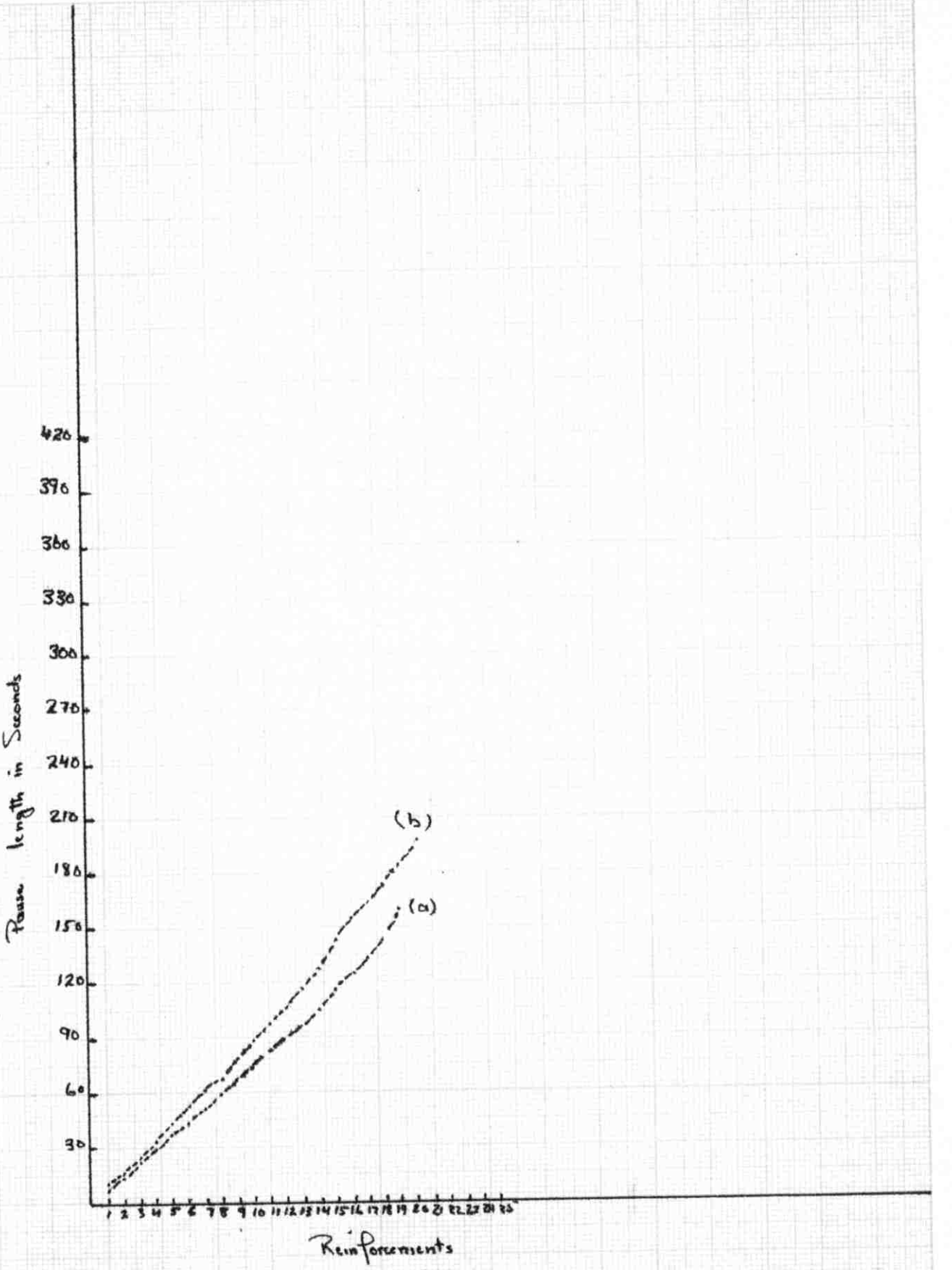

Figure 59. Cumulative records of animal Ky 22 after the long ratio. (a) Pause on pre-test day (light). (b) Pause on test day (dark)

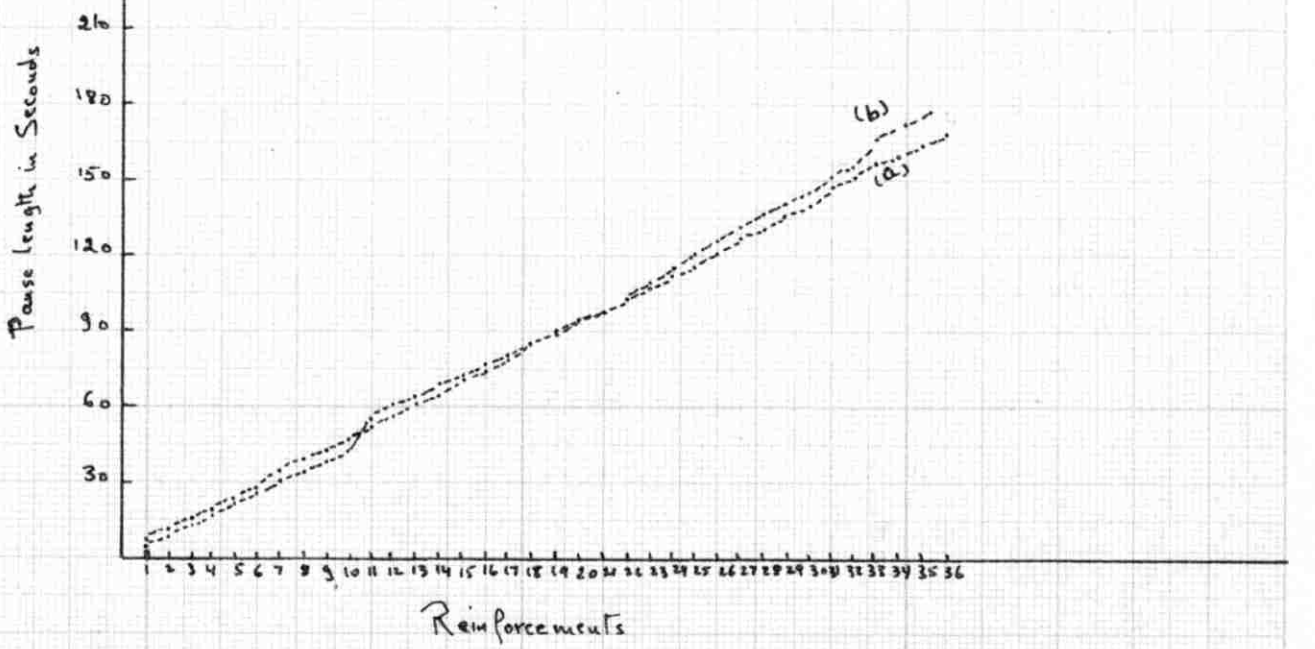

Figure 60. Cumulative records of animal Ky 23 after long ratio. (a) Pause on pre-test day (light). (b) Pause on test day (dark)

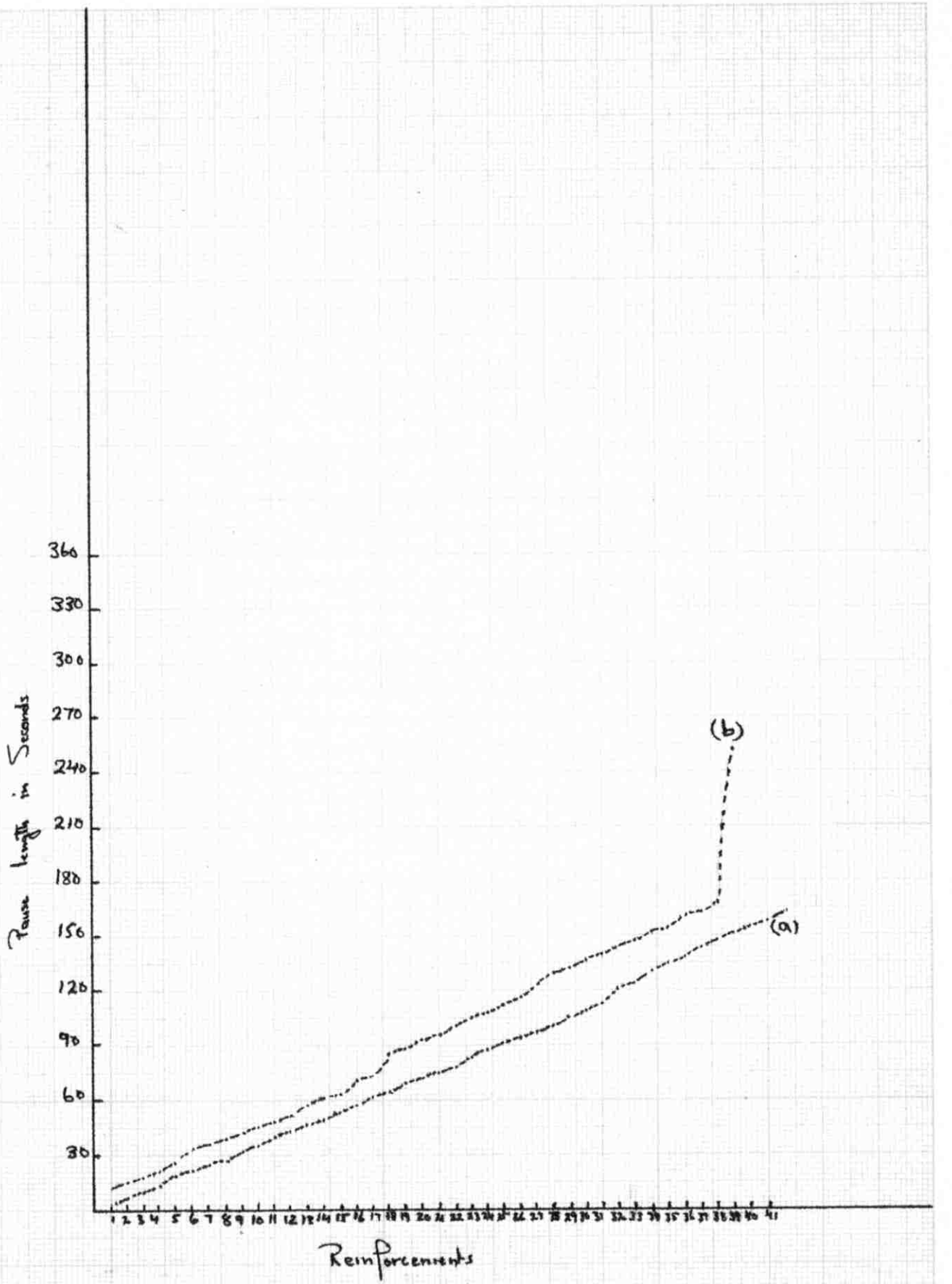

Figure 61. Cumulative records of animal 1Cy 24 after the long ratio. (a) Pause on pre-test day (light). (b) Pause on test day (dark)

Chapter IV

Discussion

The stimulus conditions controlling the post-reinforcement pause length are no doubt complex, but two simplified possibilities will be discussed in the light of the present results. These are the possibility that:

Explanation A. The stimulus condition present during the pause controls the length of the pause.

Explanation B. The stimulus condition present during the preceding ratio controls the length of the post-reinforcement pause.

Diagram (a) shows schematically the results of the present experiment, namely that normally long pauses followed the short ratio and short pauses followed the long ratio.

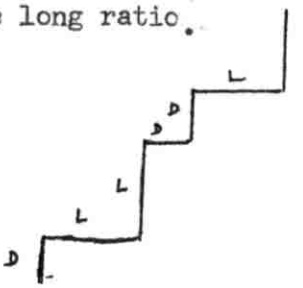

Diagram (a).

It is also shown in Diagram (a) that the long ratio and the preceding long pause were performed in the light (L), while the short ratio and the preceding short pause were performed in the absence of the light (D).

The test for the effect of the exteroceptive stimulus on the post-reinforcement pause length was carried out in either of two ways: first, by light being paired with both ratios; second, by dark being paired with both ratios.

Explanation A.

In terms of Explanation A, then, if the light controlled the long pause and its absence controlled the short pause, the expected results of changing the exteroceptive stimulus condition would be as follows:

Condition 1: Light paired with both ratios.

Under this test, the change occurred in the stimulus condition present during the short pause which had taken place previously in the absence of light. Now with the introduction of light, the short pause would be expected to increase in length if, previously, light had functioned to control the long pause. However, the long pause following the short ratio would not be expected to change in length, (except through interaction effects), for no change occurred in the prevailing stimulus condition.

The results, as shown in Table 2 and figs. 2-6, do not conform to this expectation. There was a decrease instead of an increase in the post-reinforcement pause length after the long ratio (short pause) in the case of animals Ky22, Ky23, and Ky24. Two tests were performed with animal Ky2. In one test, there was almost no change in the pause length after the long ratio; while in the other there was an increase, as expected, but it was small. Also, a very small increase occurred in the case of animal Ky3. Furthermore, the pause after the short ratio decreased instead of keeping its length, and this was the case with all animals, except animal Ky24. The pauses of this animal did not practically change in length.

Condition 2. Light removed from both ratios

Under this test, the change occurred in the stimulus condition present during the long pause which had taken place previously in the presence of light. Now, if explanation A is correct with the removal of

light, the long pause would be expected to decrease in length if, previously, the absence of light had functioned to control the short pause. However, the short pause following the long ratio would not be expected to change in length (except through interaction effects), for no change occurred in its stimulus condition.

The results, as shown in Table 2 and figs. 2-6, partially confirm Explanation A. There was a decrease in the post-reinforcement pause length after the short ratio (long pause), as supported by all animals (N = 4), except animal Ky24. The pauses of this animal did not practically change in length. However, the pauses after the long ratio (short pause) increased in length, as shown by all animals except animal Ky23. The pause of this animal decreased instead of remaining the same.

All in all, the results from condition 1 do not support the expectations derived from Explanation A. Of 6 possible changes, only 2 were in the expected direction. Nevertheless, these latter changes were very small to be taken into consideration. However, in condition 2, of 5 possible changes, 4 were in the expected direction.

Explanation B.

In accordance with Explanation B, if light controls the short pause and its absence controls the long pause, the expected results of changing the exteroceptive stimulus conditions would be as follows:

Condition 1: Light paired with both ratios.

Under this test, the change occurred in the stimulus condition present during the short ratio which had taken place previously in the absence of light. Now, with the introduction of light, the long pause following the short ratio would be expected to decrease in length if,

previously, light had functioned to control the short pause. However, the short pause after the long ratio would not be expected to change in length (other than through interaction effects), for no change occurred in its prevailing stimulus condition.

The results, as shown in Table 2 and figs 2-6, confirm this expectation. There was a decrease in the post-reinforcement pause length after the short ratio (long pause), as supported by all animals (N = 4), except animal Ky24. The pauses of this animal did not practically change in length. However, the post-reinforcement pause lengths after the long ratio (short pause) did not keep their original lengths, as shown by all animals. The changes were not consistent. There was an increase in the pause length after the long ratio shown by 2 animals, but in the case of animals Ky22, Ky23, and Ky24 a decrease occurred.

Condition 2: Light removed from both ratios.

Under this test, the change occurred in the stimulus condition present during the long ratio which had previously been run in the presence of light. Now, with the removal of light, the short pause following the long ratio would be expected to increase in length if, previously, the absence of light had functioned to control the long pause. However, the long pause following the short ratio would not be expected to change in length(other than through interaction effects), for no change occurred in its prevailing stimulus condition.

The results in Table 2 and figs. 2-6, generally confirm these expectations. There was an increase in the post-reinforcement pauses after the long ratio (short pause), of all animals except animal Ky23. The pauses of this animal decreased in length. However, the pauses after the short ratio (long pause) decreased in length instead of its remaining

the same in the case of all animals (N = 4) except animal Ky24. The amount of this decrease in the pause lengths after the short ratios was even larger than the amount of increase in the pause lengths after the long ratios. However, the variability of the former and the stability of the latter curves gave more importance to the change after the long ratio.

Altogether the results on mean pauses obtained in this experiment do not give clear support for either Explanation A or Explanation B. However, if interaction effects are ignored for the moment and attention is concentrated only on those changes in pause lengths that would be expected as a direct result of the stimulus changes, the weight of evidence supports the notion that the stimulus condition present prior to the pause controlled its length.

Thus, according to Explanation B, 5 out of 6 predictions in Condition 1 were in the expected direction. Also, in Condition 2, 4 out of 5 predictions were confirmed. That is, pauses decreased when they were expected to do so (Condition 1), and they also increased as expected (Condition 2). This result confirms previous tentative findings of Salman,(24) which are not entirely convincing.

The notion that the stimulus conditions present during the preceding ratio controlled the post-reinforcement pause length received further confirmation from the cumulative records (figs.57-61). The development of the post-reinforcement pause length can be easily traced through these cumulative curves which aid in explaining the fluctuations in mean pauses occuring after the short ratio from day to day (figs. 2-6). The cumulative curves help in locating the points at which any abrupt increase

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(24) Salman, op.cit., p. 24.

within a session occurs, thus affecting the mean pause on any day. Furthermore, figs 51-61 show that changes in pause length resulting from changes in the stimulus conditions occurred in the expected directions, thus supporting the above notion that the post-reinforcement pause length is controlled by the stimulus conditions prevailing during the preceding ratio. However, changes in the post-reinforcement pause length occurring in the absence of changes in the stimulus conditions can be attributed to interaction effects. Such unexpected changes might have been due to the behavior of the organism itself rather than the exteroceptive stimuli present during the schedule.(25) Such a possibility would contradict Skinner's assumption that each of a set of performances exhibited by the animal could be brought under separate exteroceptive stimulus control.(26)

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(25) Findley, op.cit., p. 132.

(26) Skinner, Cumulative record, op.cit., p. 109.

SUMMARY

Five albino rats were trained to bar press in a Skinner box on a multiple schedule of reinforcement, with light being paired with the longer ratio and dark with the shorter ratio. The general trend of behavior exhibited by all animals shows that long pauses followed short ratios and short pauses followed long ratios. Tests for the effect of the exteroceptive stimulus on the post-reinforcement pause length were carried out in one of two ways: either light being paired with the ratios or light being removed from both ratios (dark).

Curves of mean pauses after the short ratios showed fluctuations while those after the long ratios tended to be stable. When light was paired with both ratios, the post-reinforcement pause length was reduced after the short ratio. However, when dark was paired with both ratios, the post-reinforcement pause length increased after the long ratio.

Cumulative records of post-reinforcement pauses after each ratio confirmed further the above results. It was clearly demonstrated by these cumulative curves that the exteroceptive stimulus present during the preceding ratio controlled the post-reinforcement length.

Appendix I

Figures 7 - 50.

Cumulative records of the pause length of the last 3 pre-test sessions and the test session for all animals.

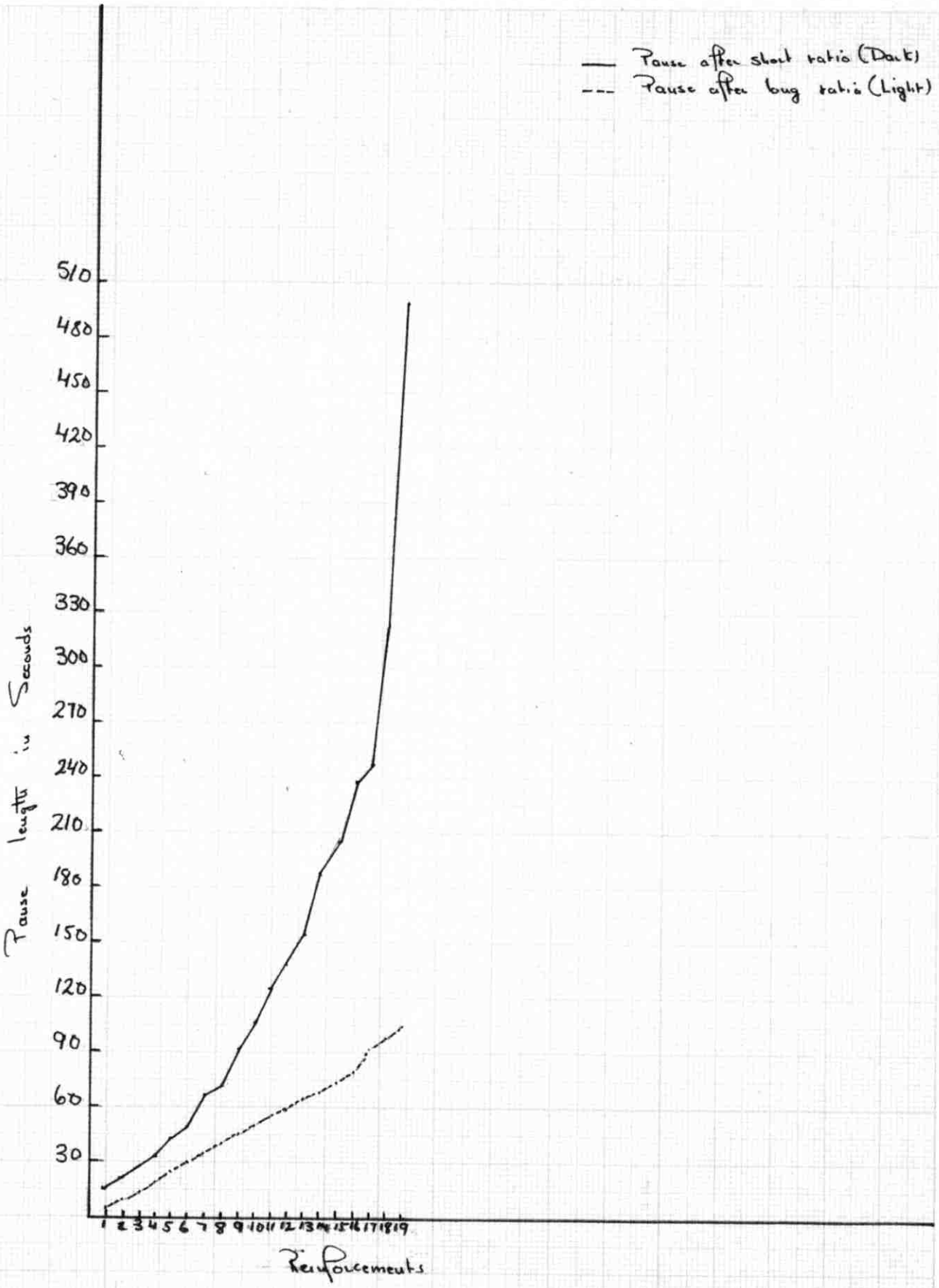

Figure 7. Cumulative record of animal KG 2

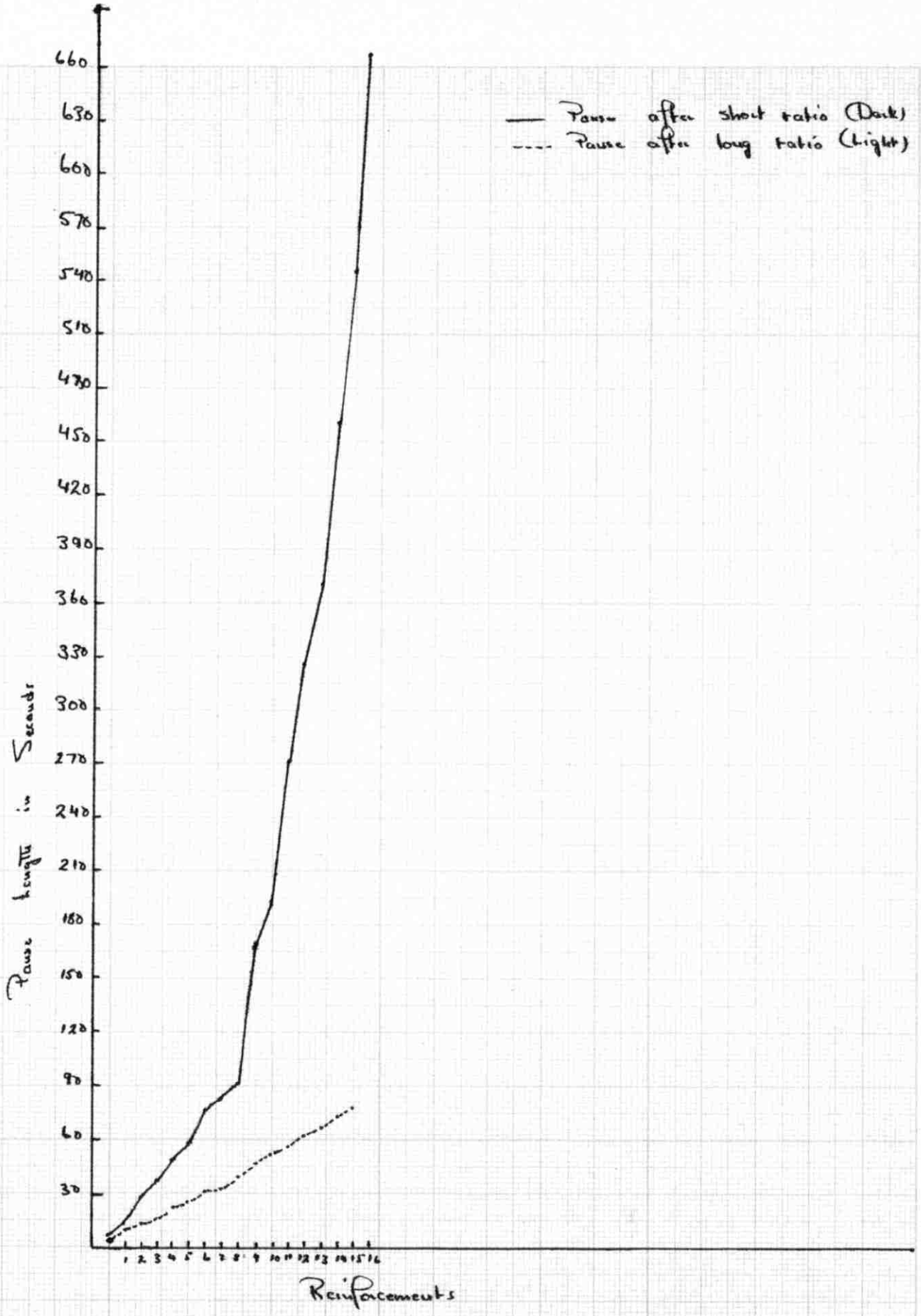

Figure 8. Cumulative records of animal No 2

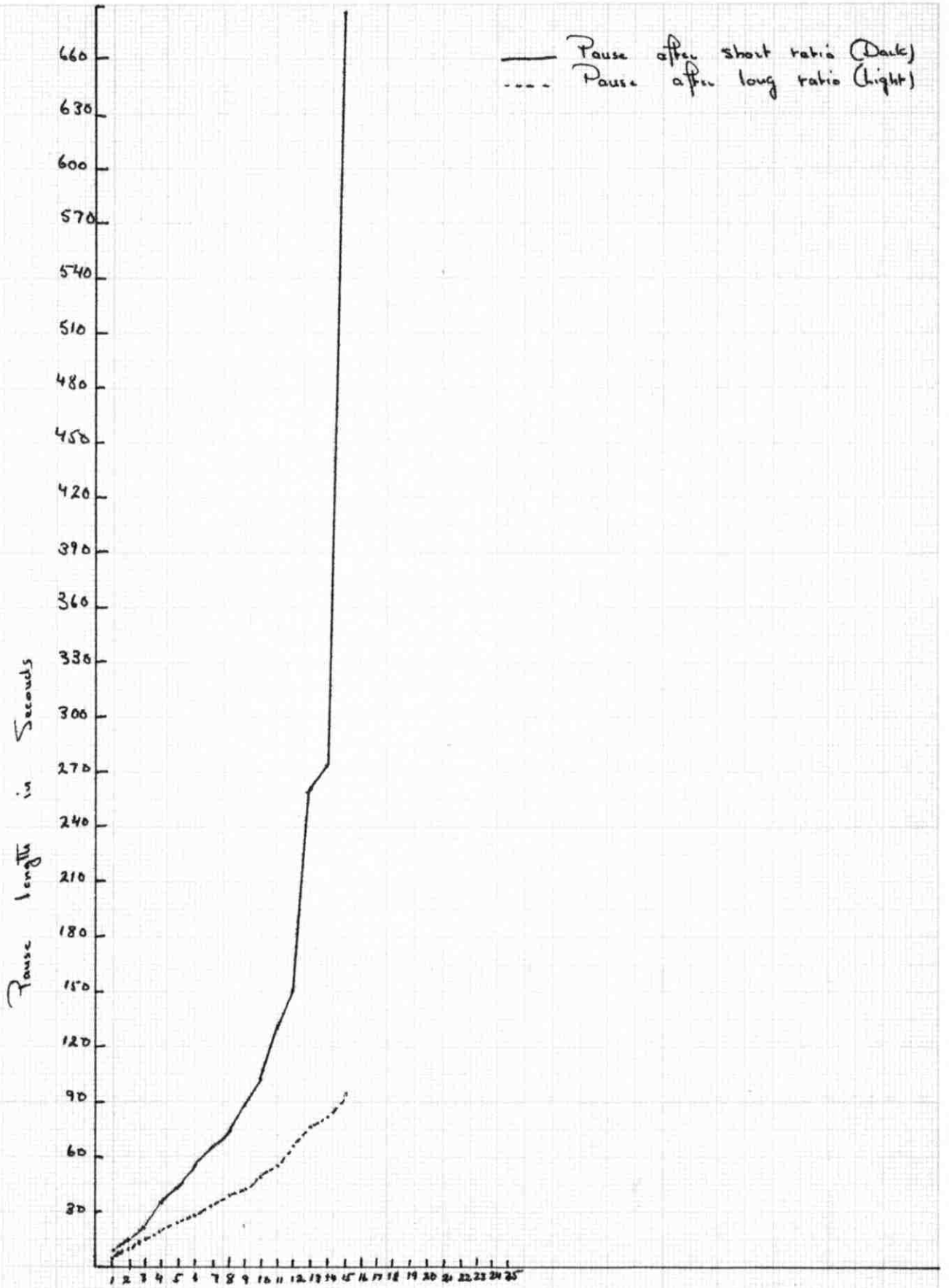

Figure 9. Cumulative records of animal Cy 2

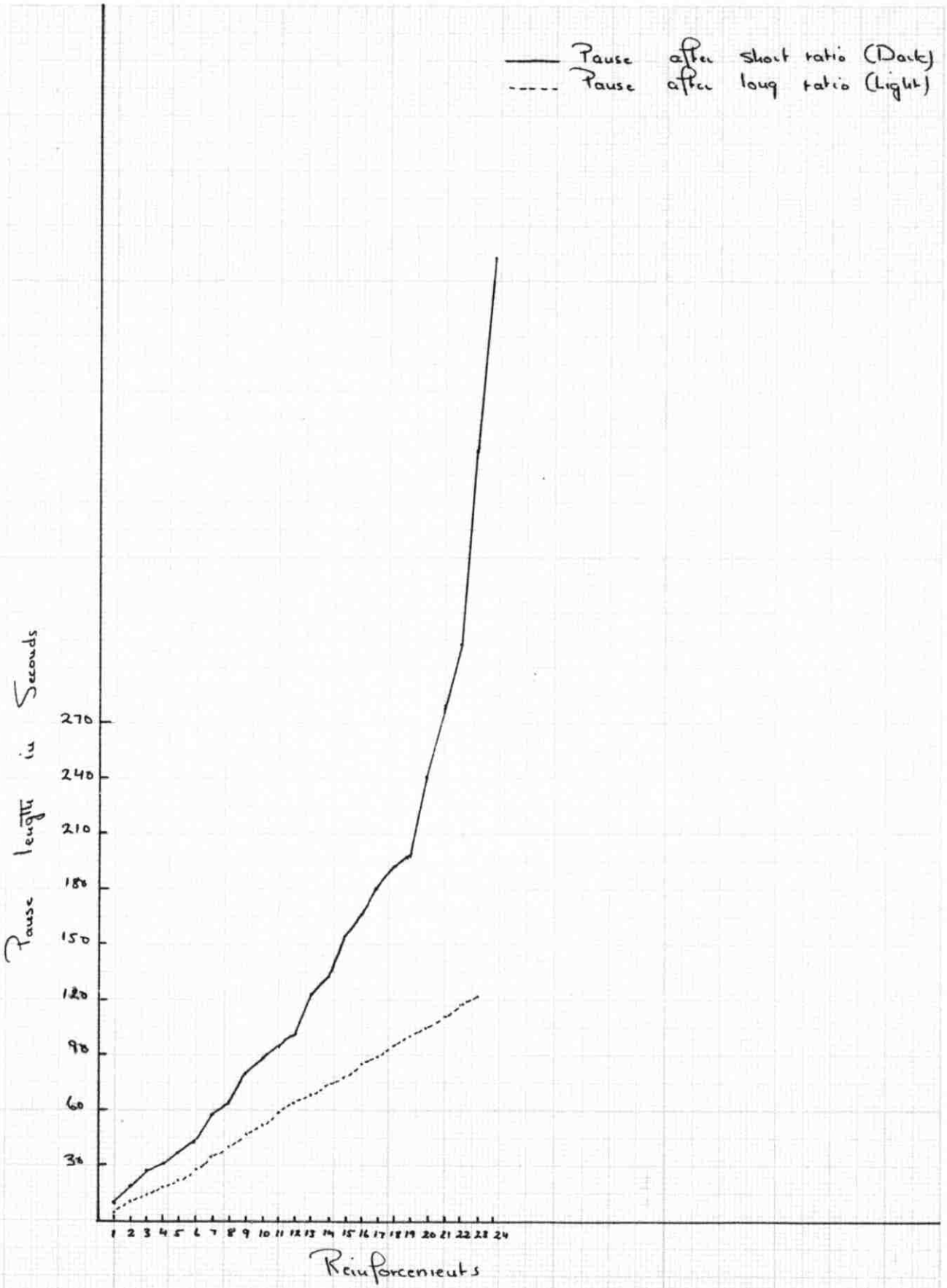

Figure 10. Cumulative records of animal 1Cy 2

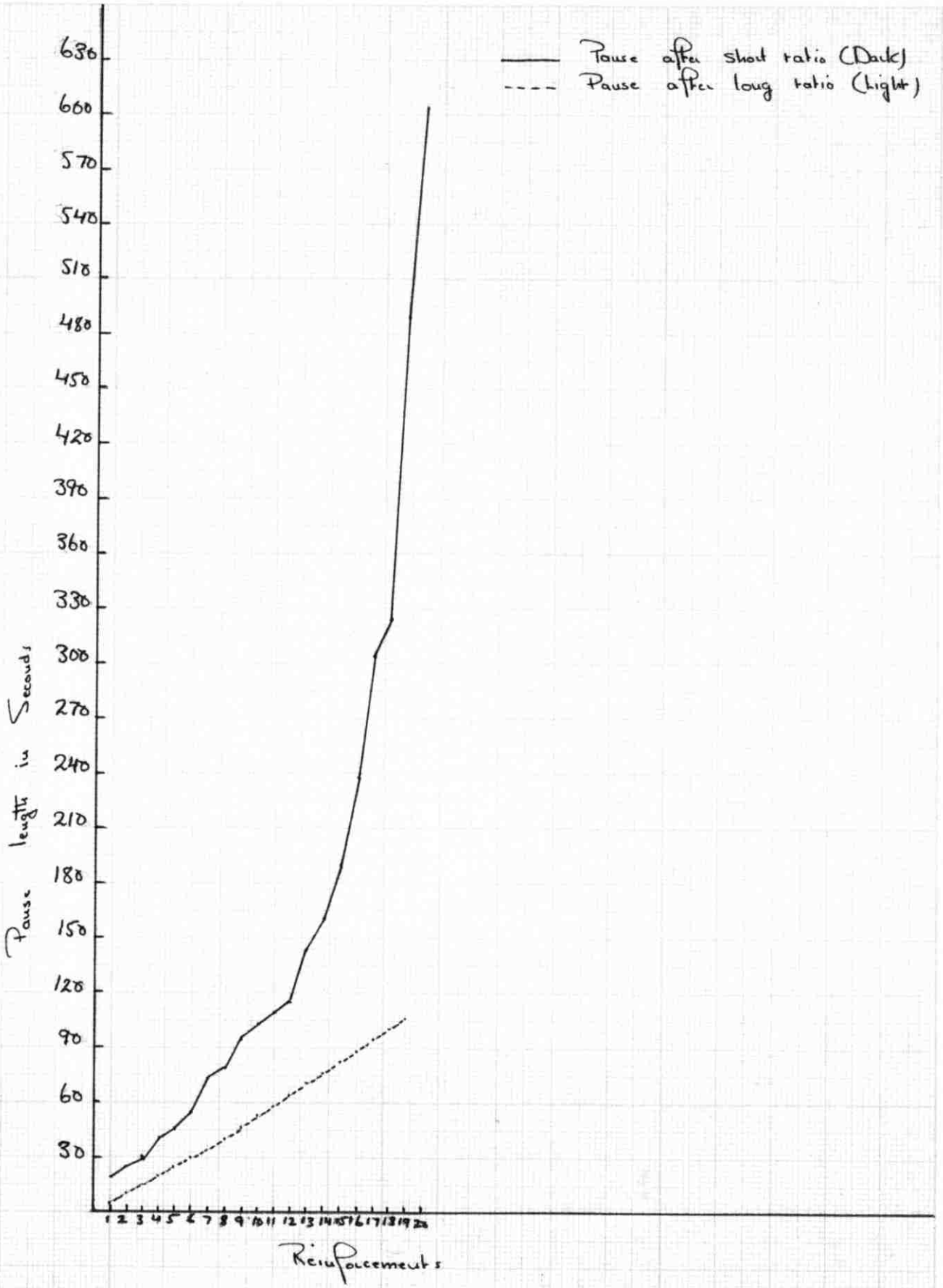

Figure 11. Cumulative records of animal 1Cy 2

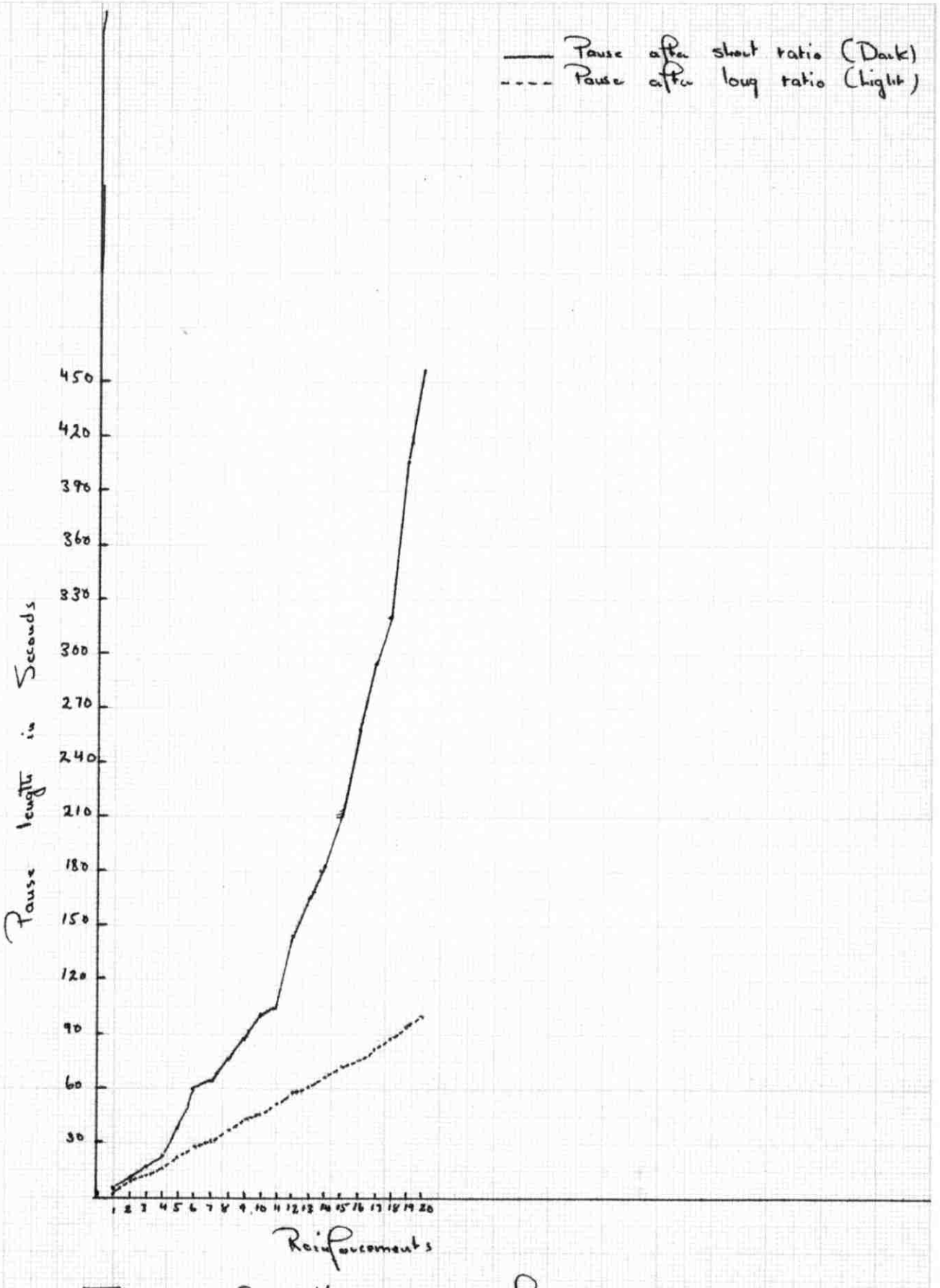

Figure 12. Cumulative records of animal KG 2

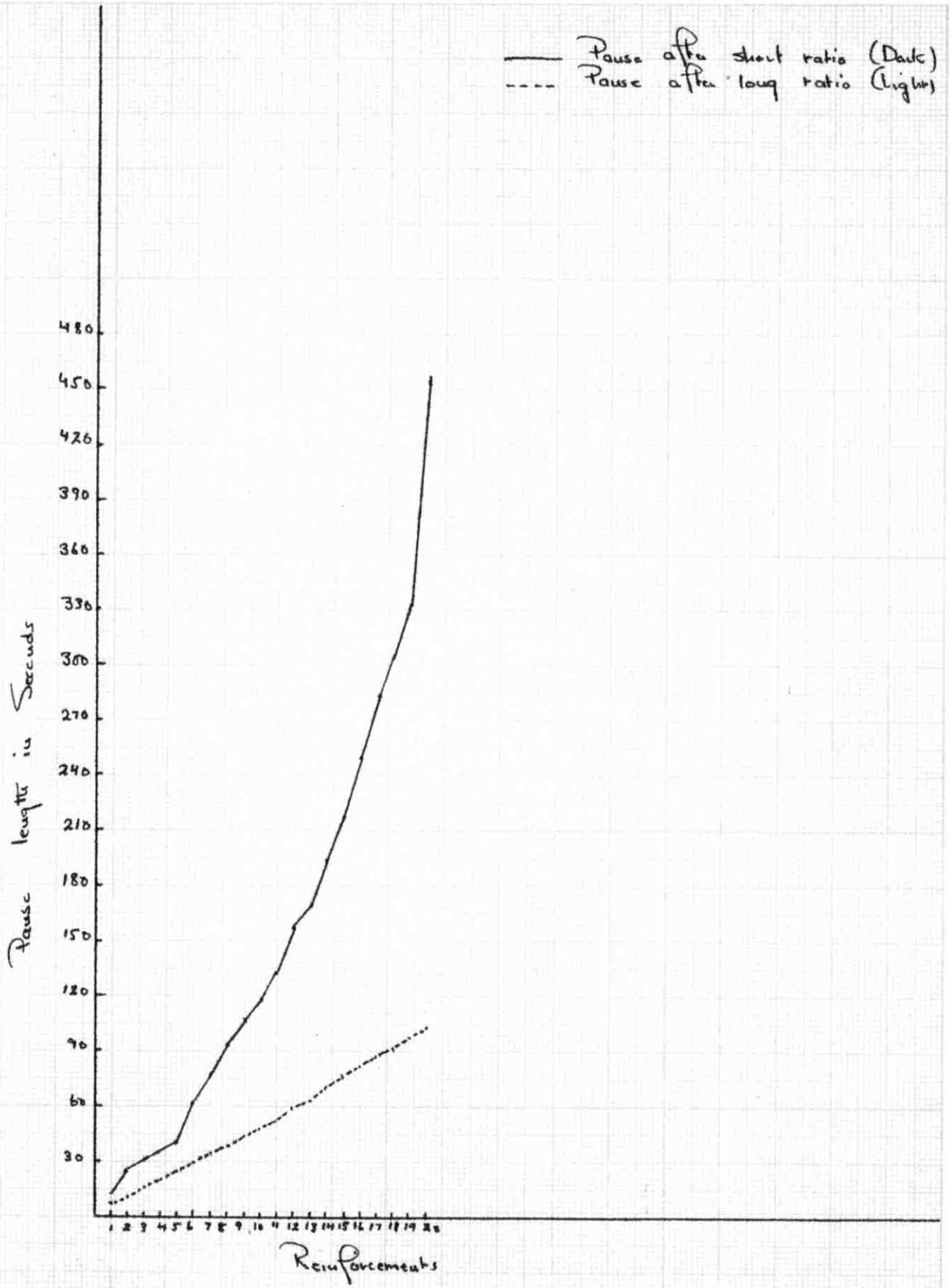

Figure 13. Cumulative records of animal Ky 2

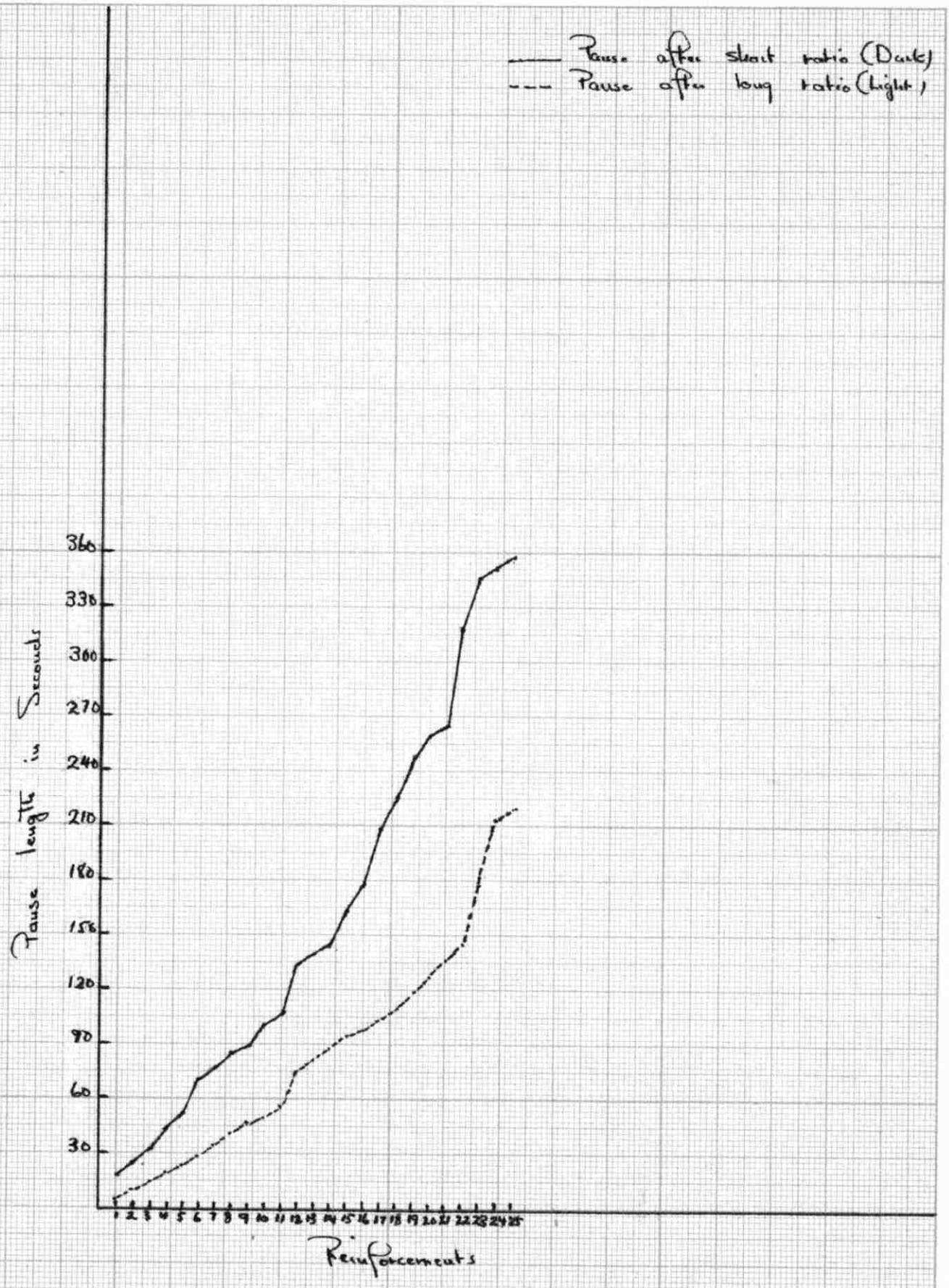

Figure 14. Cumulative records of animal Ky 3

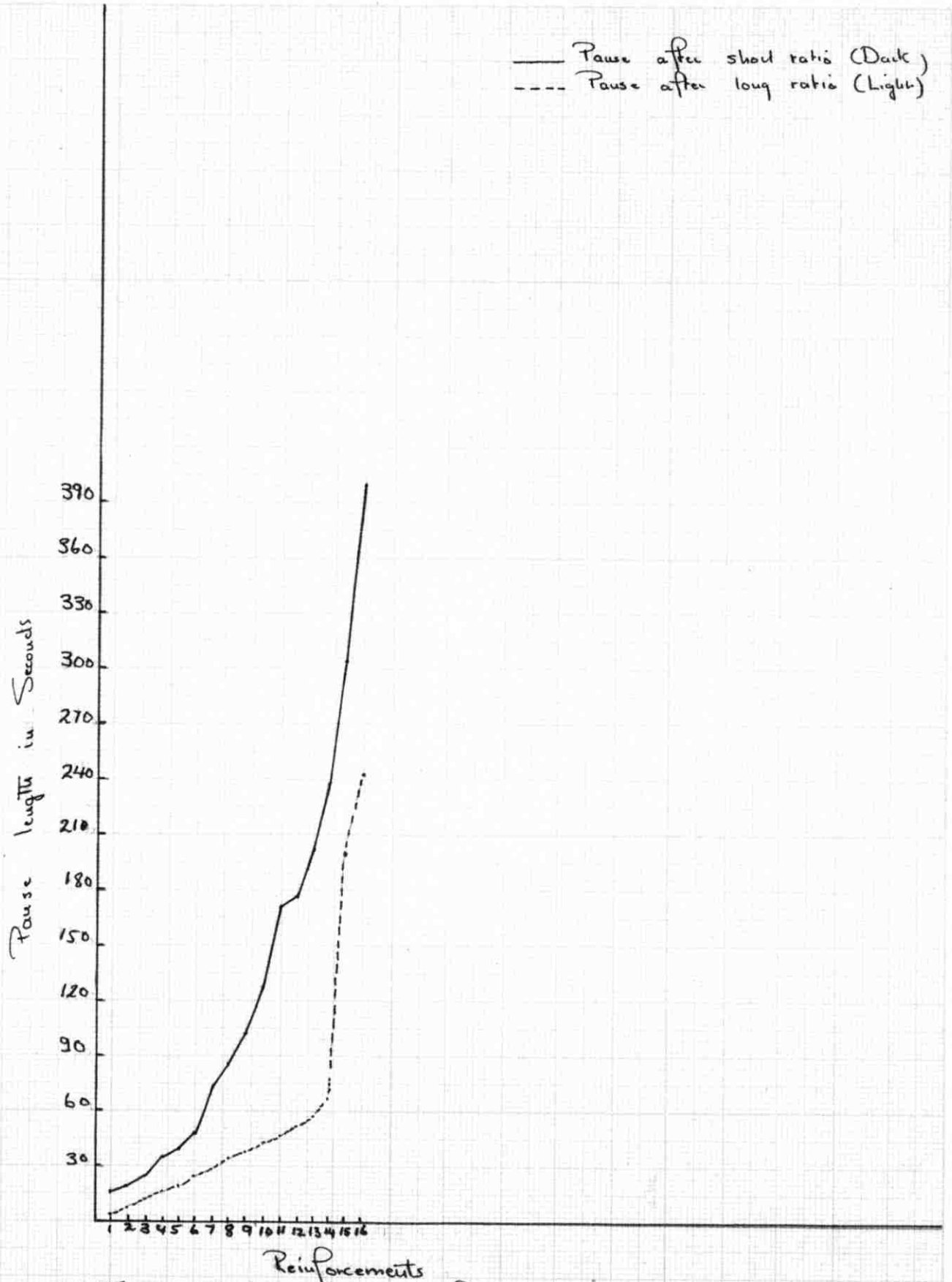

Figure 15. Cumulative record of animal 1Cy 3
Prefed 2 c.c. of 12% sucrose solution

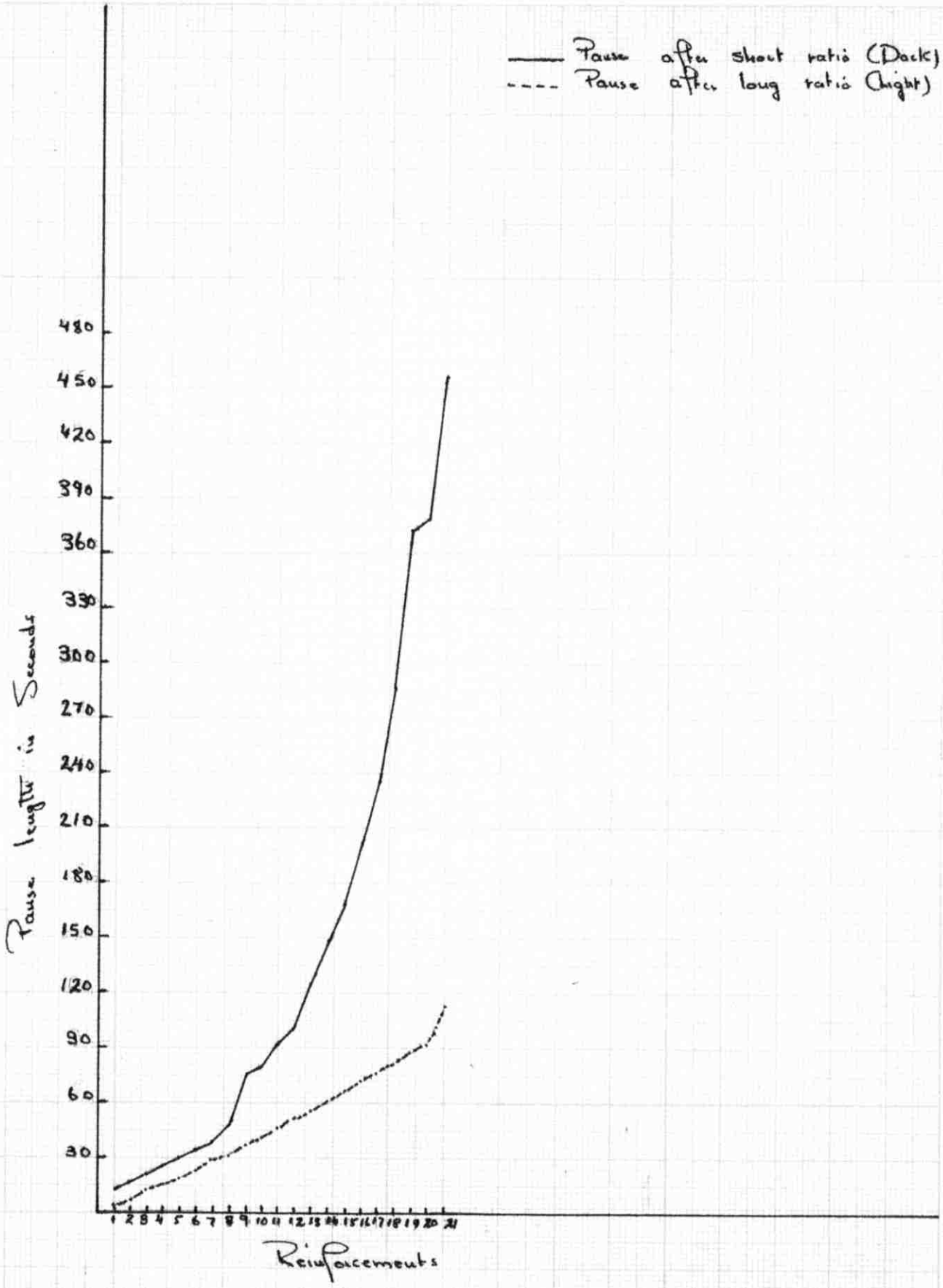

Figure 16. Cumulative record of animal 1Cy3
Prefed 2 c.c. of 12% Sucrose Solution

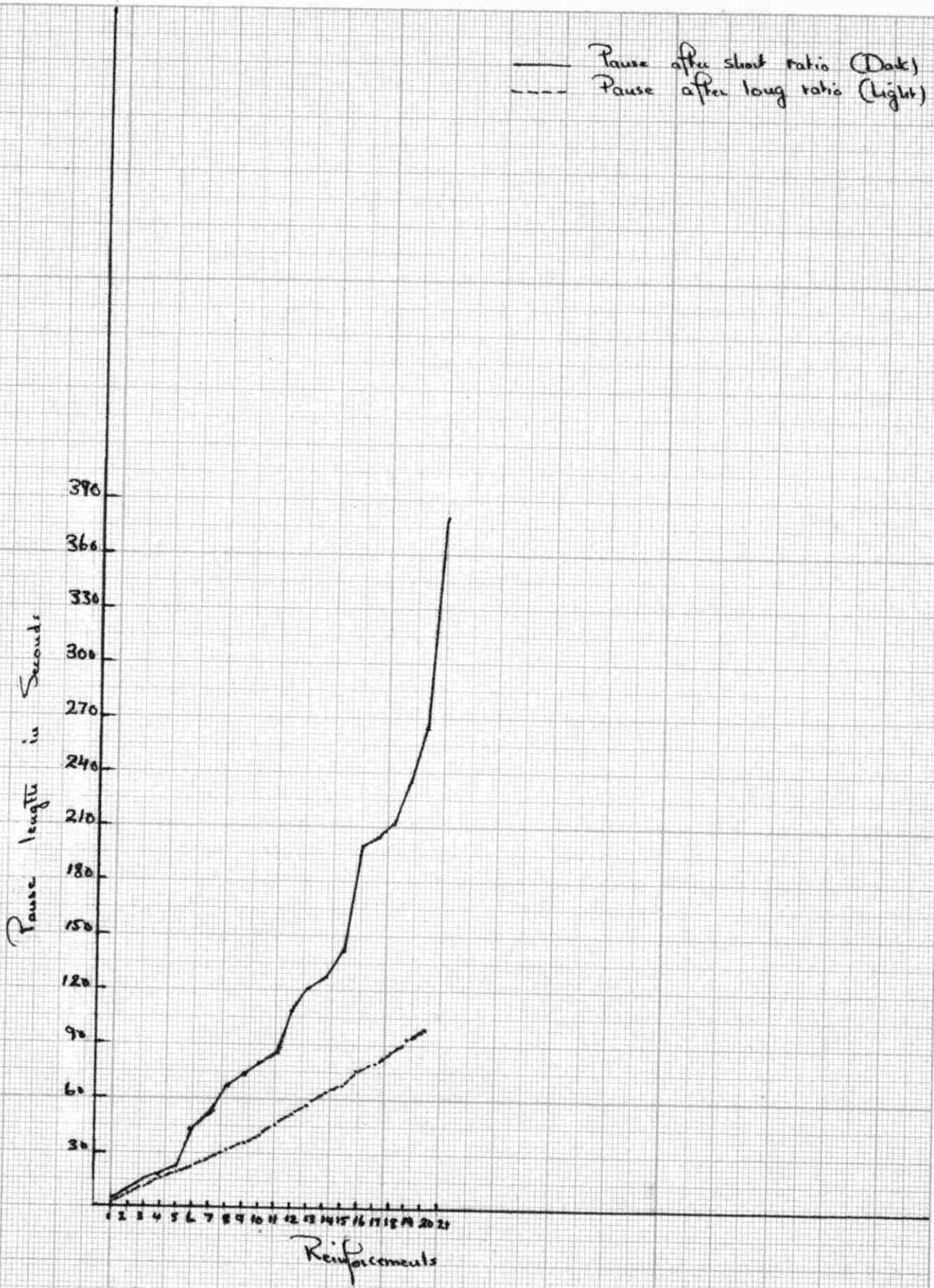

Figure 17. Cumulative record of animal 1Cy 3 Prefed 2c.c. 12% Sucrose Solution

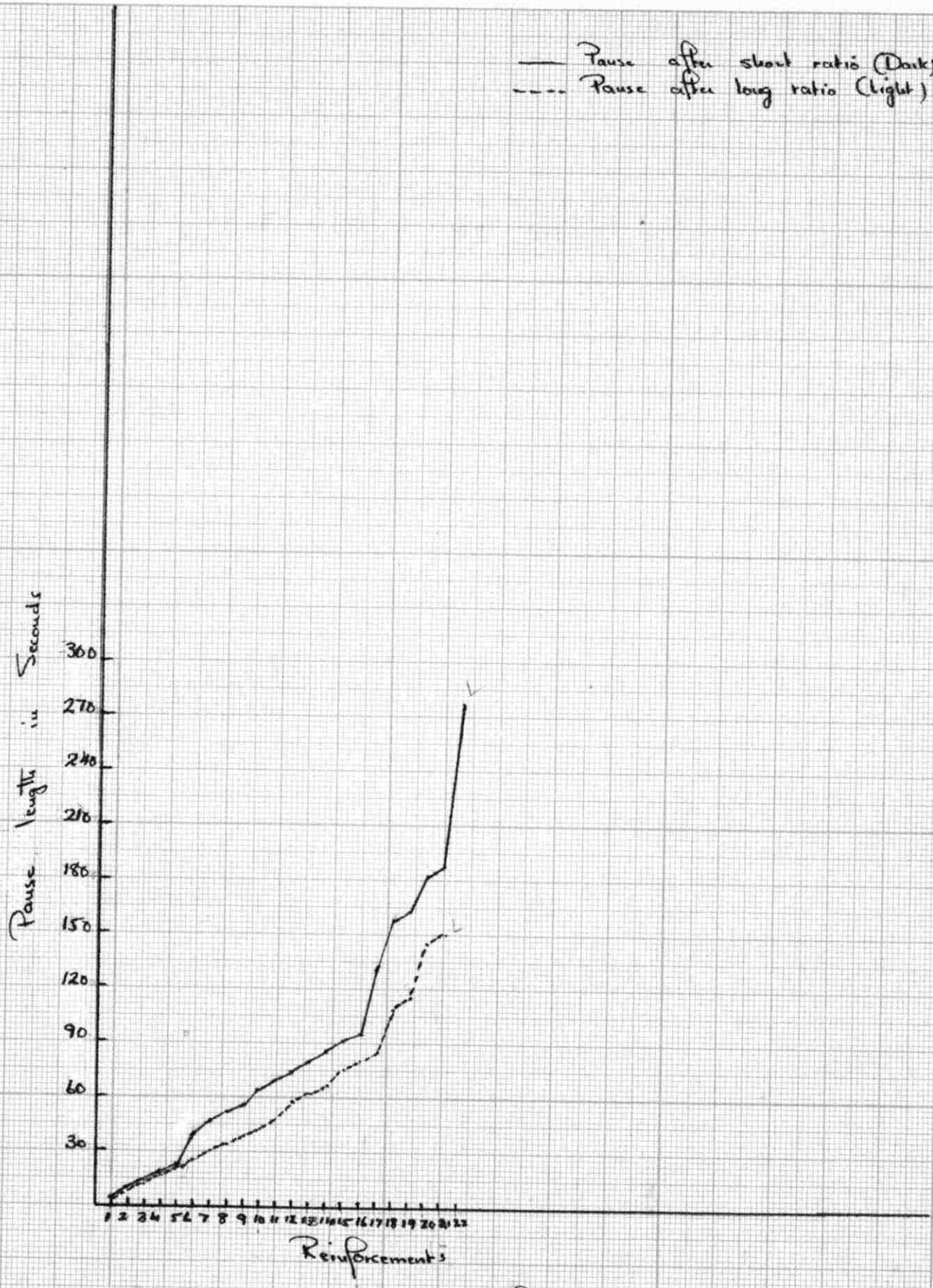

Figure 18. Cumulative record of animal 1C4 3
Test session light. Prefed 2c.c. 12% sucrose solution

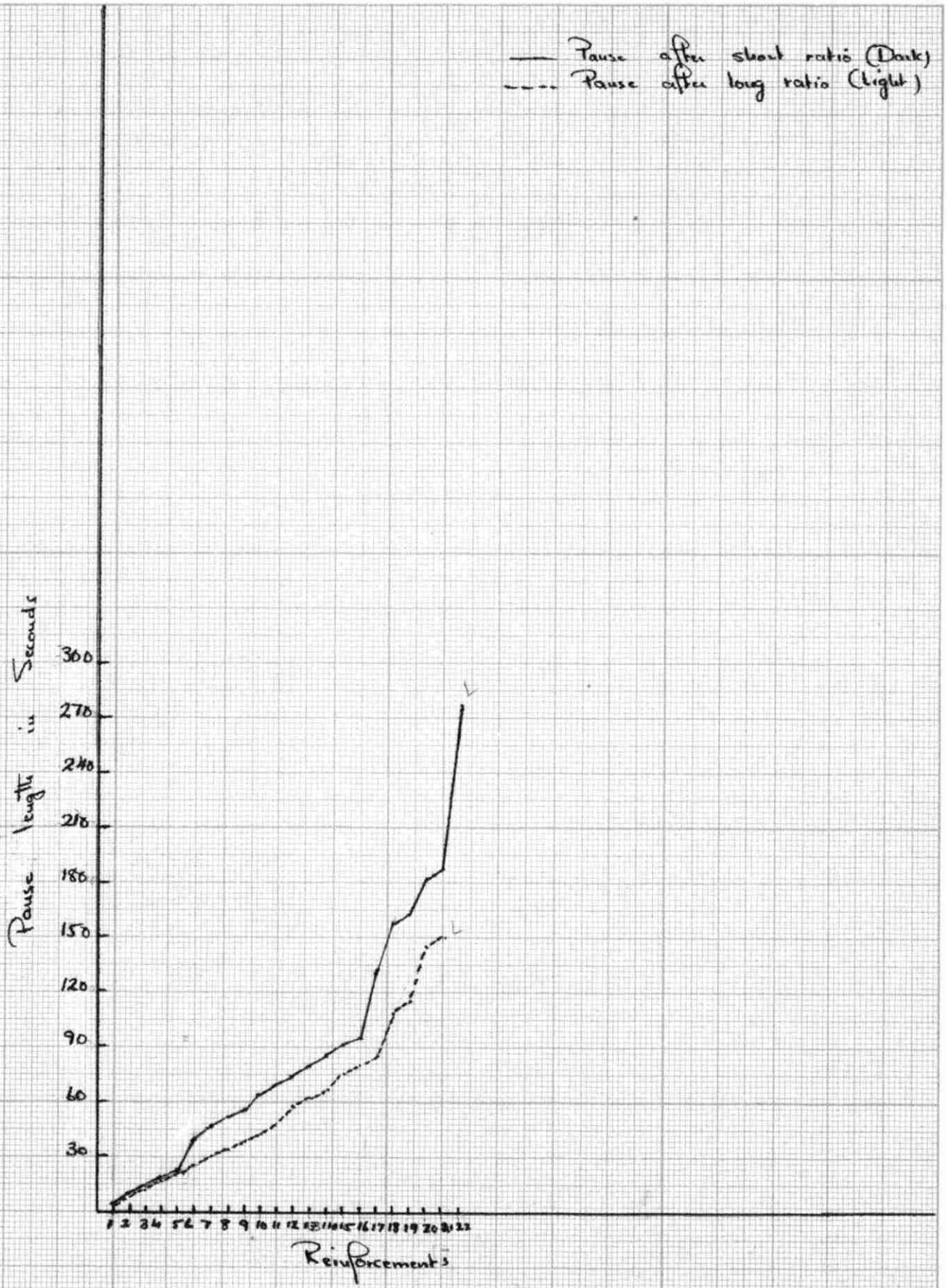

Figure 18. Cumulative record of animal 164 3
Test session light. Prefed 2 c.c. 12% sucrose solution

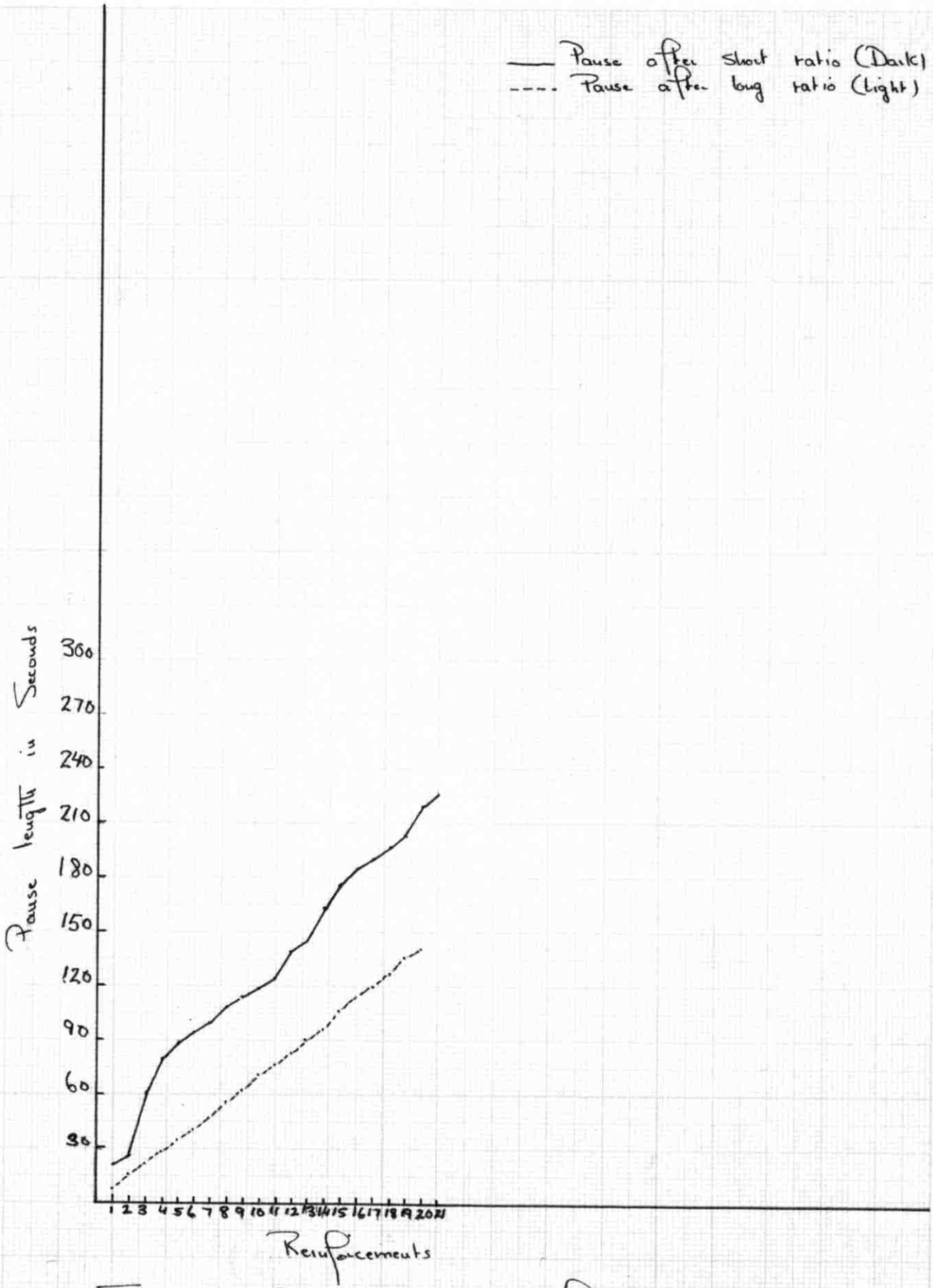

Figure 19. Cumulative record of animal Ky 22

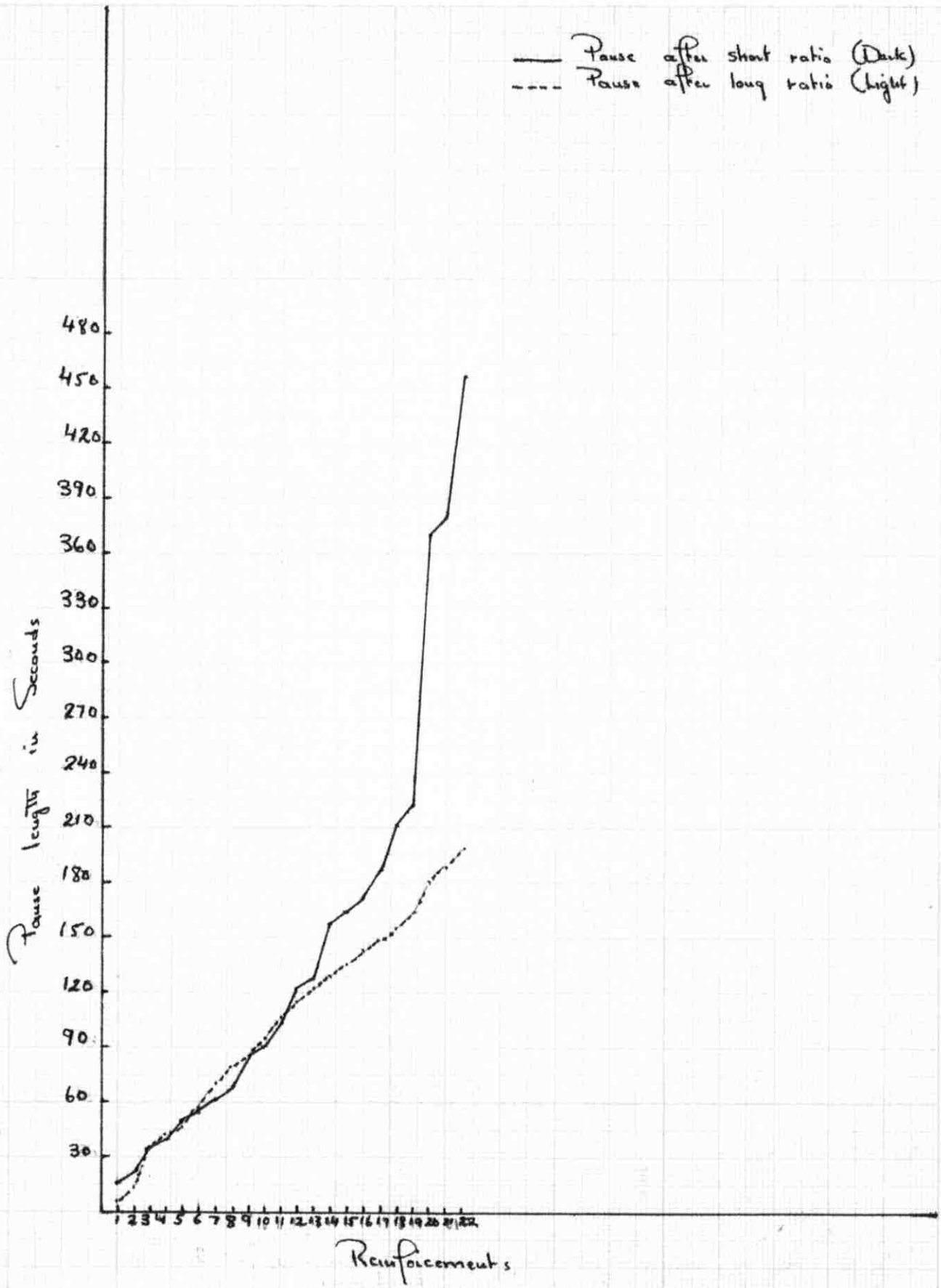

Figure 20. Cumulative record of animal Ky 22

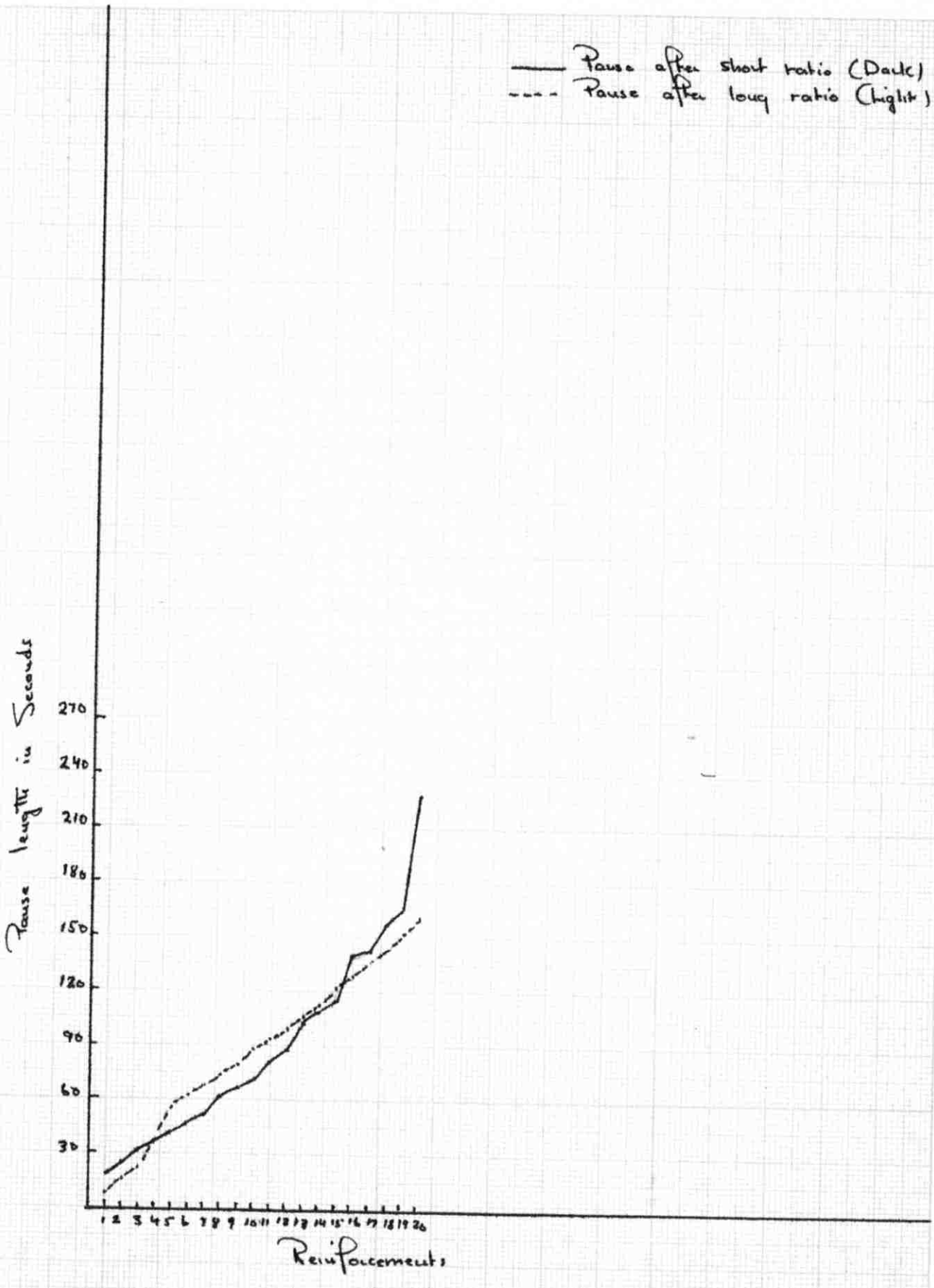

Figure 22. Cumulative record of animal LG 22

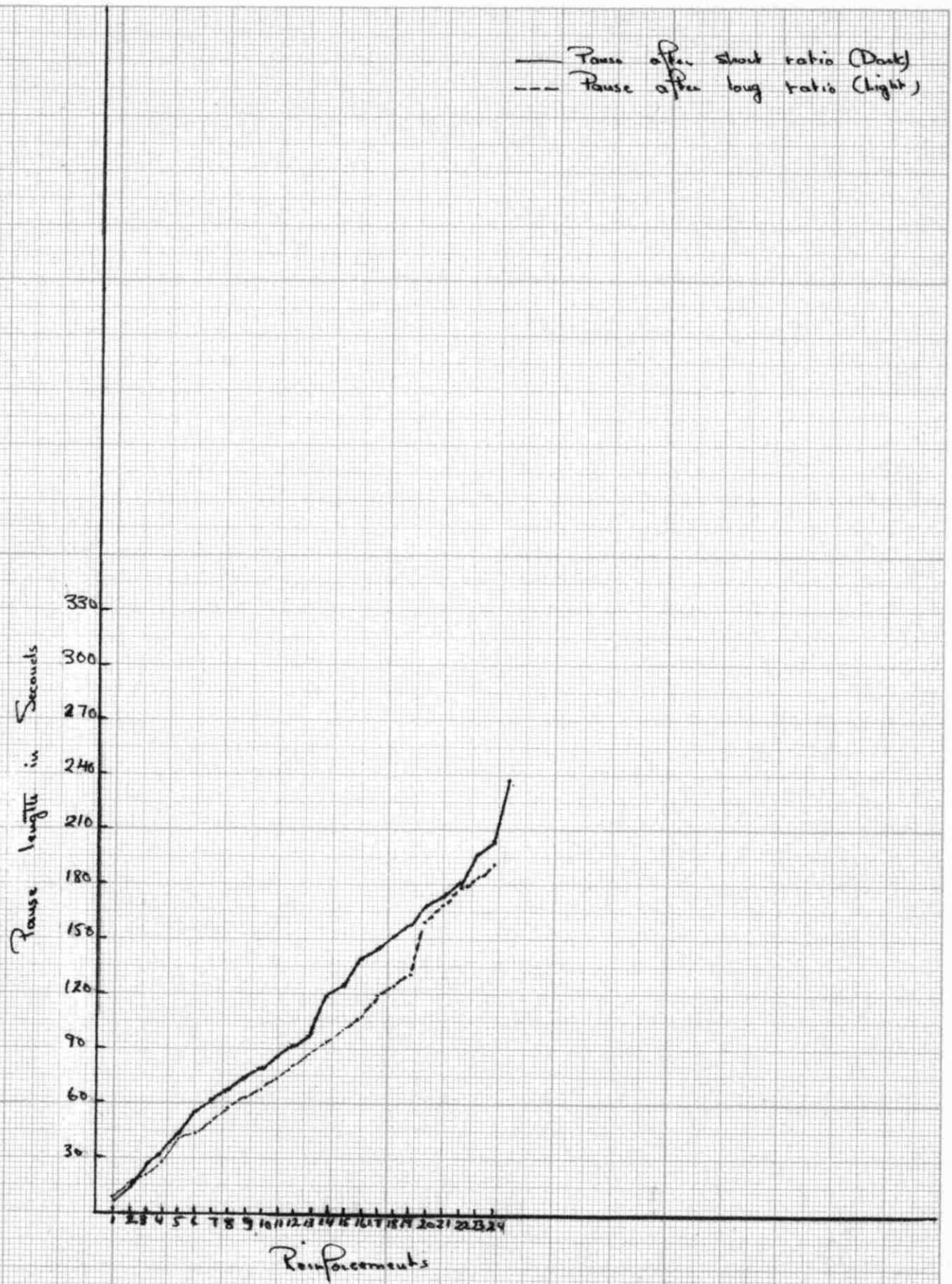

Figure 22. Cumulative records of animal 1C4 22
Test session - Light

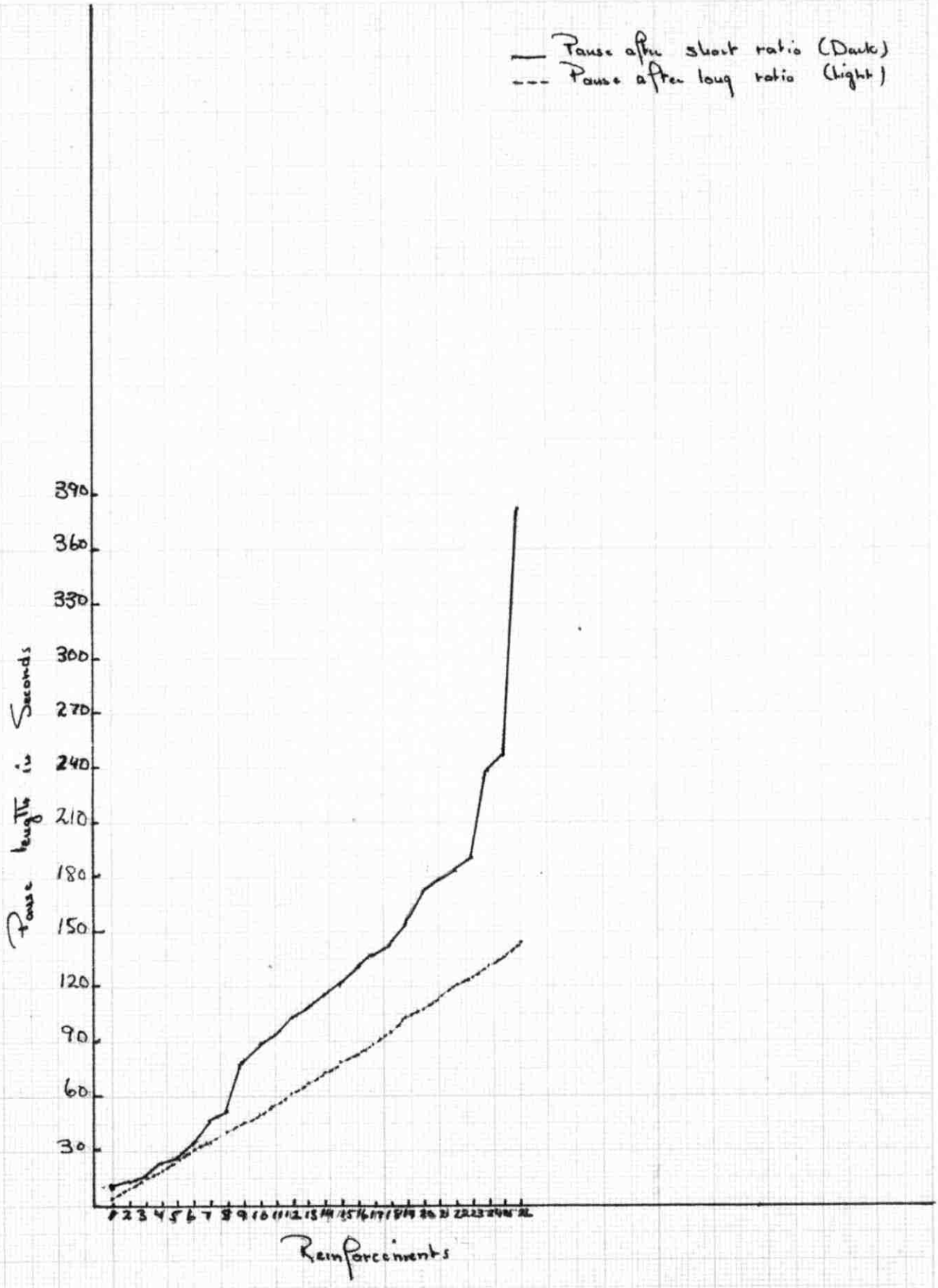

Figure 23. Cumulative records of animal Ky 23

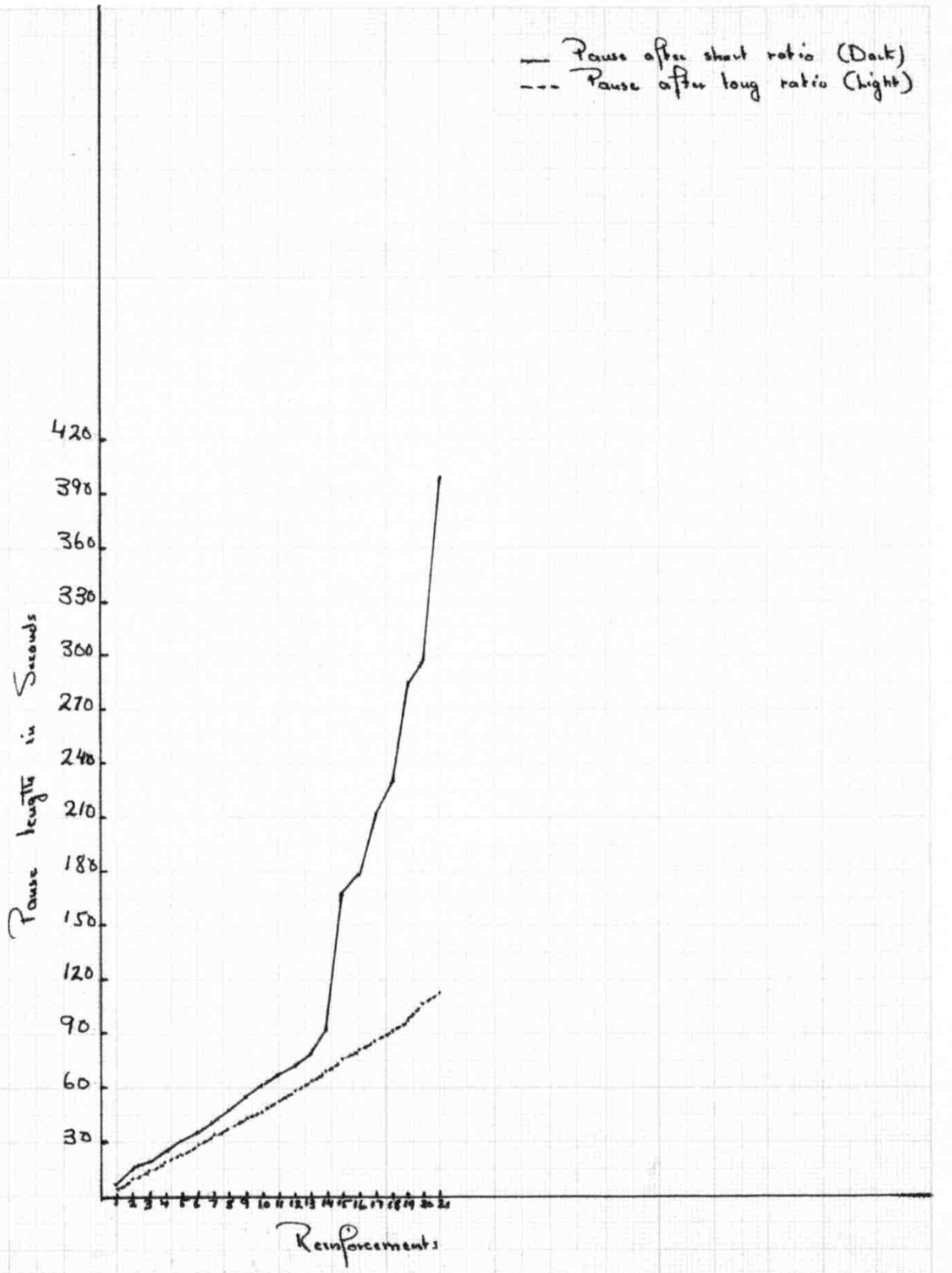

Figure 24. Cumulative records of animal Kg 23

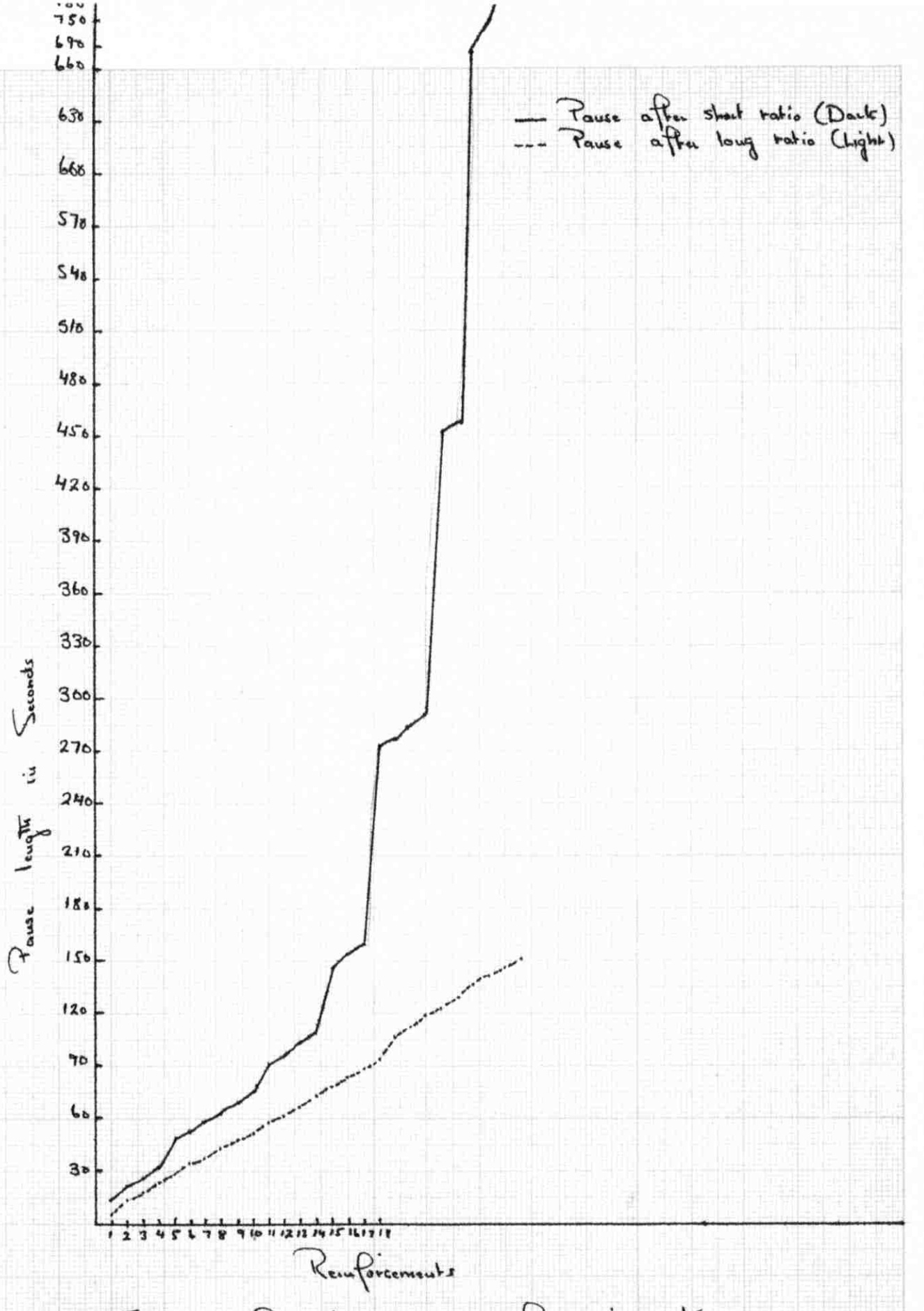

Figure 25. Cumulative records of animal Ky 23

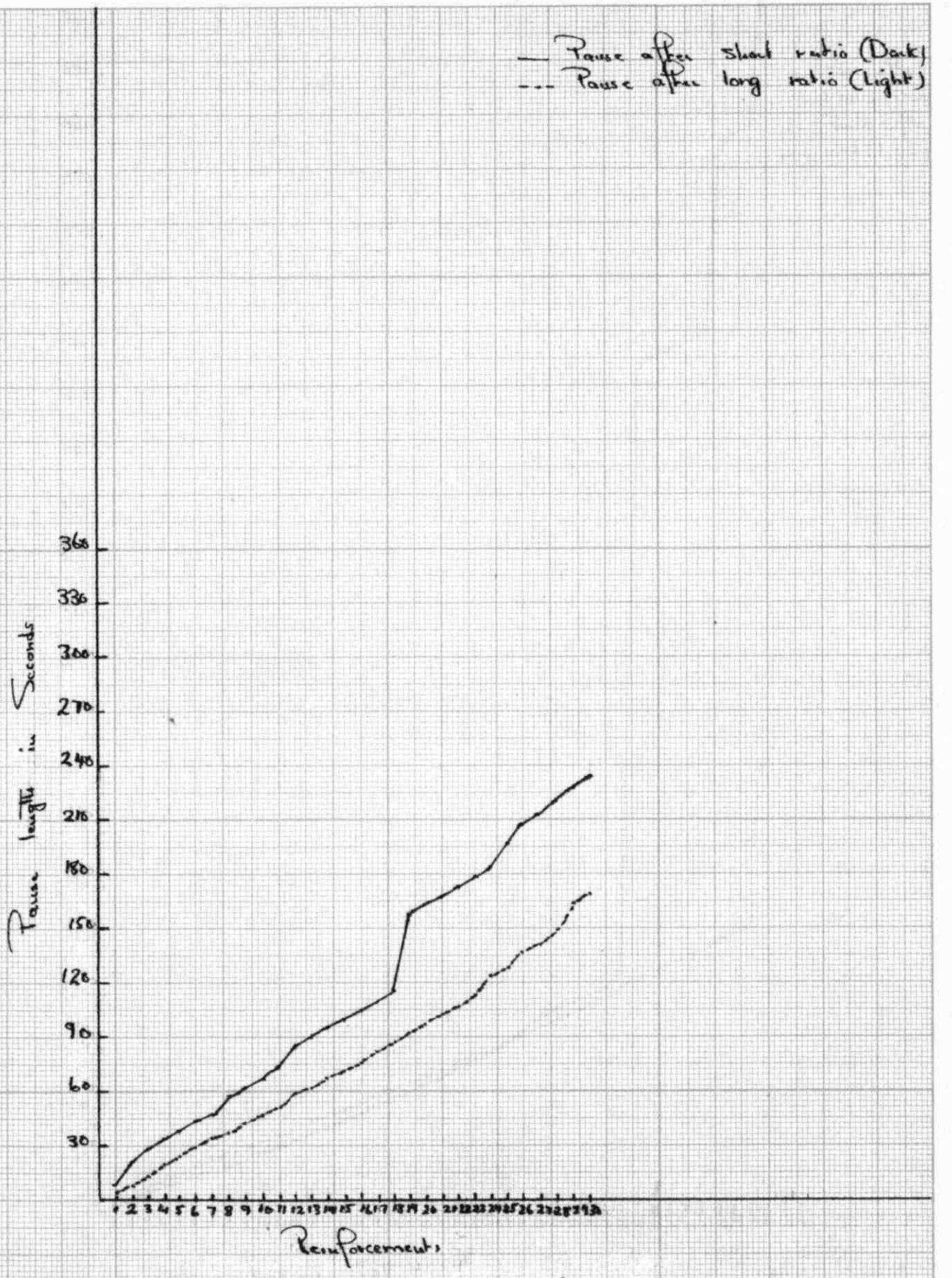

Figure 26. Cumulative records of animal Ky 23
Test Session - Light

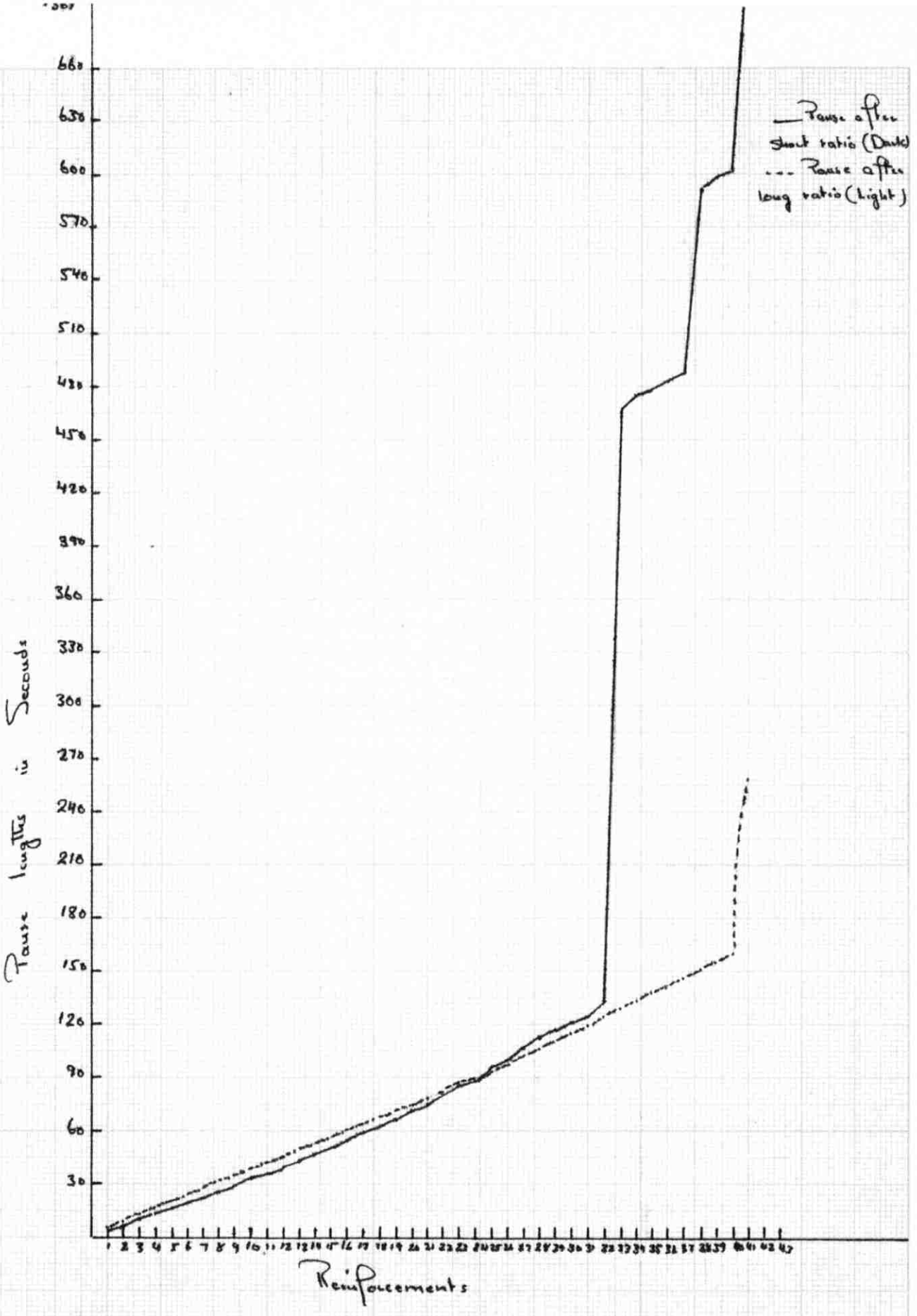

Figure 27. Cumulative record of animal Cy 24

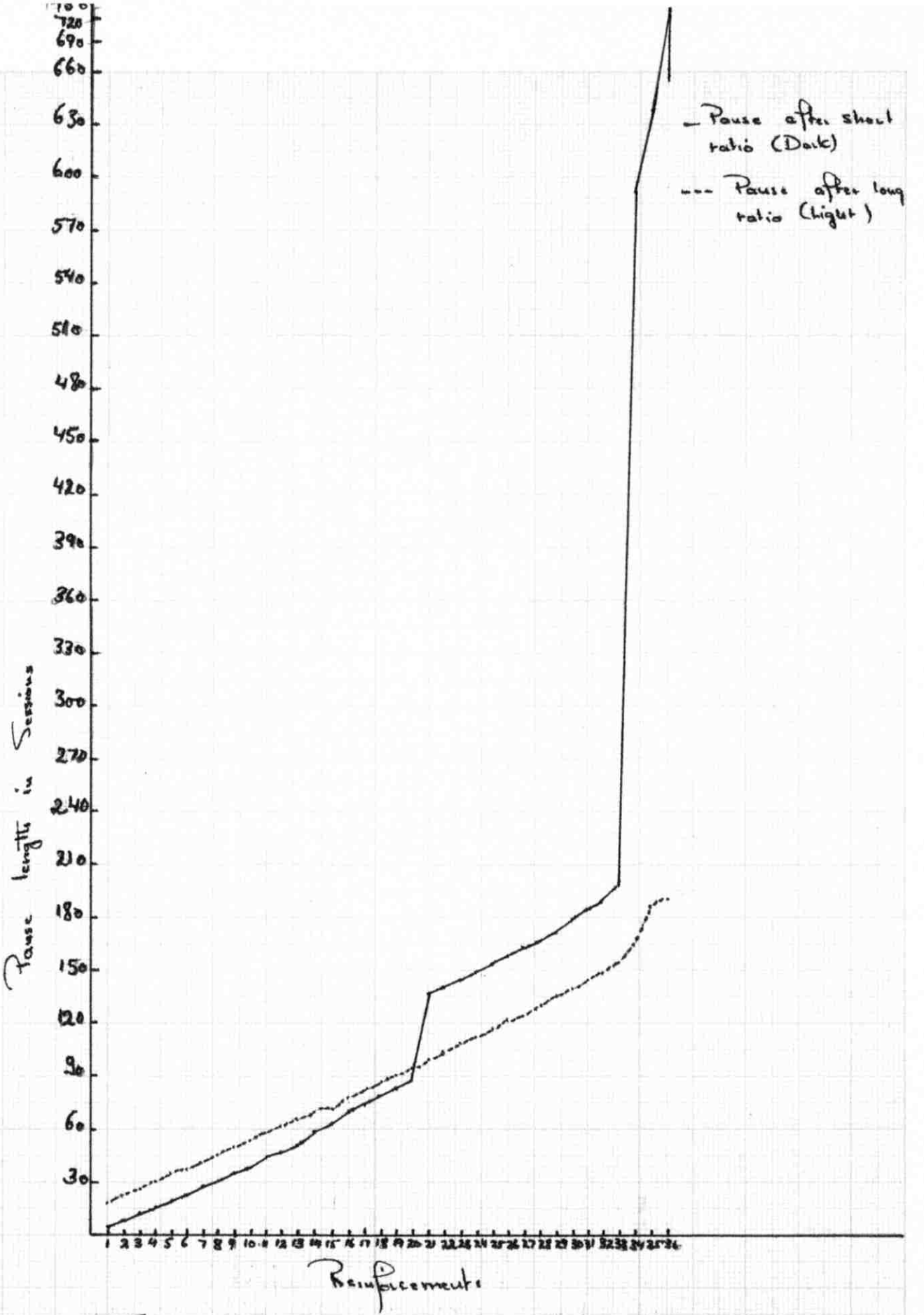

figure 28. Cumulative records of animal Ky 24

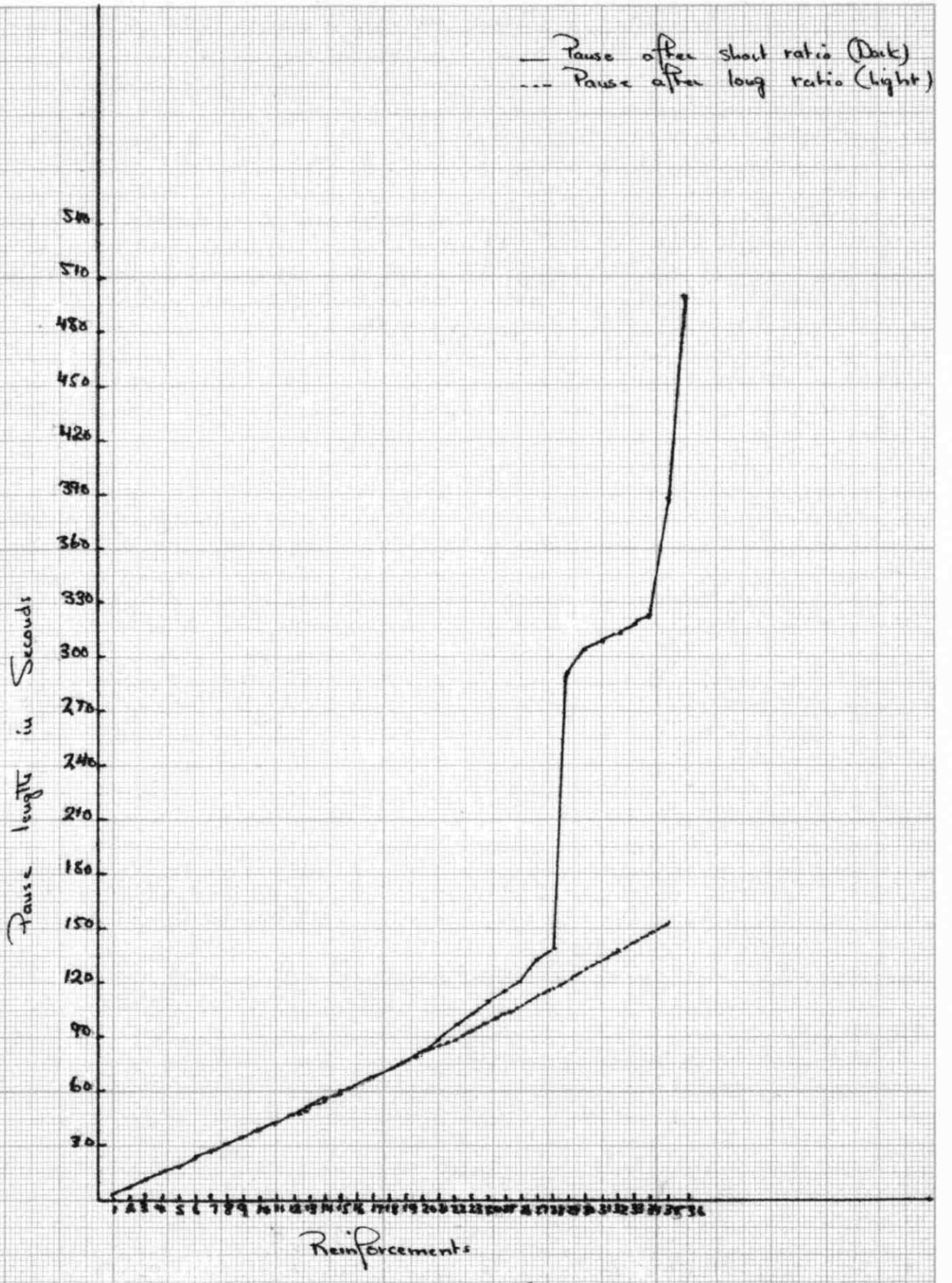

Figure 29. Cumulative records of animal Ky 24

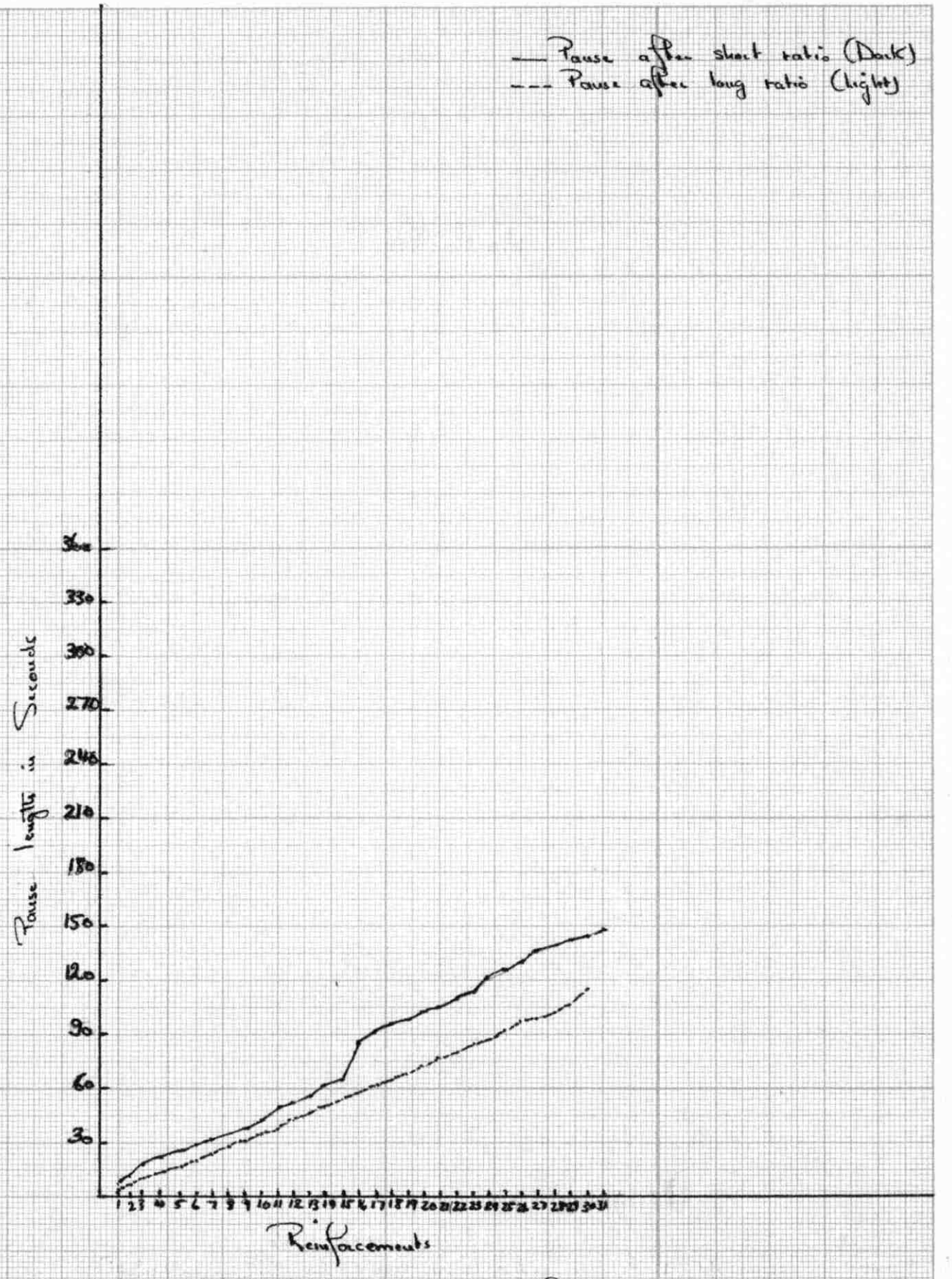

Figure 30. Cumulative records of animal Ky 24
Test Session - Light

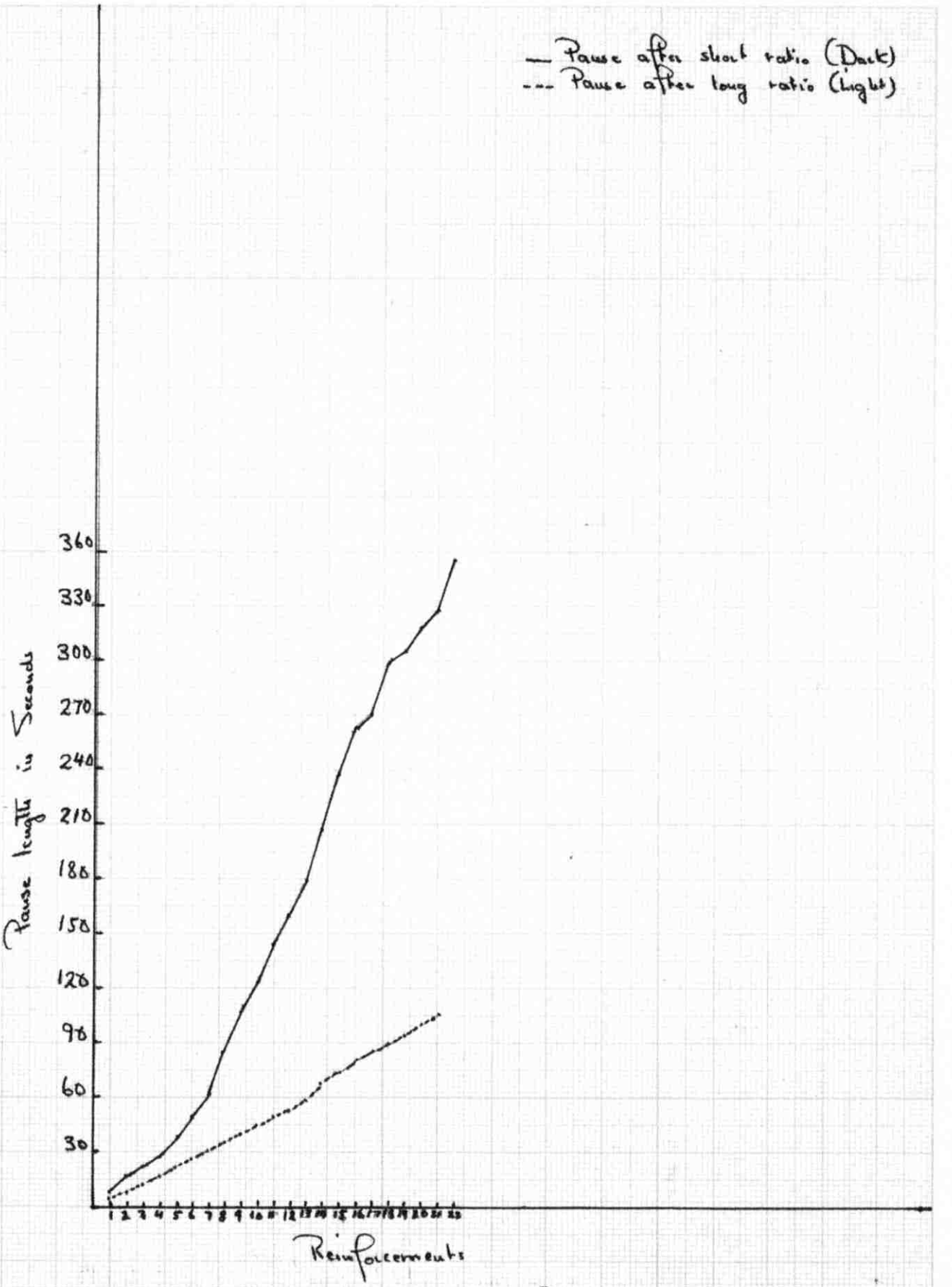

Figure 31. Cumulative records of animal Cy 2

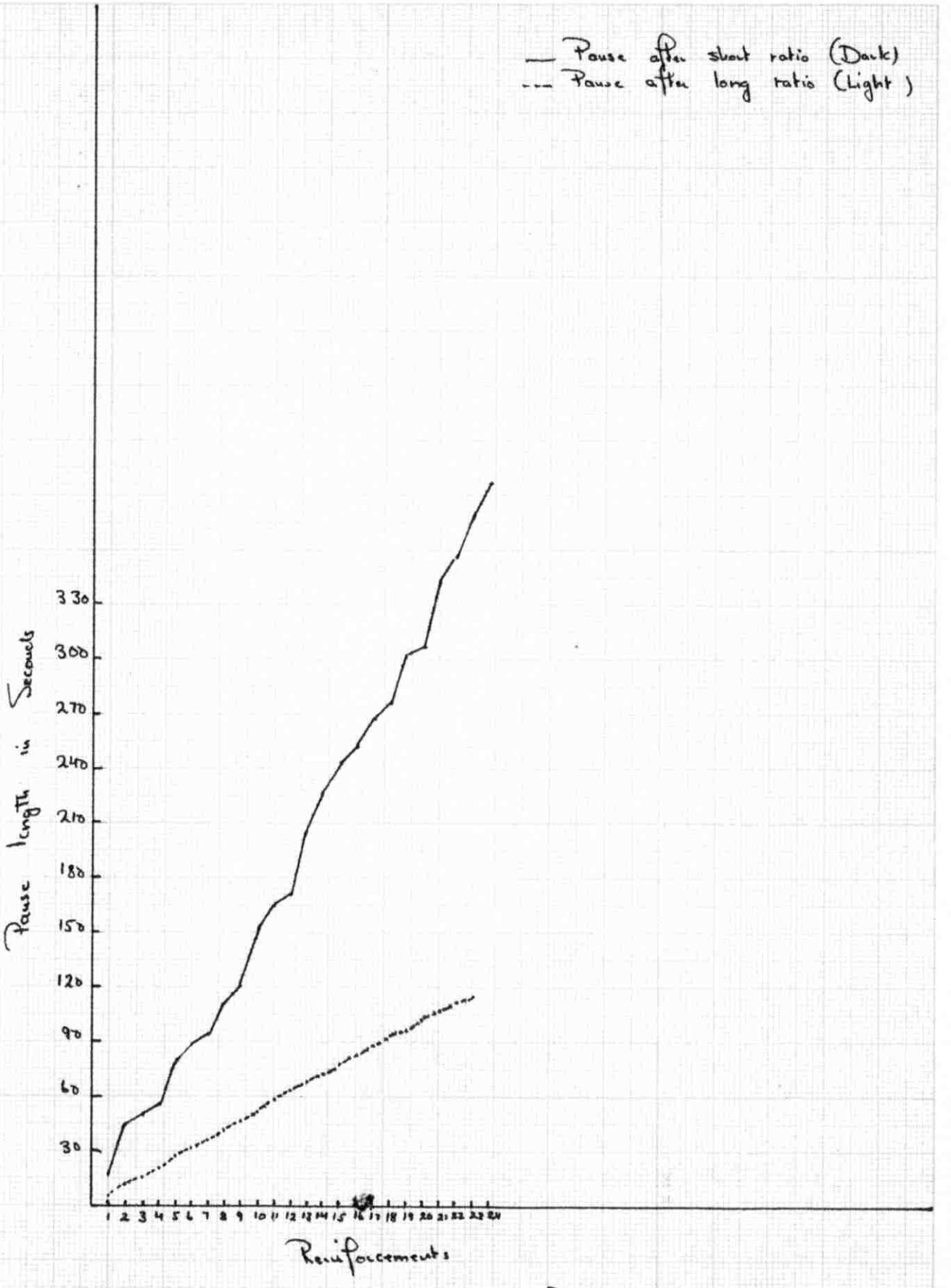

Figure 32. Cumulative records of animal Ky 2

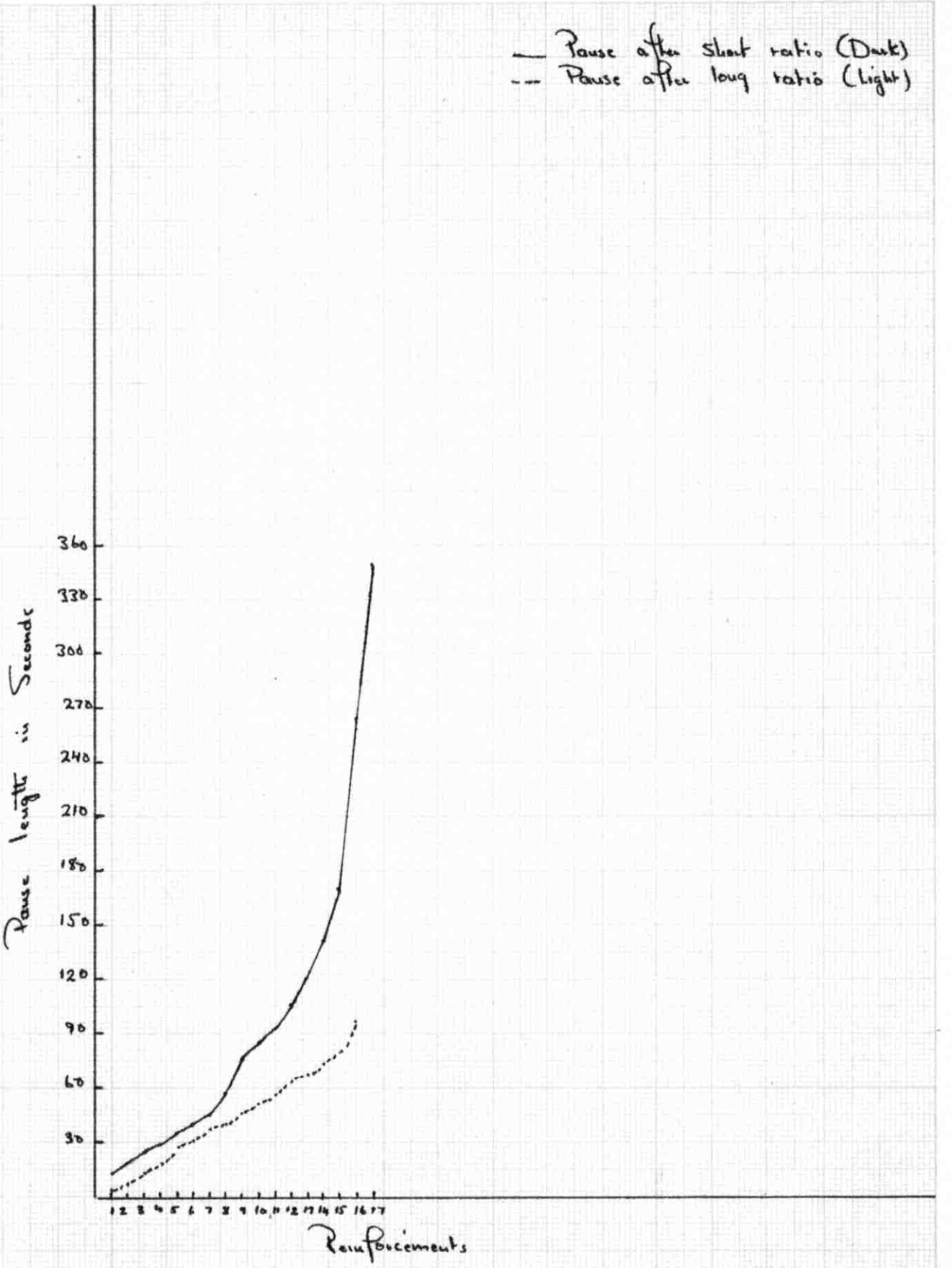

Figure 38. Cumulative records of animal Ky 2

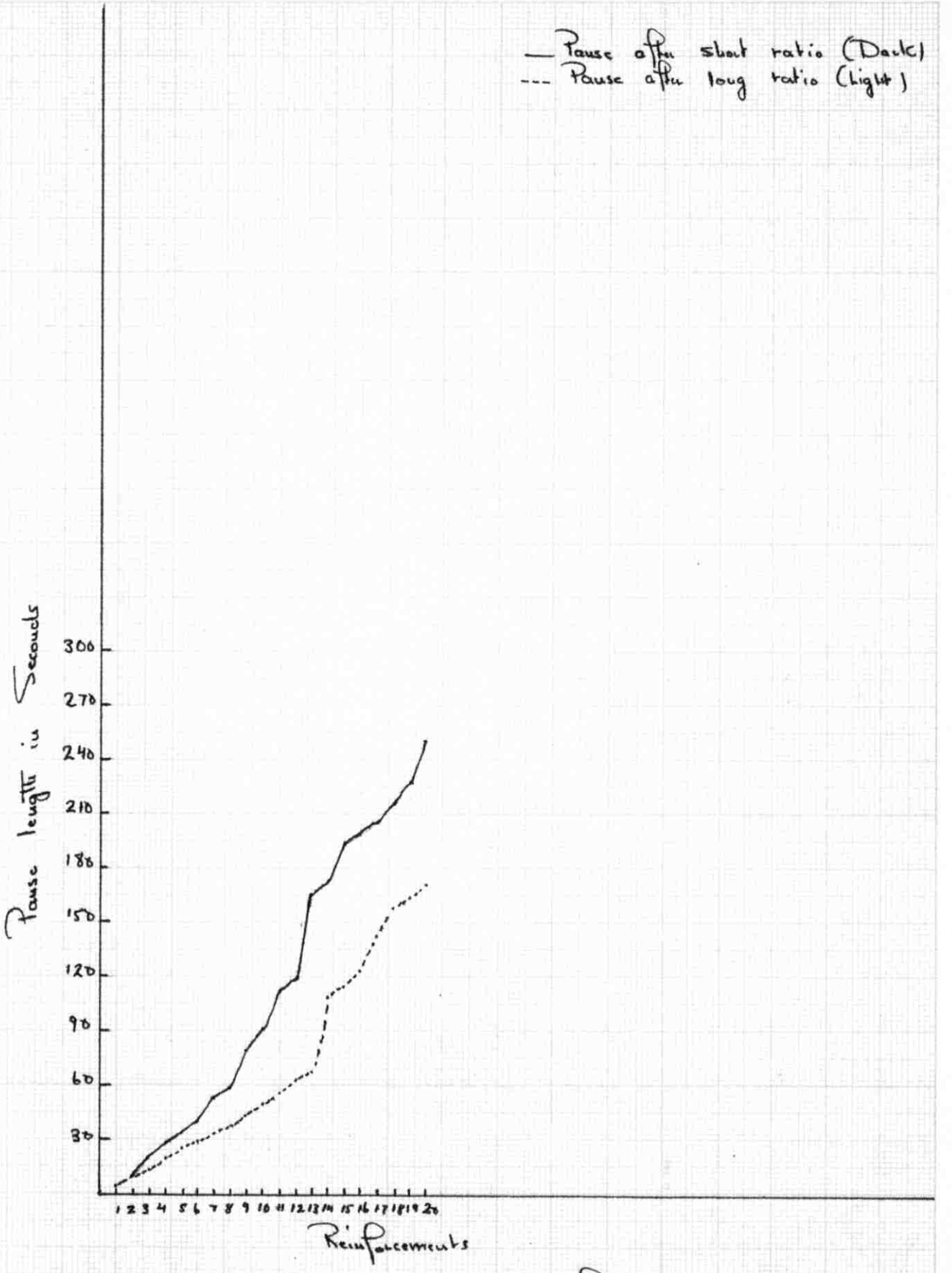

Figure 34. Cumulative records of animal Ky 2

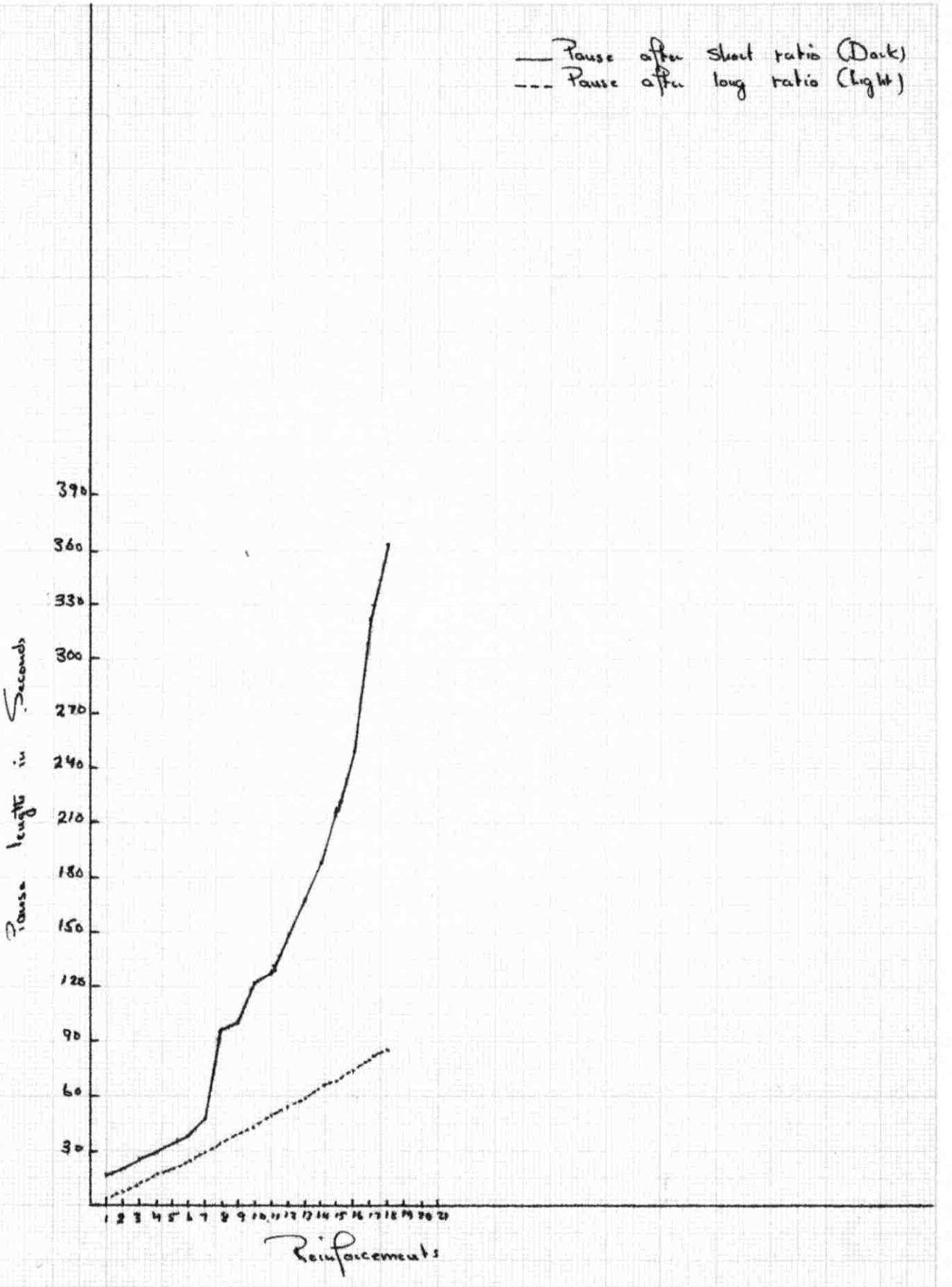

Figure 85. Cumulative records of animal Ky 3

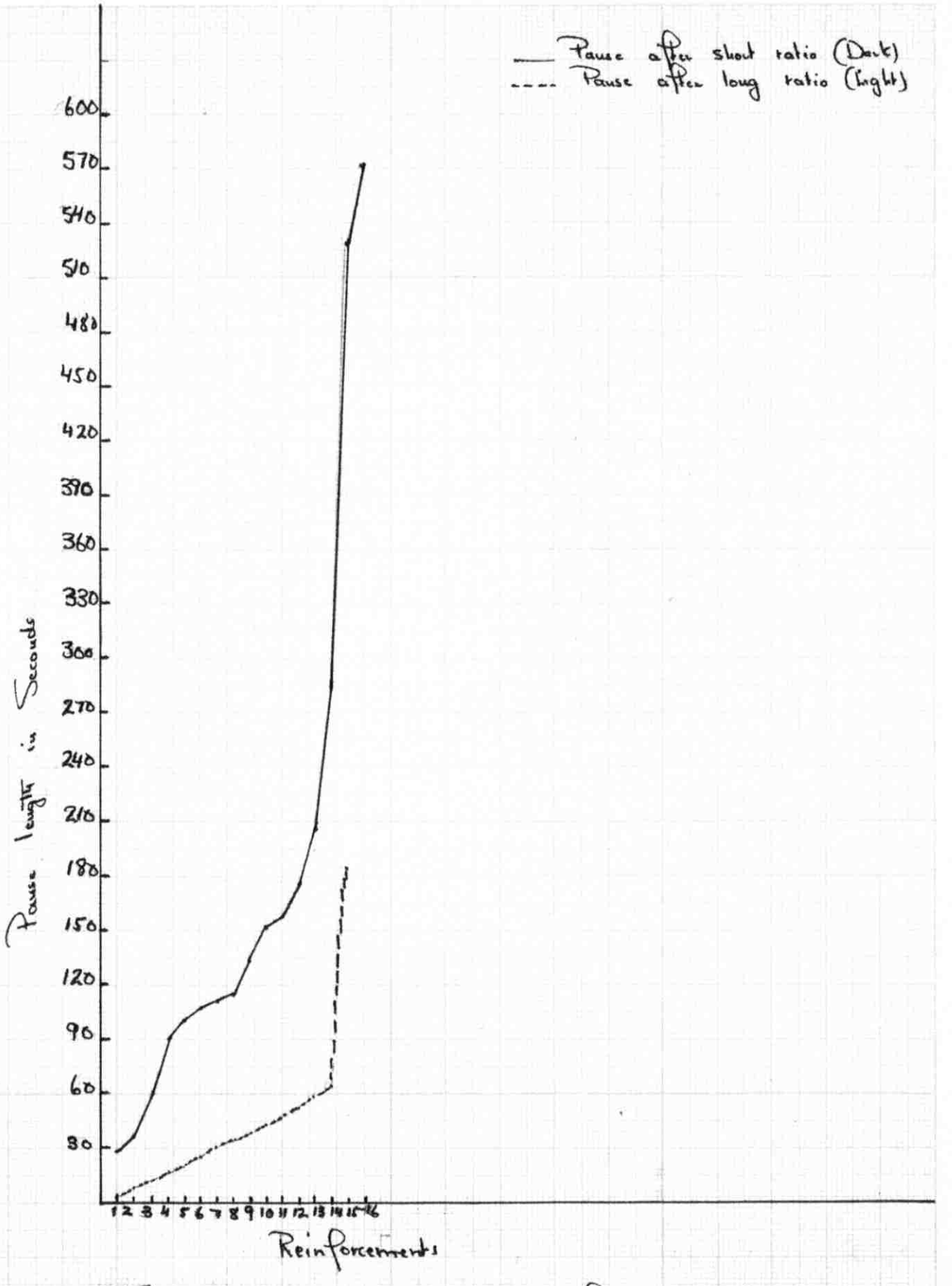

Figure 36. Cumulative records of animal Ky 3 (Pre fed)

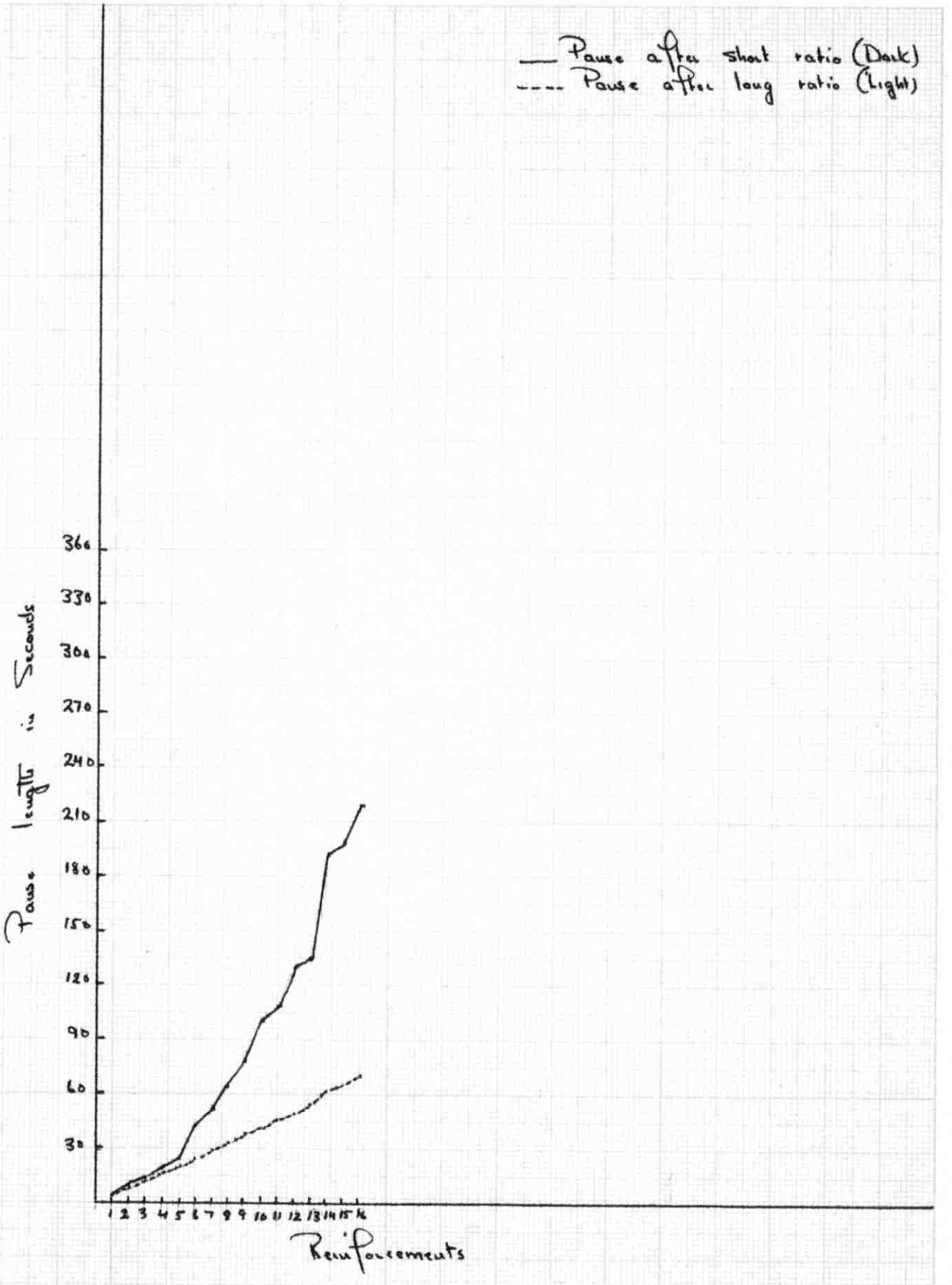

Figure 37. Cumulative records of animal Cy 3

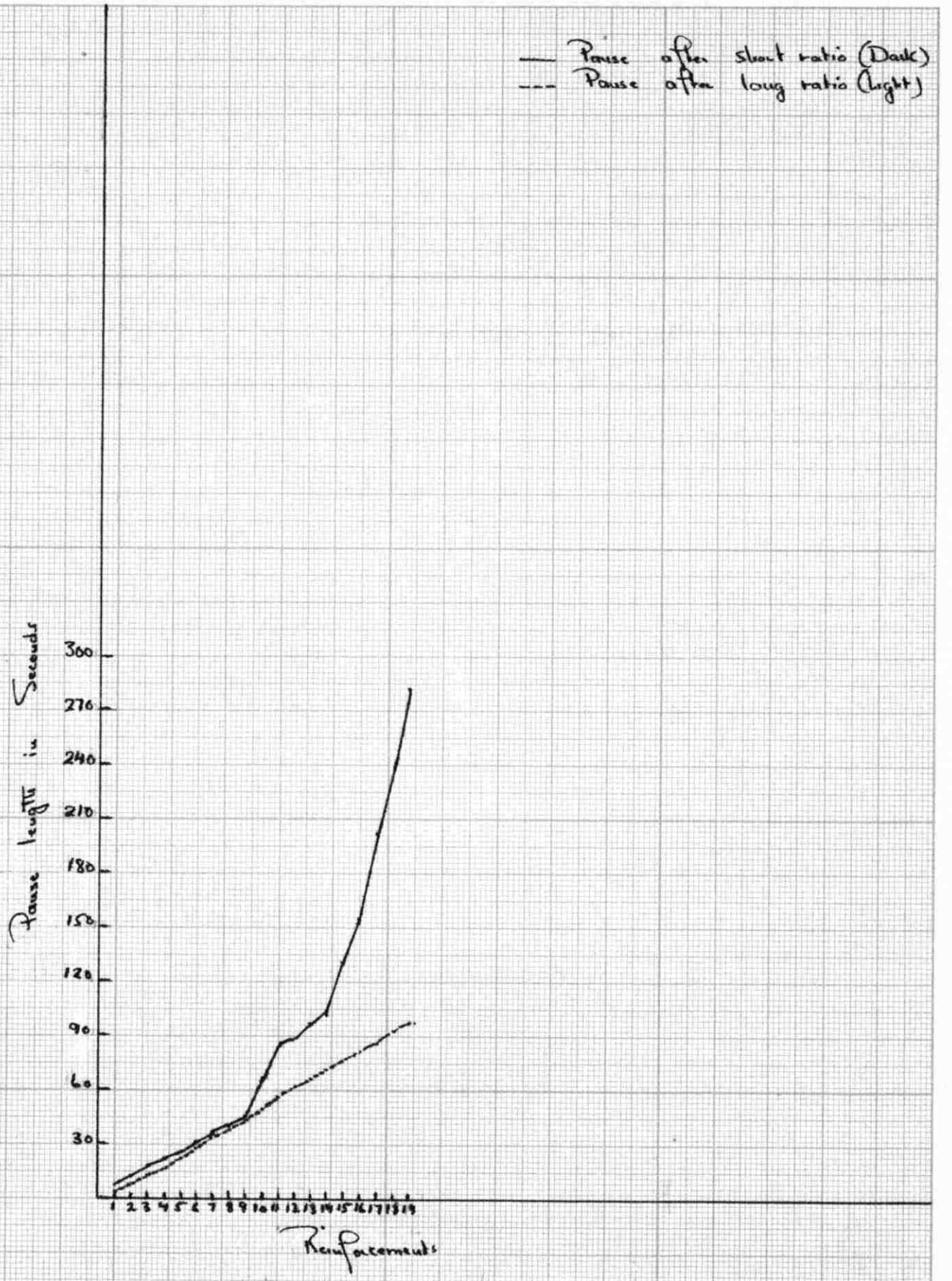

Figure 38. Cumulative records of animal 1C4 3
Test Session - Dark
Prefed

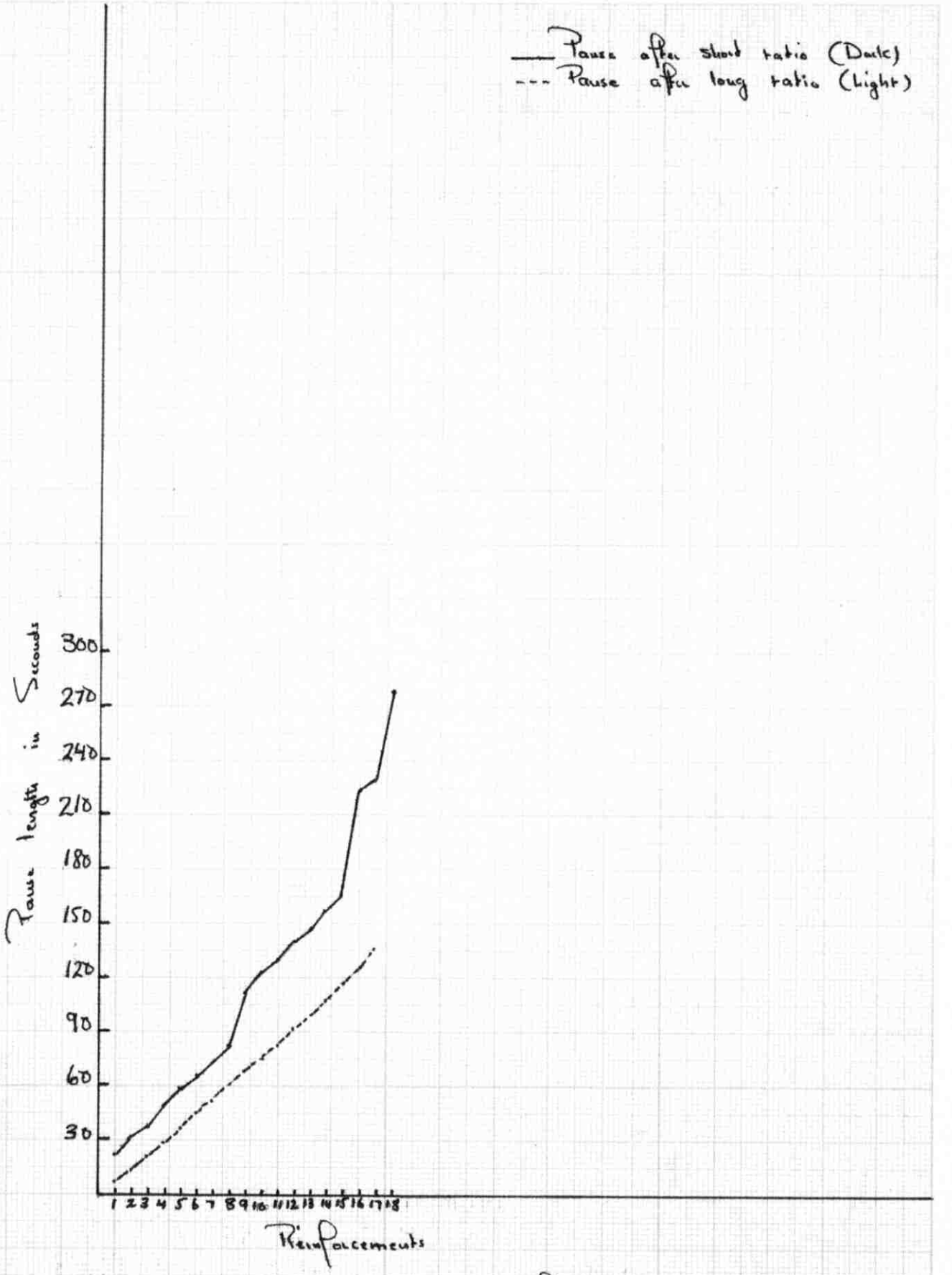

Figure 39. Cumulative records of animal 1Cy 22

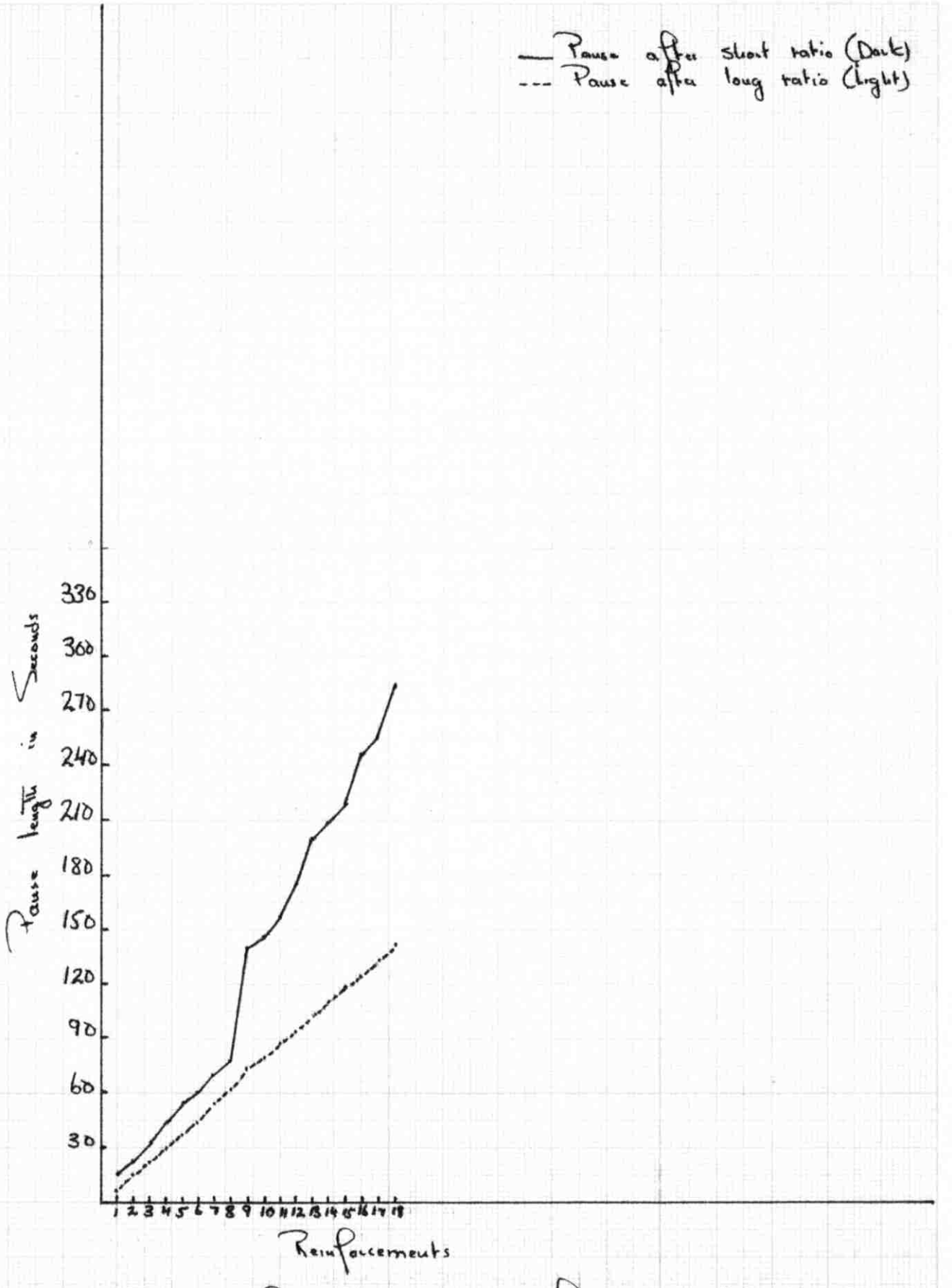

Figure 40. Cumulative records of animal Ky 22

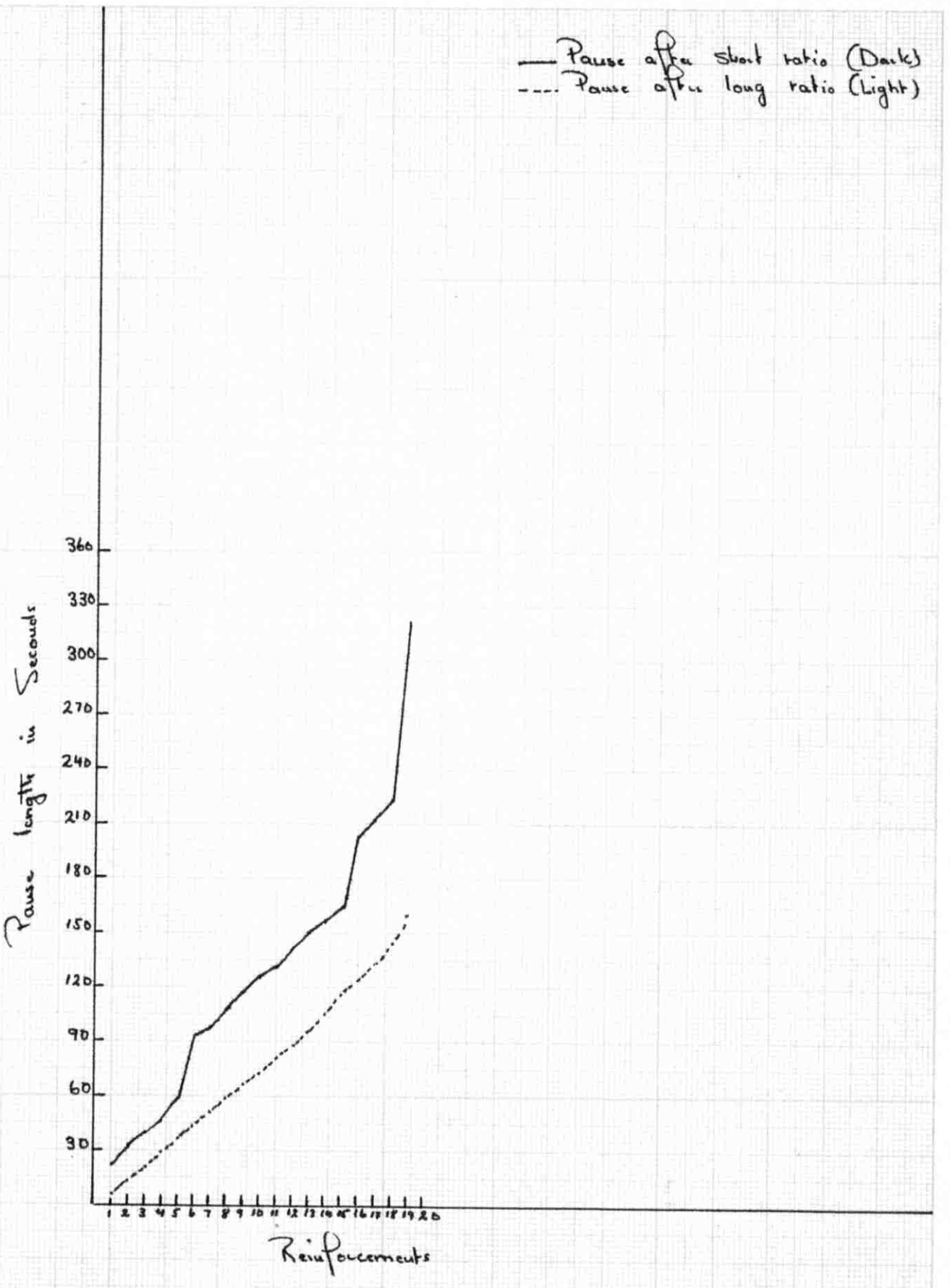

Figure 41. Cumulative records of animal IC4 22

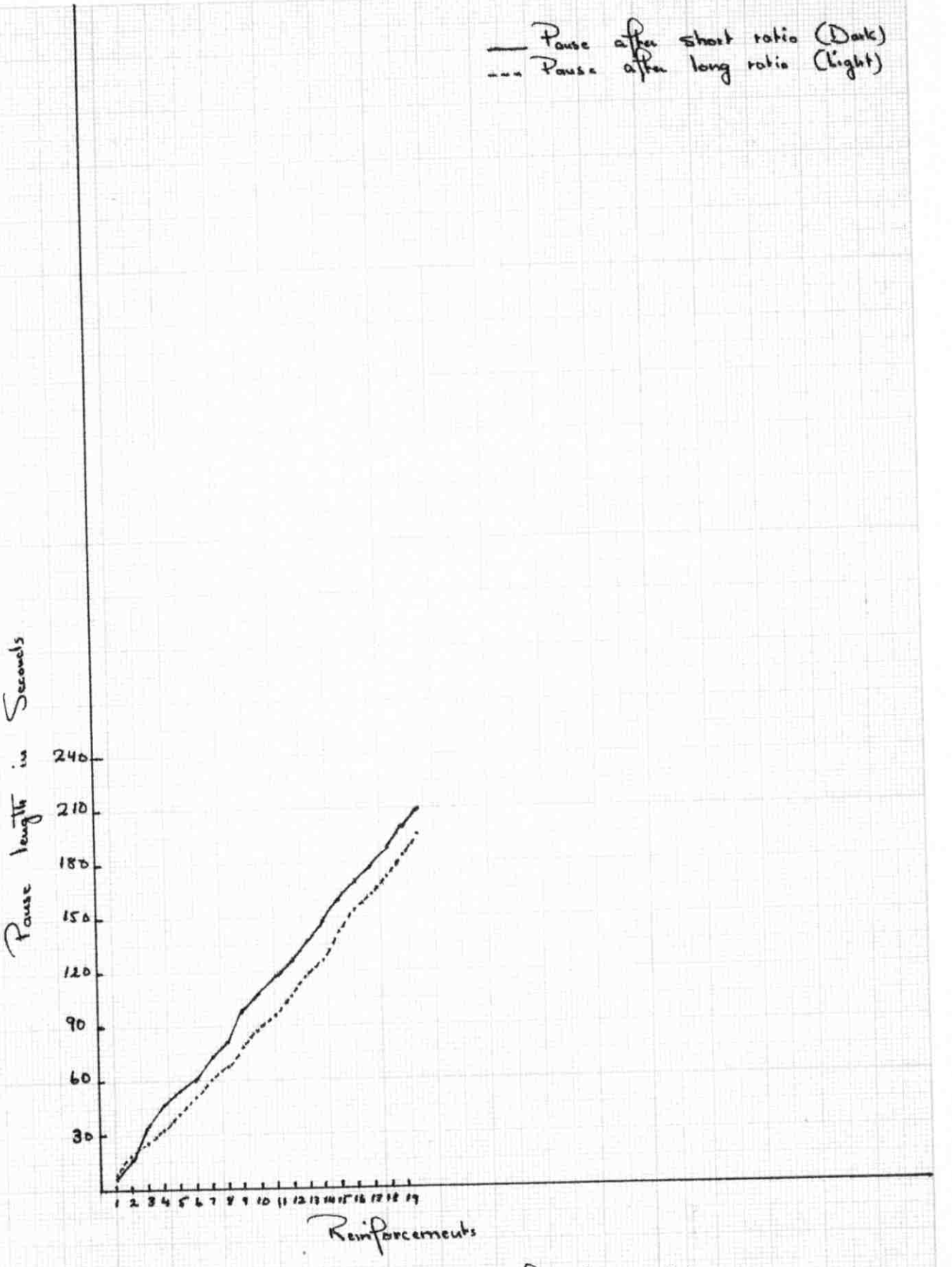

Figure 42. Cumulative records of animal IC4 22

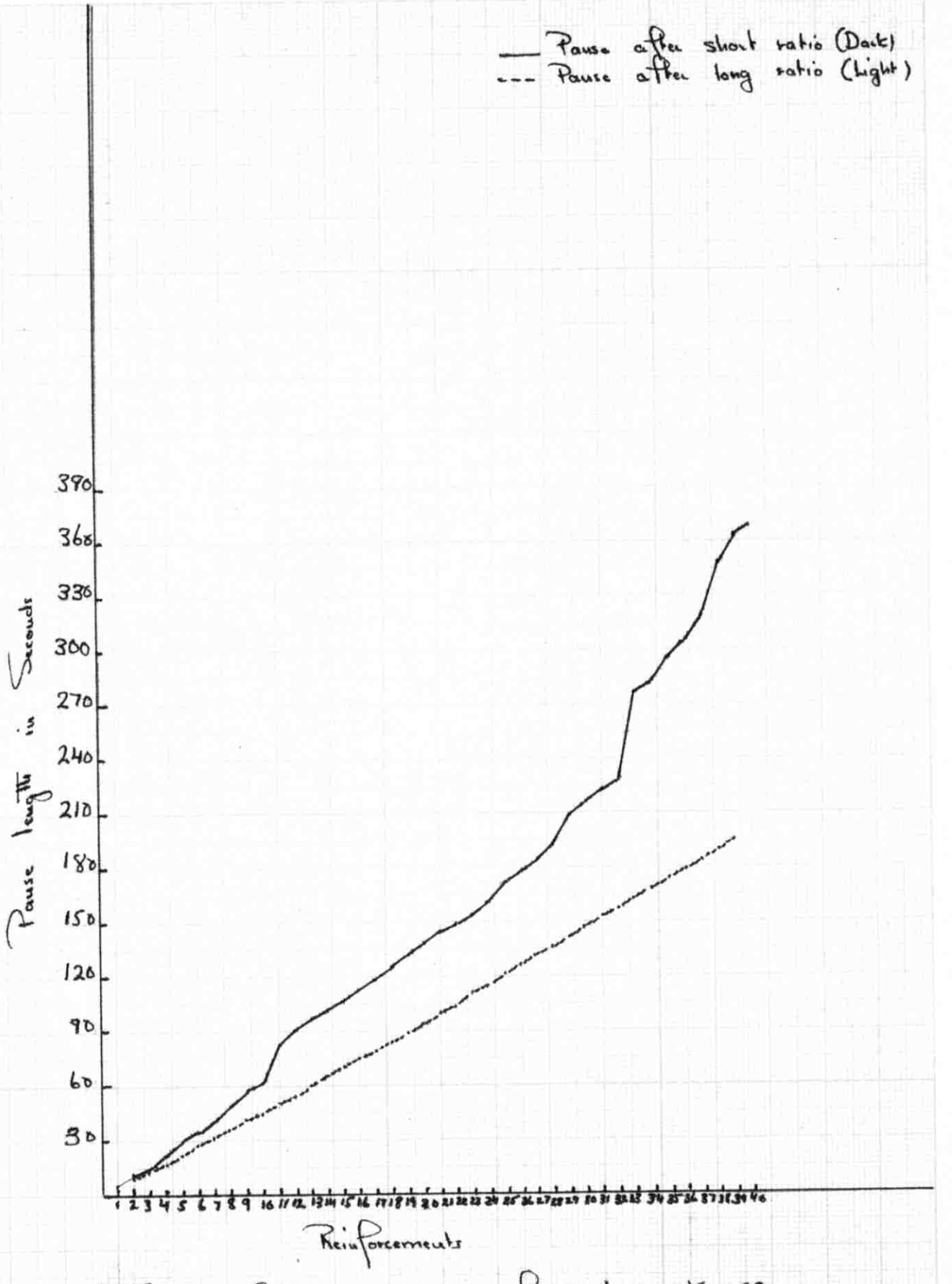

Figure 43. Cumulative records of animal Ky 23

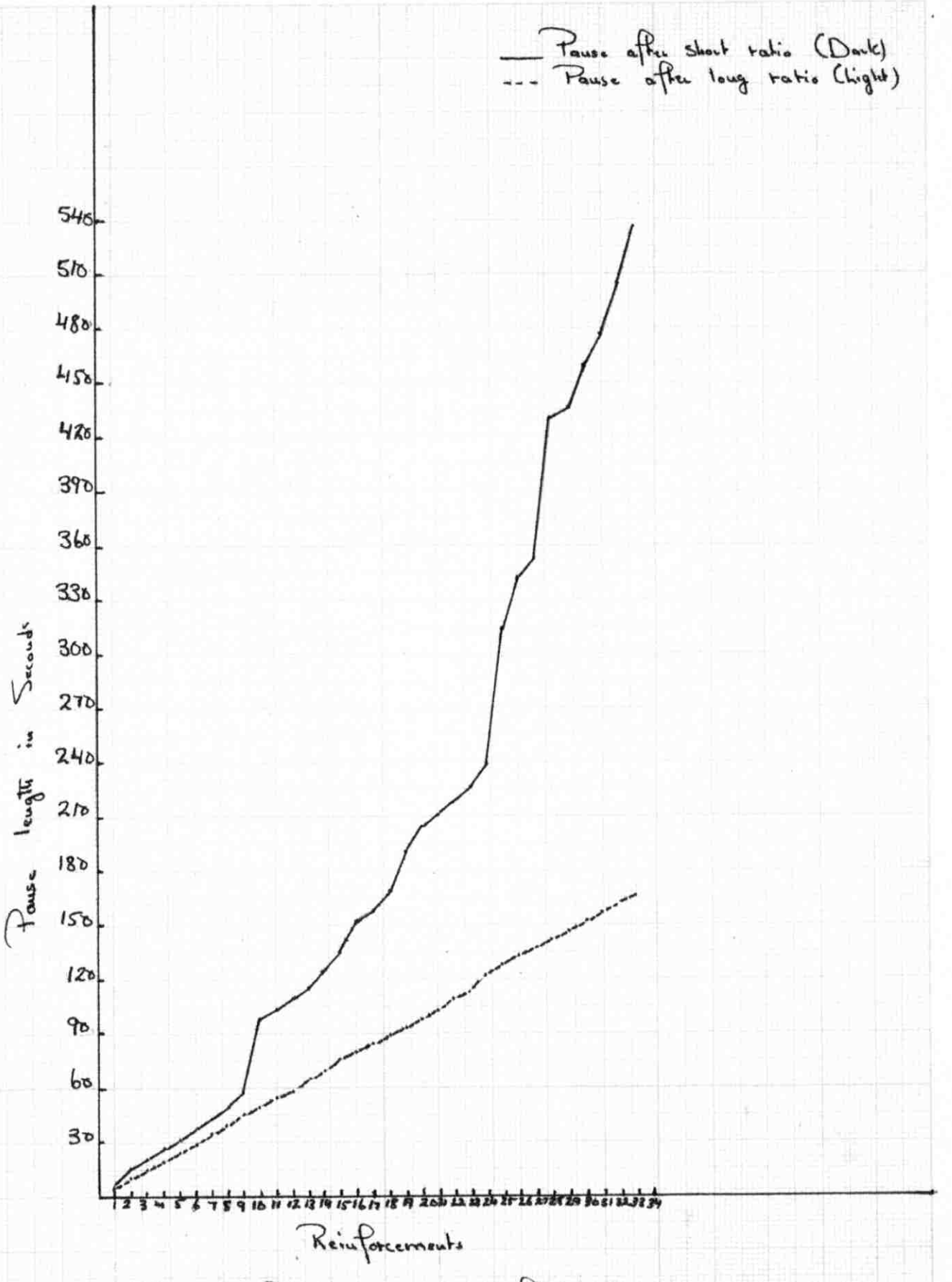

figure 44. Cumulative records of animal Ky 23

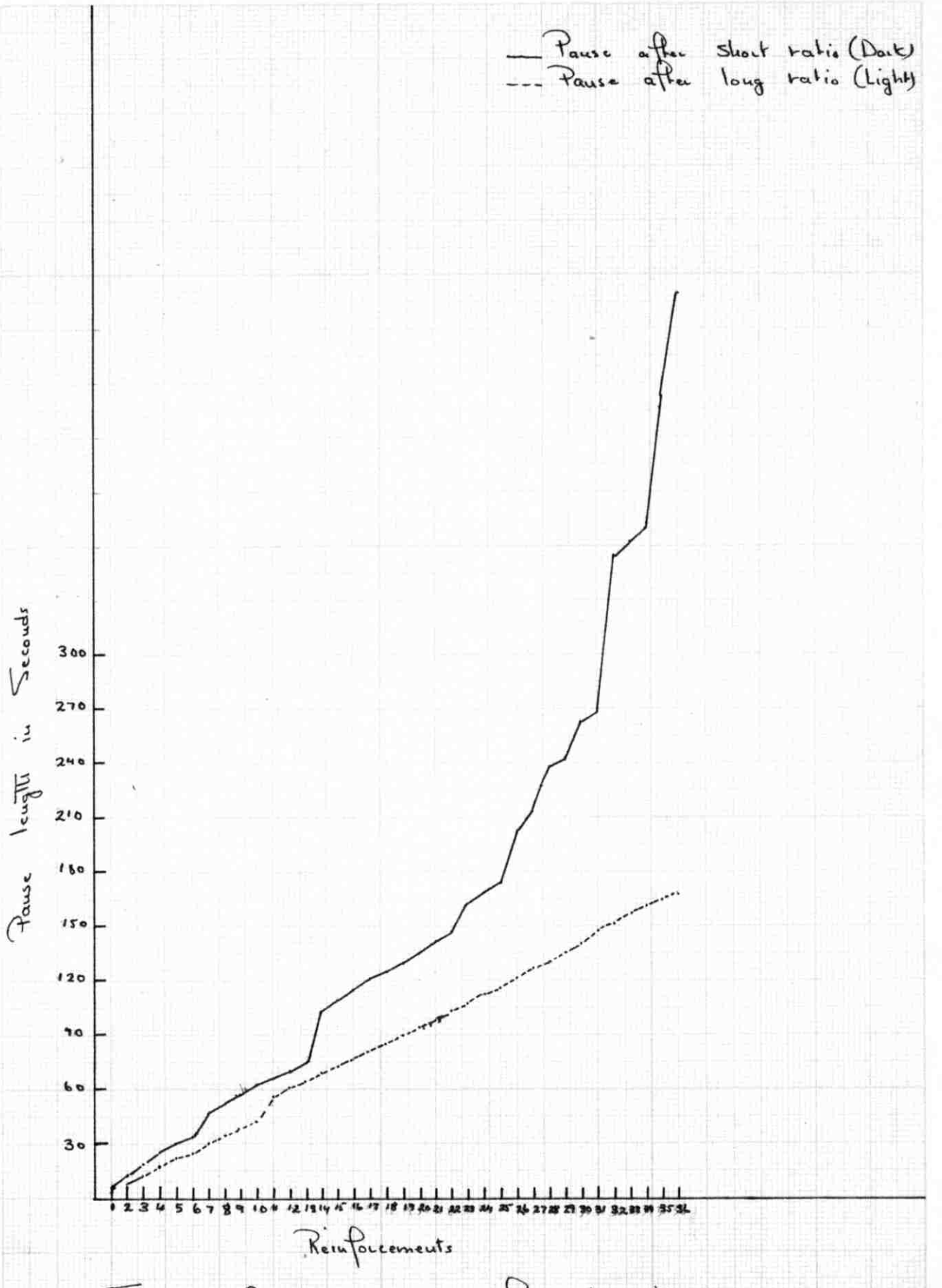

Figure 45. Cumulative records of animal Ky 23

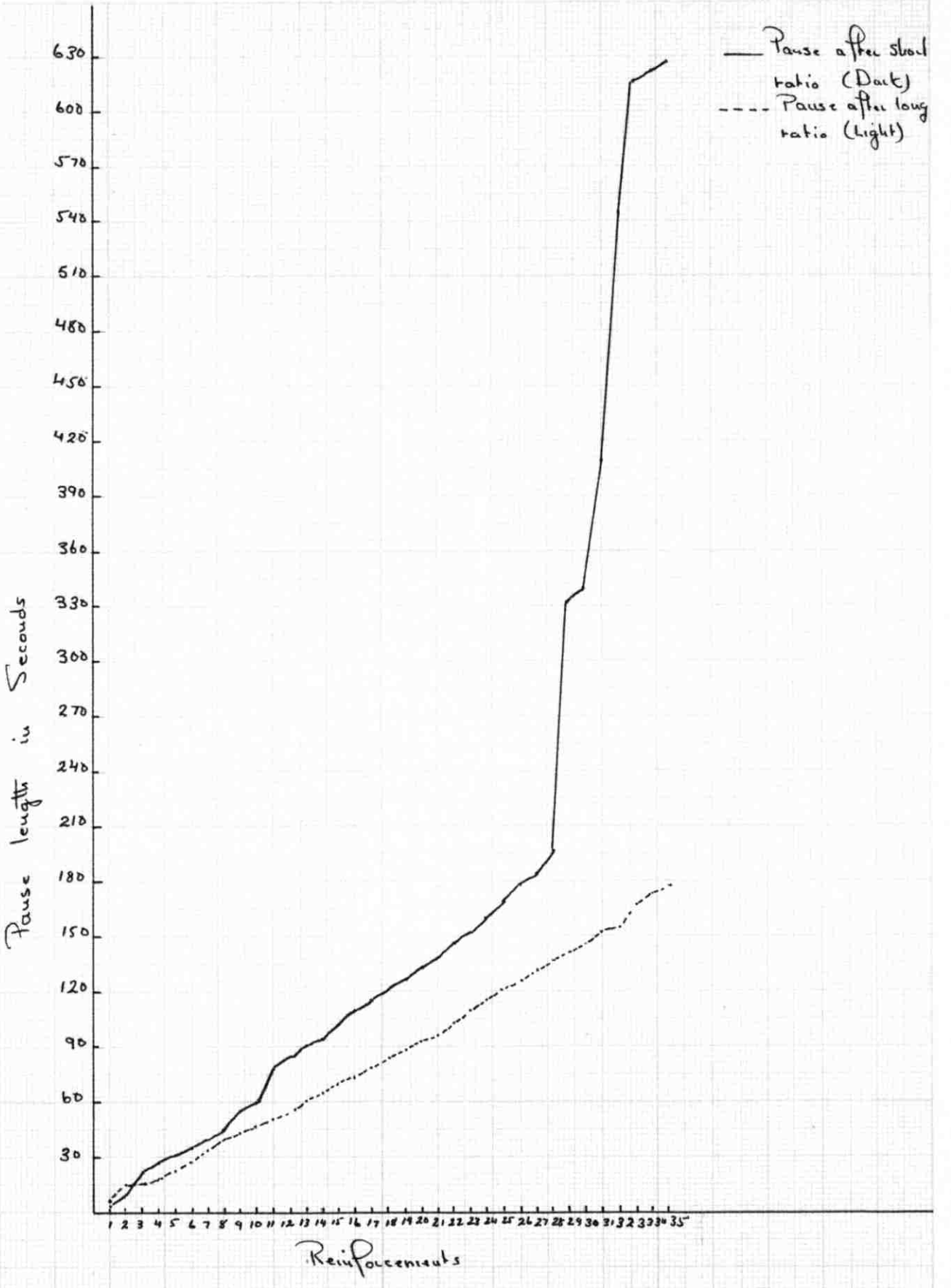

Figure 46. Cumulative records of animal Ky 23

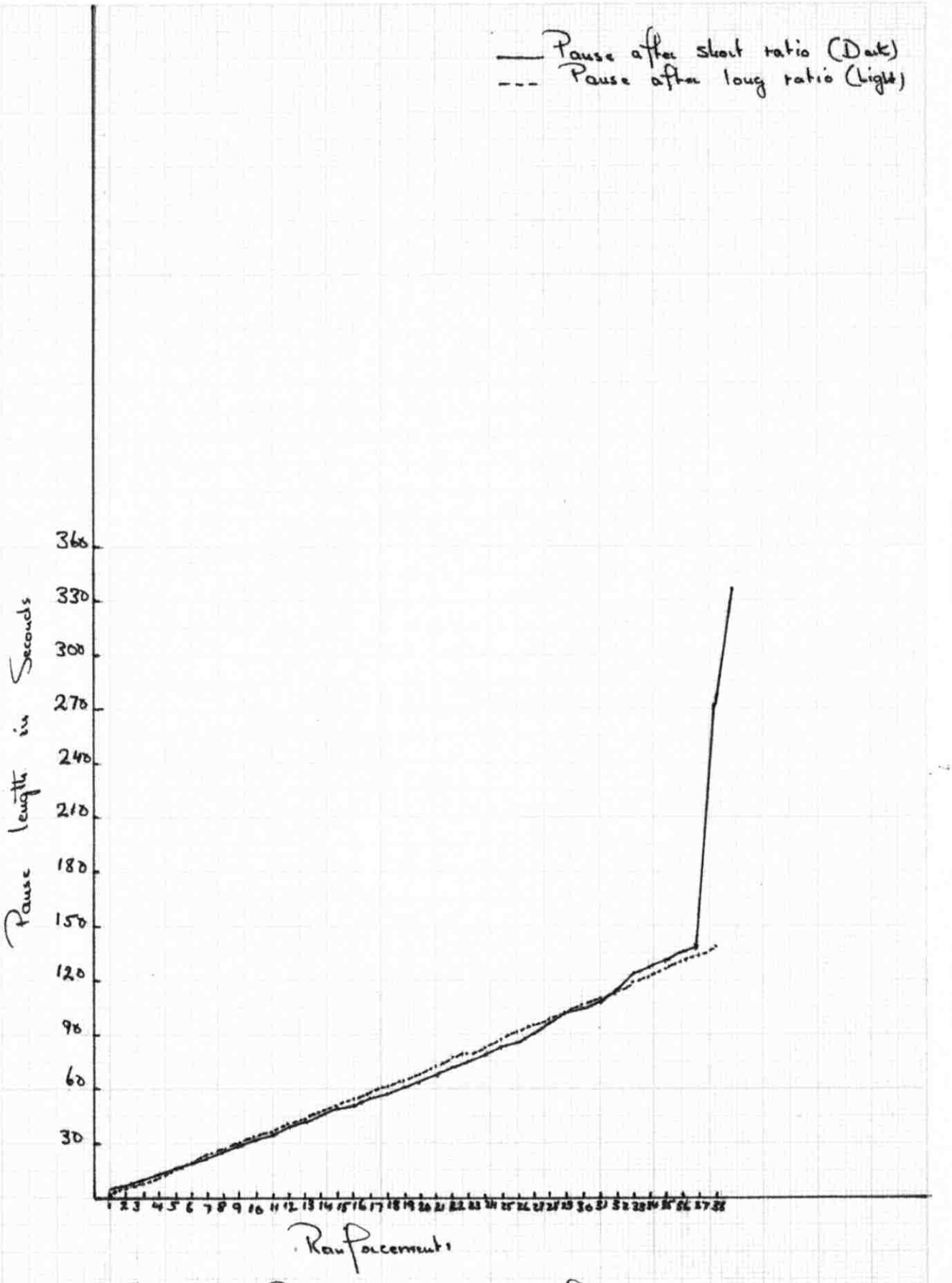

Figure 47. Cumulative records of animal Ky 24

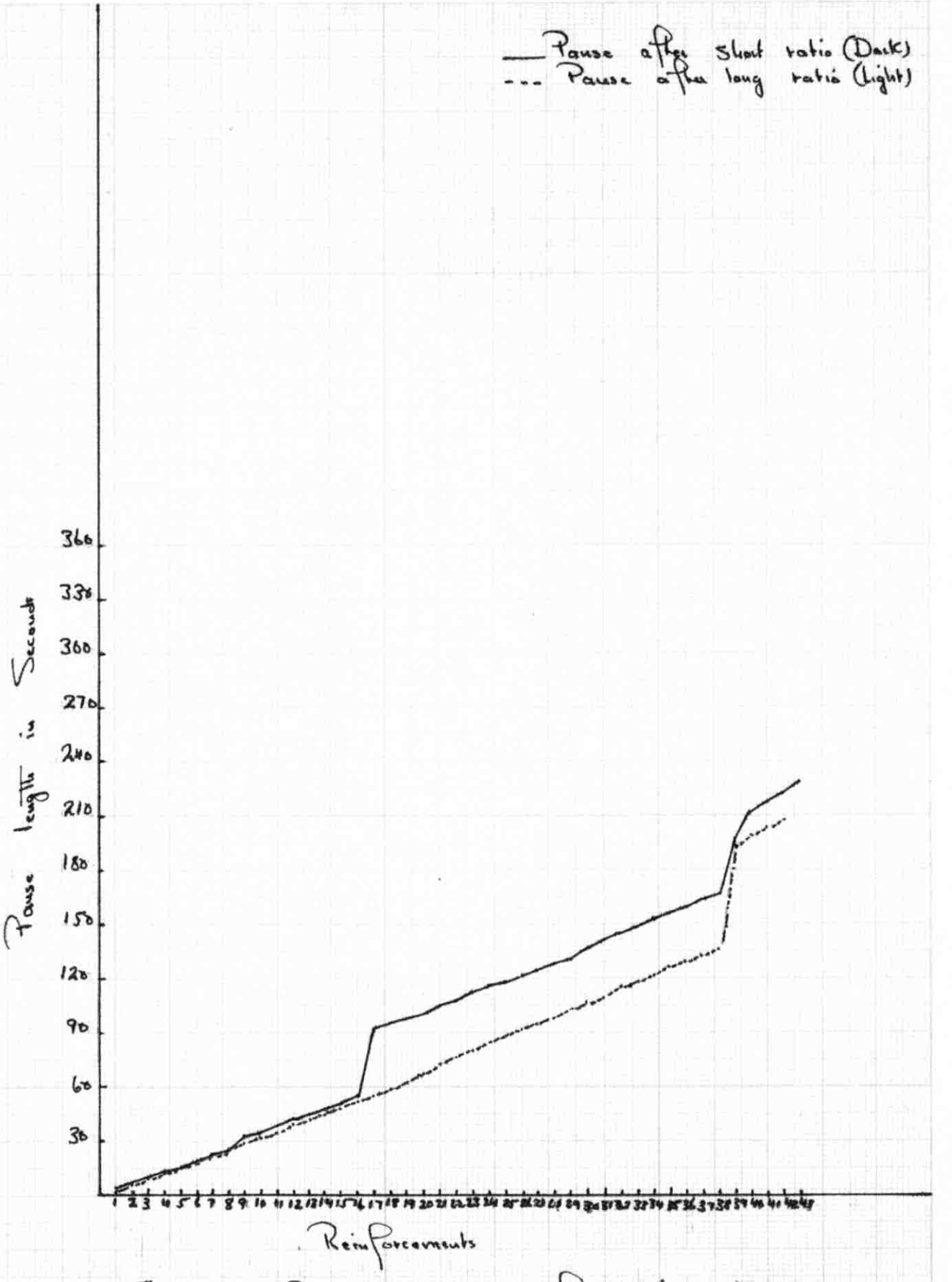

Figure 48. Cumulative records of animal Ky 24

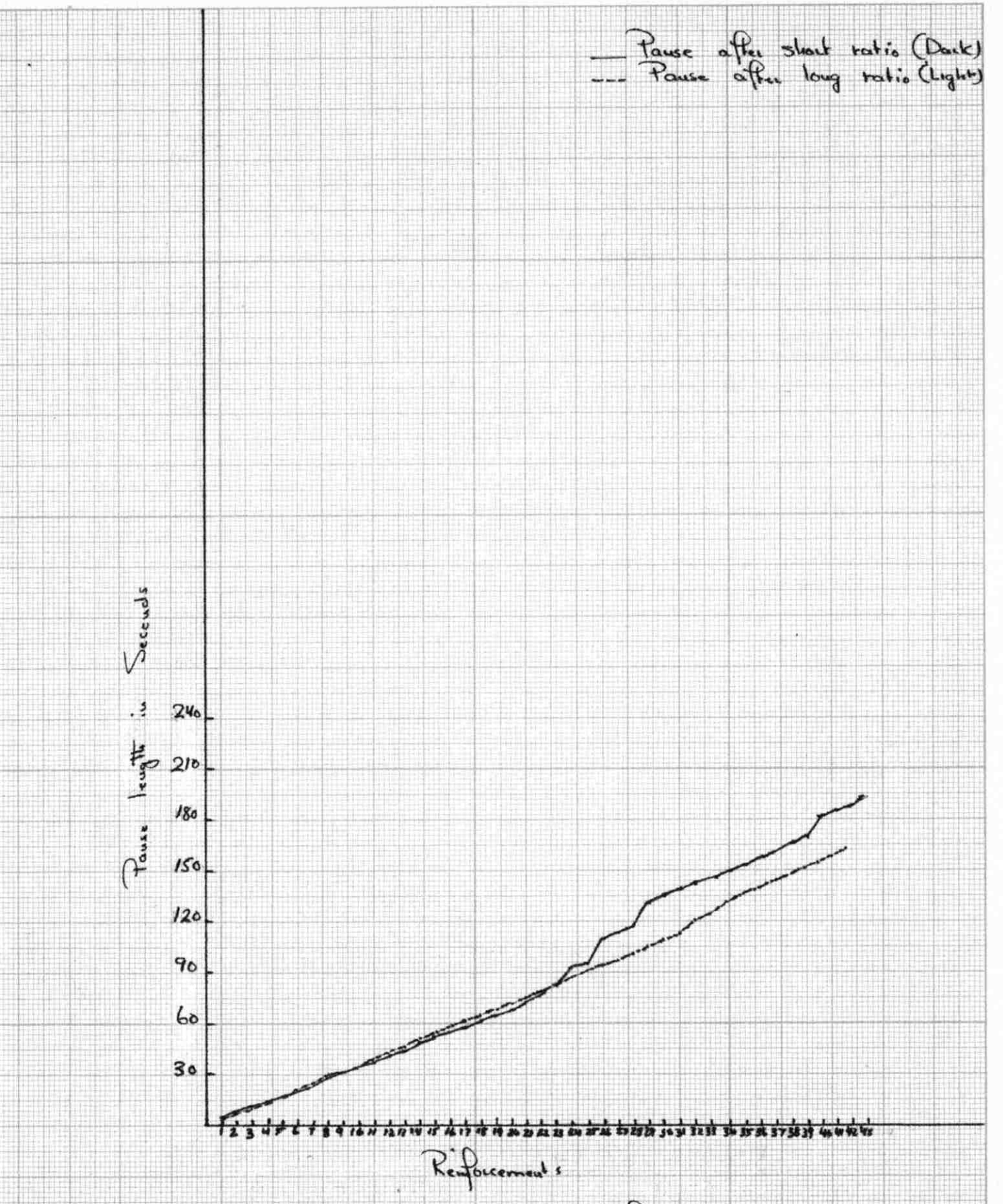

Figure 49. Cumulative records of animal 1Cy 24

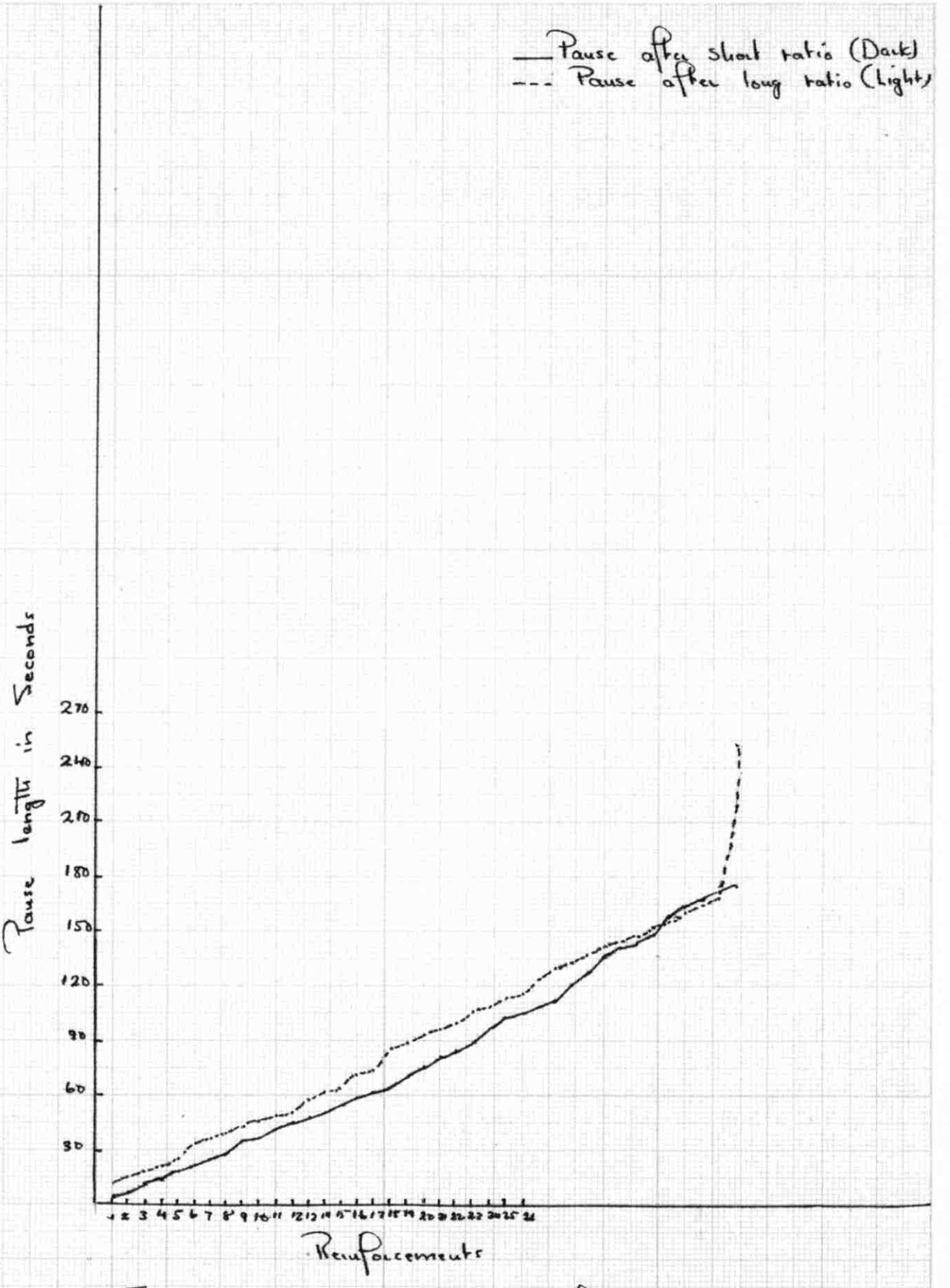

figure 50. Cumulative records of animal Ky 24

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