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A comparison of the prism rock test to standard convergence tests

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Abstract

Fifty-nine volunteer college students were used as subjects. Phorias and base in ductions were correlated with base in prism rock performance. Base out ductions and phorias at near and far were not correlated with base out prism rock. Base out. prism rock findings were positively related to base in prism rock performance. Correlation between base out and base in prism rock was not high enough t o warrant individual prediction. There appears to be separate systems at work for divergence and convergence.

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Harold M. Haynes

Subject Categories

Optometry

A COMPARISON OF THE PRISM ROCK TEST TO STANDARD CONVERGENCE TESTS

E55

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF OPTOMETRY

BY

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March, 1977

This Thesis Accepted by Harold M. Haynes, O.D.

This Thesis Presented by:

The authors would like to thank Dr. Harold M. Haynes for the assistance and guidance given. Dr. Haynes has not only helped us to complete this thesis, but has greatly added to the projects value as a learning experience for the authors.

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STATEMENT OF THE PROBLEM

This paper is a comparative study of a prism rock test correlated with standard convergence measurements commonly included in an optometric examination. As a secondary objective, the repeatability of the findings of Berreth and Smith[1] was investigated.

REVIEW OF THE LITERATURE

A prism rock test is a relative convergence responce time test at the nearpoint where base in or base out prisms are "flipped" in and out before the eyes to increase or decrease the convergence stimulus. The accommodative stimulus is held constant. When a subject meets the discriminatory criterion of the test, the accommodative responce is confined within the depth of focus for 20/20 acuity letters at the distance of 40 cm (2.5 diopters excluding lag). Prism rock tests are calibrated in alternations or cycles per minute.

Several studies of prism rock under the supervision of Professor Harold Haynes have Been performed at Pacific University College of Optometry. Berreth and Smith[1] in a normative study of college students found a mean value of approximately 23 cycles per minute on the Base Out prism phase and 19 cycles per minute on the Base In prism phase (8 prism diopters in each phase). A correlation of .51 was found between the base out and base in phase of the test. Test or retest reliability between the first and second minute performances was 0.91 for the Base Out and 0.84 for Base In.

Cameron, et al[2], found that cycles per minute vary as a function of the amount of disparity introduced by different magnitudes of prism. A representative sample of magnitudes of prisms used by Cameron were 2, 4, 8, and 12 prism diopters. These prism powers yielded median responses (cycles per minute) of: 36, 32, 28, and 19 for base out prism; 35, 28, 22, and 18 for base in prism on 25 female and 25 male subjects. Very few subjects could respond to magnitudes of prism greater than 12 prism diopters.

Cameron's findings are only slightly different than the findings of Westheimer and Rashbash[3], who stated that after a latency of 160 msec. the following convergence reaction to a sudden disparity asymtotically were 800 msec. Using Westheimer and Rashbash findings, on 3 subjects, a maximum of 30 cycles per minute would be predicted. Westheimer and Rashbash used a disparity of 2 degrees (3.5 prism diopters). There is the strong possibility that both latency and reaction time could vary with a different prism disparity. Westheimer and Mitchell[4] observed that subjects often reported the objects single in a sudden disparity test even though the vergence eye movements were not yet complete. A prediction factor shown by Krishan, et al[5], could affect the performance with various prism powers and also effect maximum predicted cycles per minute.

A study by Yandle and Turk[6] was of special interest to us because the prism rock test was readily increased through training. By inspection of their data, an increase in forced lateral vergence at the nearpoint was found after the prism rock training.

DESIGN OF THE CLINICAL STUDY

This study was designed to find the degree of correlation between the prism rock test and several commonly used phoria and duction tests. The convergence tests selected were: lateral phorias at 6 meters and 40 cm (#3, #13A), and forced vergences to break and recovery (ductions) at 6 meters and 40 cm (#10, #11, #16B, #17B). The phorias and ductions were taken through the subjects habitual correction at each respective distance.

SELECTION OF SUBJECTS: A group of volunteer college-aged persons habitually corrected to 20/20 visual acuity at the far and near points were used as subjects. Volunteers with strabismus, amblyopia, or a history of binocular dysfunctions were excluded. Sex as a variable was not studied because previous studies[1,2] showed no sex differences.

EQUIPMENT: An A.O. phoropter (RxMaster) was used for measuring the phorias and the ductions. The prism rock test was performed using a Van Orden Flipper with two round 4 diopter prisms. The target was a single vertical row of seven 20/20 letters for all tests. A stop watch was employed for the timed prism rock measurements.

TESTING PROCEDURE: The lateral phorias and duction findings were taken in accordance with Pacific University-OEP standardized proceedures. The prism rock measurements met the following requirements:

A. Distance = 16"

B. P.D. - fixed at 60mm

C. Illumination - back lighted at 100 fc

D. Phases

1. 8^{Δ} BO to plano to 8^{Δ} BO . . .
2. 8^{Δ} BI to plano to 8^{Δ} BI . . .

E. Time = 1 minute for each phase

F. Cycles per minute after 30 and 60 seconds

G. Target - 20/20 row of vertical letters

H. Demonstrate to subject while the instructions are read.

I. Binocular control determined by observation of eye movements by examiners.

J. Habitual Rx with a V.A. of 20/20 at 16"

K. Order of testing - alternate from phase 1 followed by phase 2 to phase 2 followed by phase 1 for successive subjects.

INSTRUCTIONS: The subject was seated in front of the Van Orden Flipper and the instrument was adjusted to the subjects heigth. The subject was told to flip the prisms as soon as the target was clear, readable, and single and to continue to flip the prisms until told to stop. The subject was told to start as soon as ready. After the minute of flipping the prisms the subject was told to stop. At that time the prisms were rotated to the opposite base direction and the subject was again told to flip the prisms as soon as the target was clear, readable, and single and to start when ready.

RESULTS

Sixty-five optometry students volunteered to serve as subjects. Of the sixty-five, five were rejected because of tropias and one because of reduced visual acuity at near. Fifty-nine were acceptable by our criteria.

Table I displays the Pearson r correlation coefficient for base in and base out prism rocks to standard optometric convergence tests, in the order taken in examination. Six correlations were equal to or greater than 0.47. Positive correlations were found with the distance phoria, distance base in duction recovery point, near phoria, near base in duction break point, near base in duction recovery point, and base out prism rock. No correlations greater than 0.25 were calculated for base out tests with base out prism rock. The phoria-accommodative stimulus ratio was calculated by the formula :

$$Ph/AS = \frac{(15 - \#3) + \#13A}{2.5 - add}$$

The ratio correlated at the -.34 level with base in prism rock and at the -.08 level with base out prism rock.

Table II displays the mean, median, mode, and standard deviations for each of the tests used in this study. The prism rock findings compare favorably to those fornd by Berreth and Smith.[1] The distance phoria closely approximates OEP norms and normative studies done at Pacific University College of Optometry. The base out duction break points and recovery points at far exceed the values expected. The base in duction findings at far fall within the previously mentioned norms. The near phoria is more eso than is expected. Of the near duction findings the base in duction findings are lower than would be expected.

Scattergrams I-IX were constructed in order to inspect the dispersion of the data to determine if the linear "r" (Pearson's) is the appropriate statistic. These scattergrams display individual groups of paired data that were found to have correlations near or greater than the 0.5 level. In addition, Scattergrams VI, VII, and VIII were plotted for the near phoria, near base out duction break and recovery points. A best fit line is displayed on each.

TABLE I

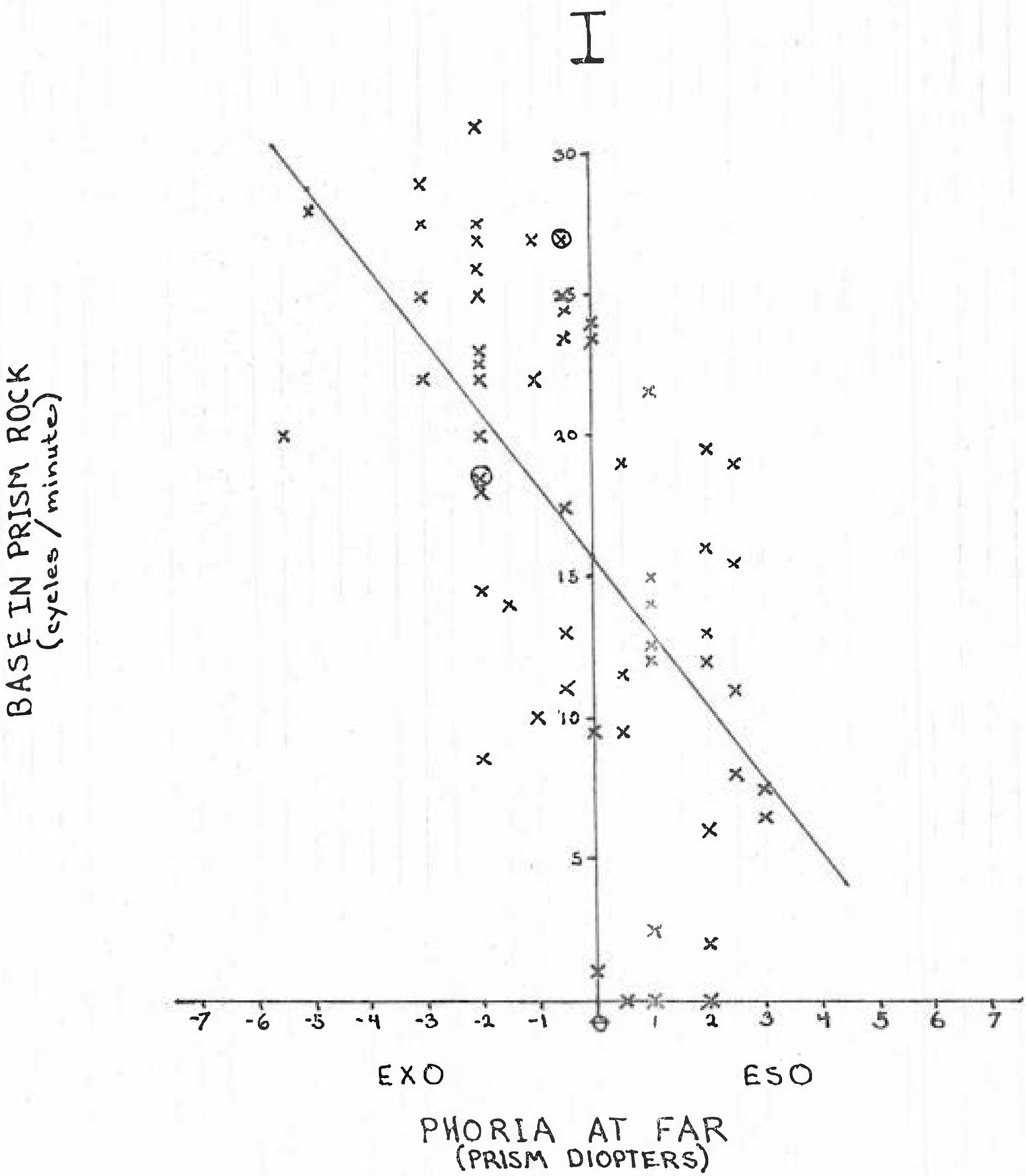
CORRELATIONS OF PRISM ROCK TO:

	BASE IN r	BASE OUT r
DISTANCE PHORIA (#3)	.61	.16
DISTANCE BASE OUT DUCTION BREAK POINT (#10K)	-.09	.23
DISTANCE BASE OUT DUCTION RECOVERY POINT (#10R)	-.03	.17
DISTANCE BASE IN DUCTION BREAK POINT (#11K)	.31	.13
DISTANCE BASE IN DUCTION RECOVERY POINT(#11R)	.47	.18
NEAR PHORIA (#13A)	.60	-.03
NEAR BASE OUT DUCTION BREAK POINT (#16K)	-.09	.25
NEAR BASE OUT DUCTION RECOVERY POINT (#16R)	-.08	.23
NEAR BASE IN DUCTION BREAK POINT (#17K)	.67	.25
NEAR BASE IN DUCTION RECOVERY POINT (#17R)	.63	.19
PHORIA/ACCOMODATION RATIO	-.34	-.08
BASE OUT PRISM ROCK	.51	

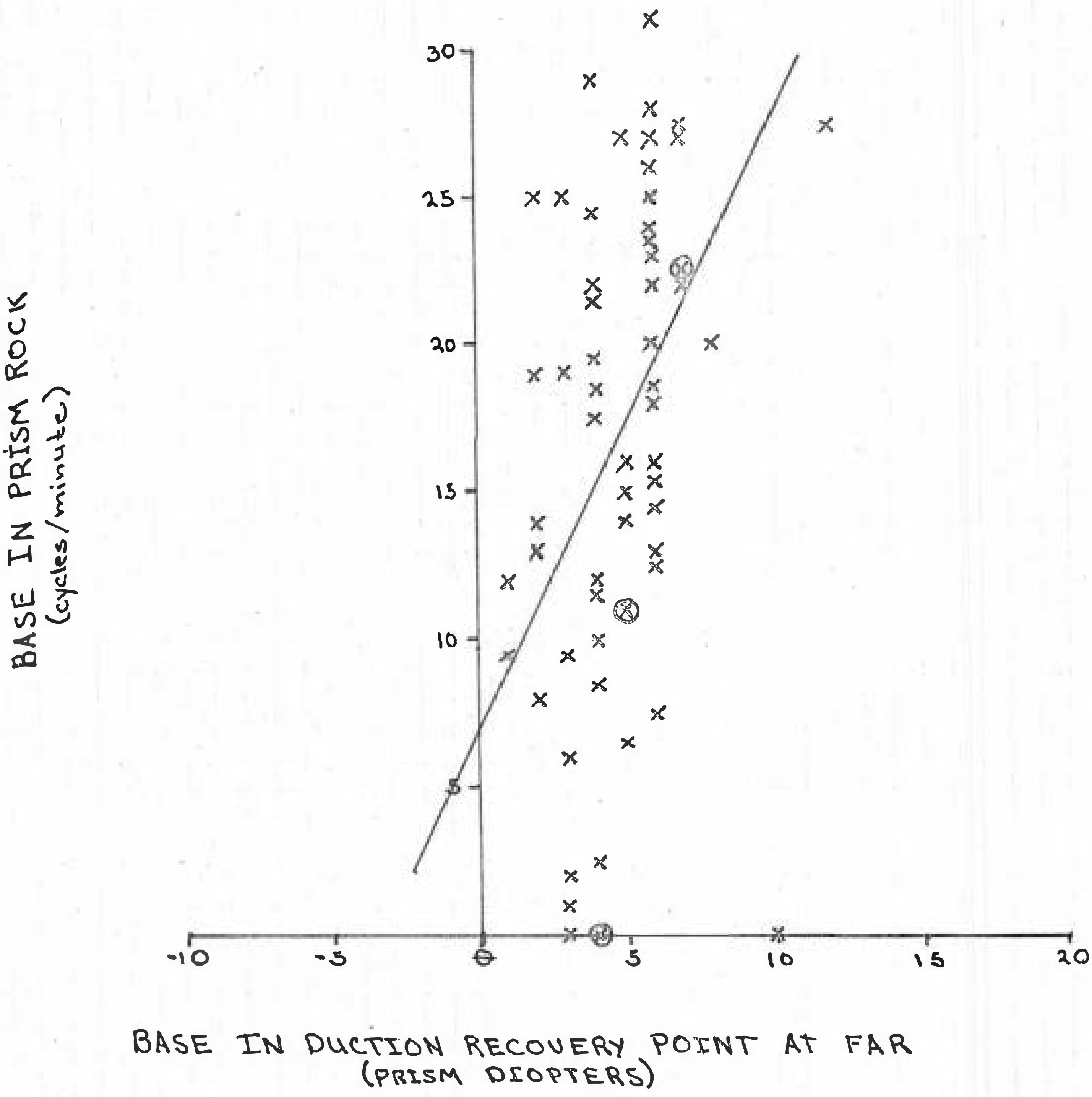
TABLE II

	MEAN	MEDIAN	MODE	STANDARD DEVIATION
BASE OUT PRISM ROCK	23.42	24	28	6.36
BASE IN PRISM ROCK	16.60	18	22	8.37
*DISTANCE PHORIA (#3)	-0.30	0	-2	1.96
DISTANCE BASE OUT DUCTION BREAK POINT (#10K)	24.56	24	24	9.27
DISTANCE BASE OUT DUCTION RECOVERY POINT(#10R)	16	12	12	10.11
DISTANCE BASE IN DUCTION BREAK POINT (#11K)	7.51	8	8	2.37
DISTANCE BASE IN DUCTION RECOVERY POINT (#11R)	4.76	5	6	1.90
*NEAR PHORIA (#13A)	0.28	-1	-2	5.98
NEAR BASE OUT DUCTION BREAK POINT (#16K)	26.83	26	24.32	8.22
NEAR BASE OUT DUCTION RECOVERY POINT (16R)	17.94	17	12	8.89
NEAR BASE IN DUCTION BREAK POINT(#17K)	14.81	14	12	6.10
NEAR BASE IN DUCTION RECOVERY POINT (#17R)	10.02	10	8	5.76

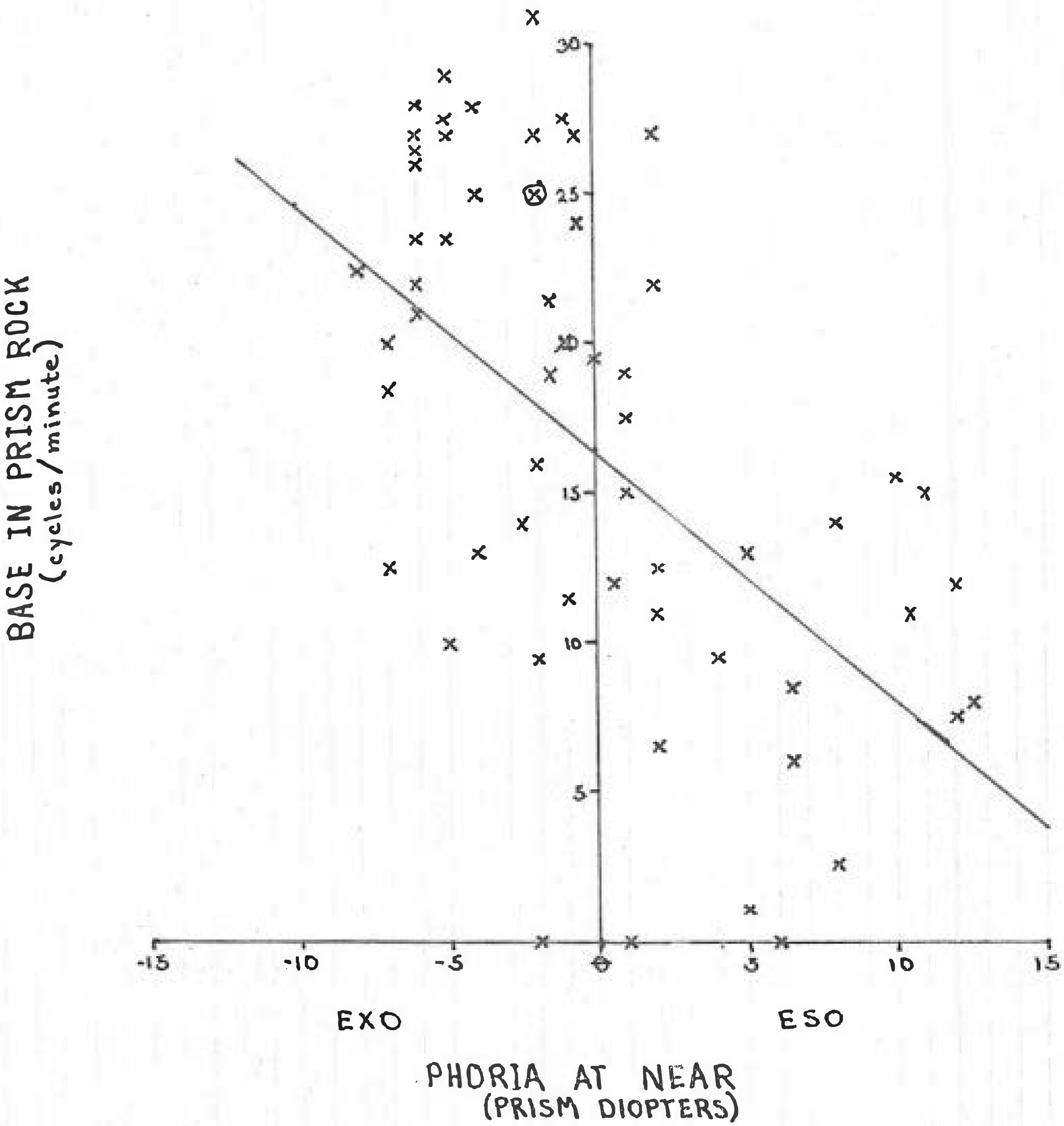
* "-" denotes exo phoria


I
BASE IN PRISM ROCK
(cycles / minute)
30
25
20
15
10
5
-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7
EXO
ESO
PHORIA AT FAR
(PRISM DIOPTERS)

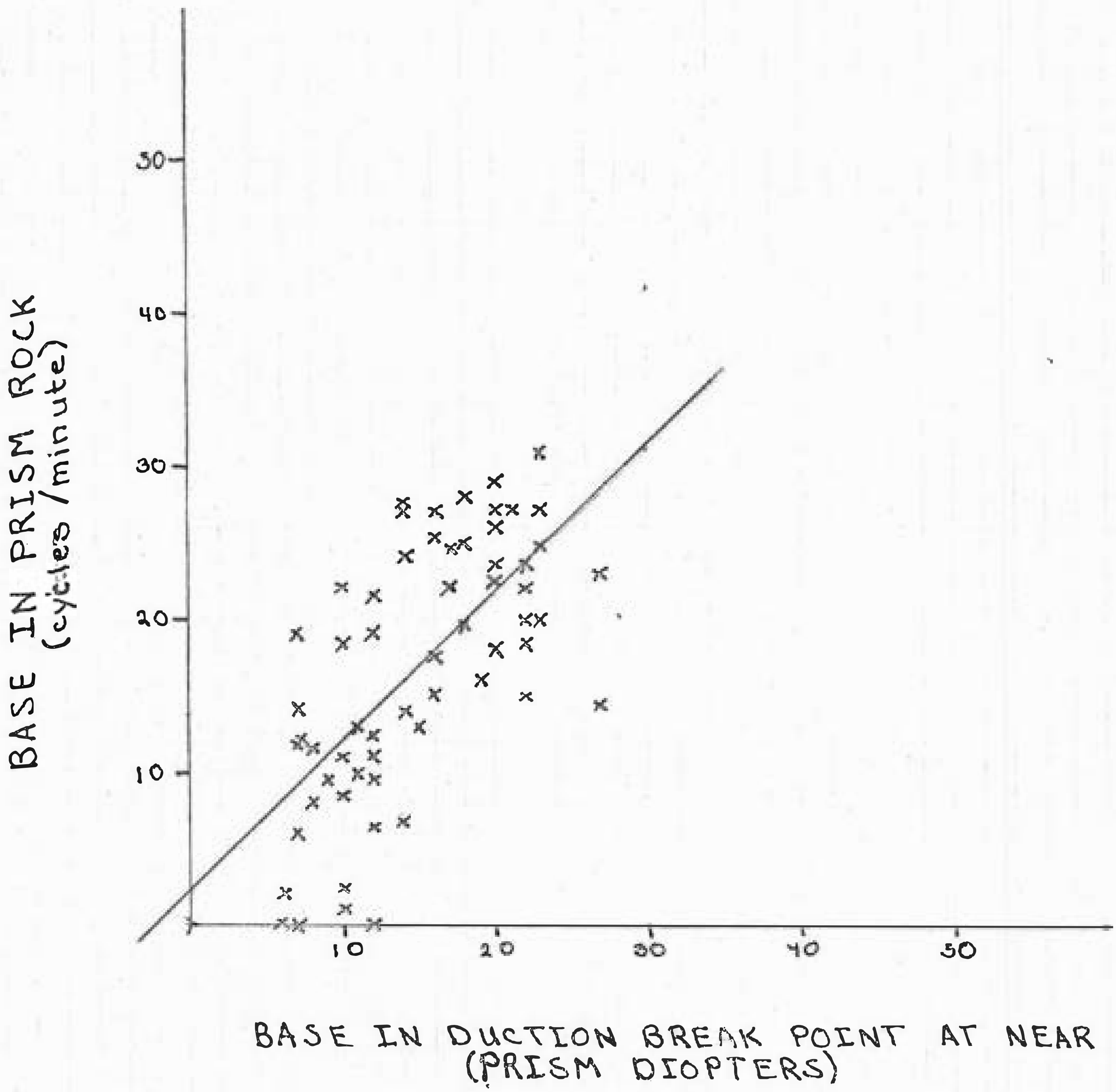
II


BASE IN PRISM ROCK
(cycles/minute)
30
25
20
15
10
5
-10
-5
0
5
10
15
20
BASE IN DUCTION RECOVERY POINT AT FAR
(PRISM DIOPTERS)

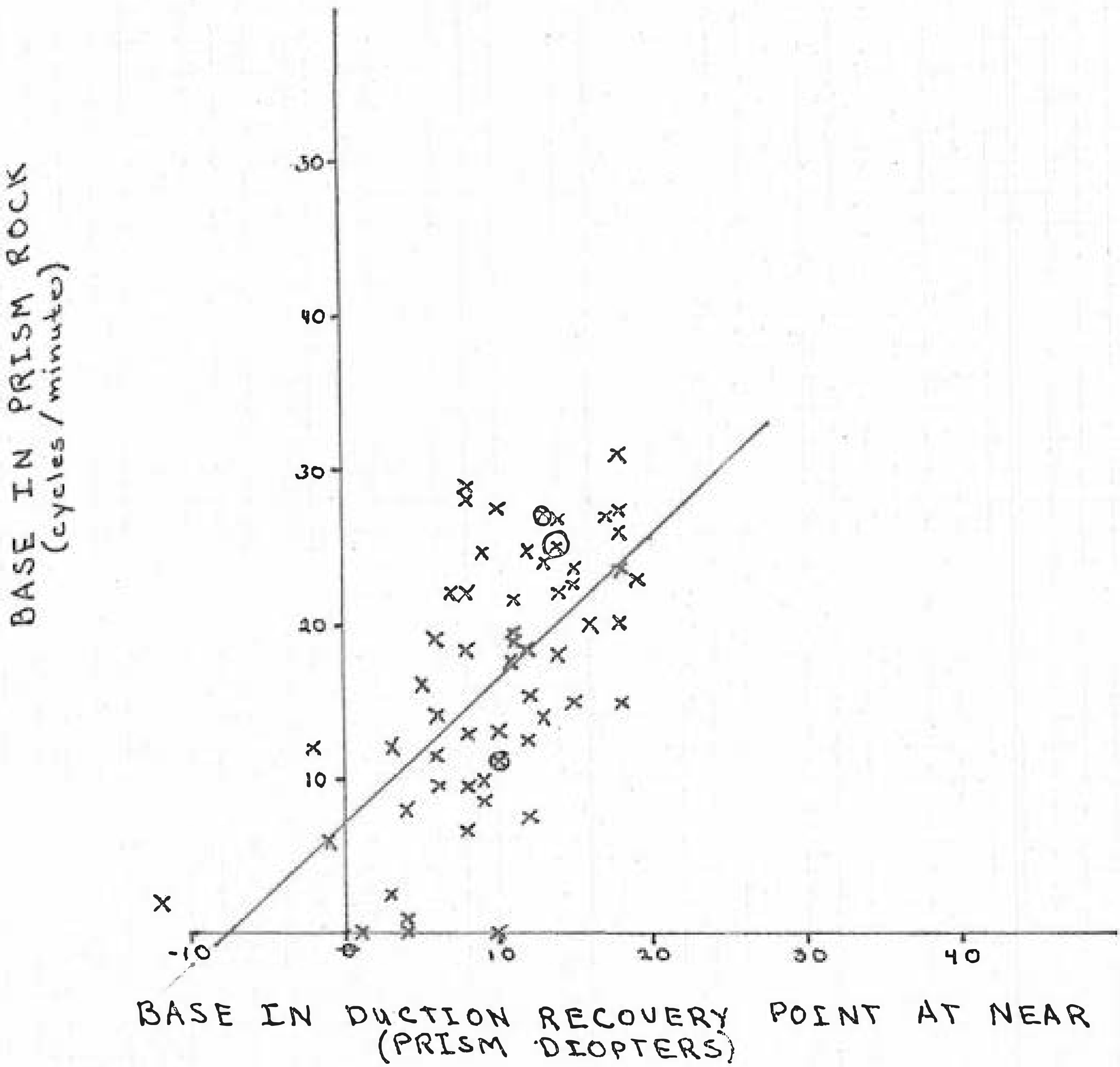
III

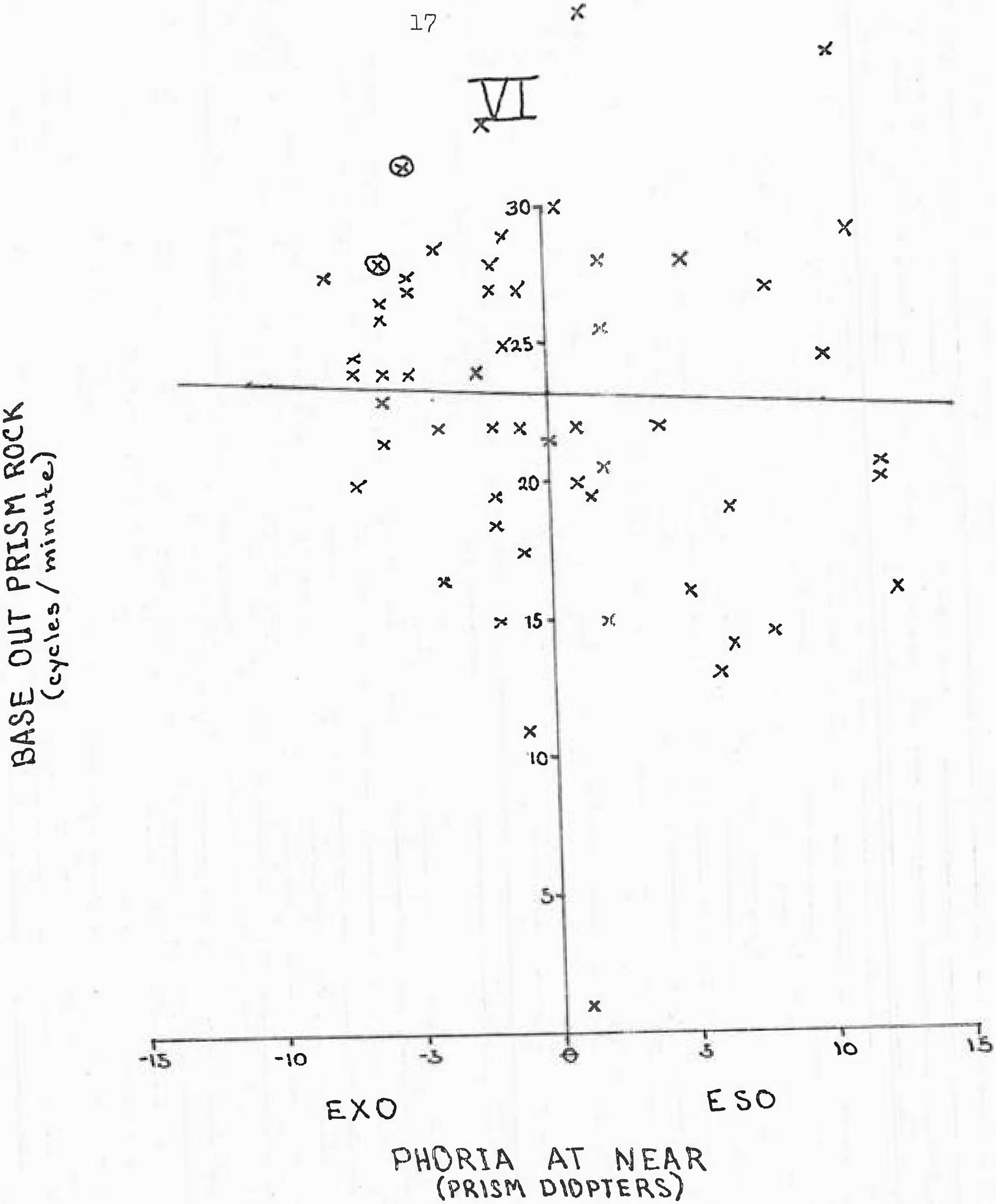

BASE IN PRISM ROCK
(cycles/minute)
30
25
20
15
10
5
-15
-10
-5
0
5
10
15
EXO
ESO
PHORIA AT NEAR
(PRISM DIOPTERS)

IV

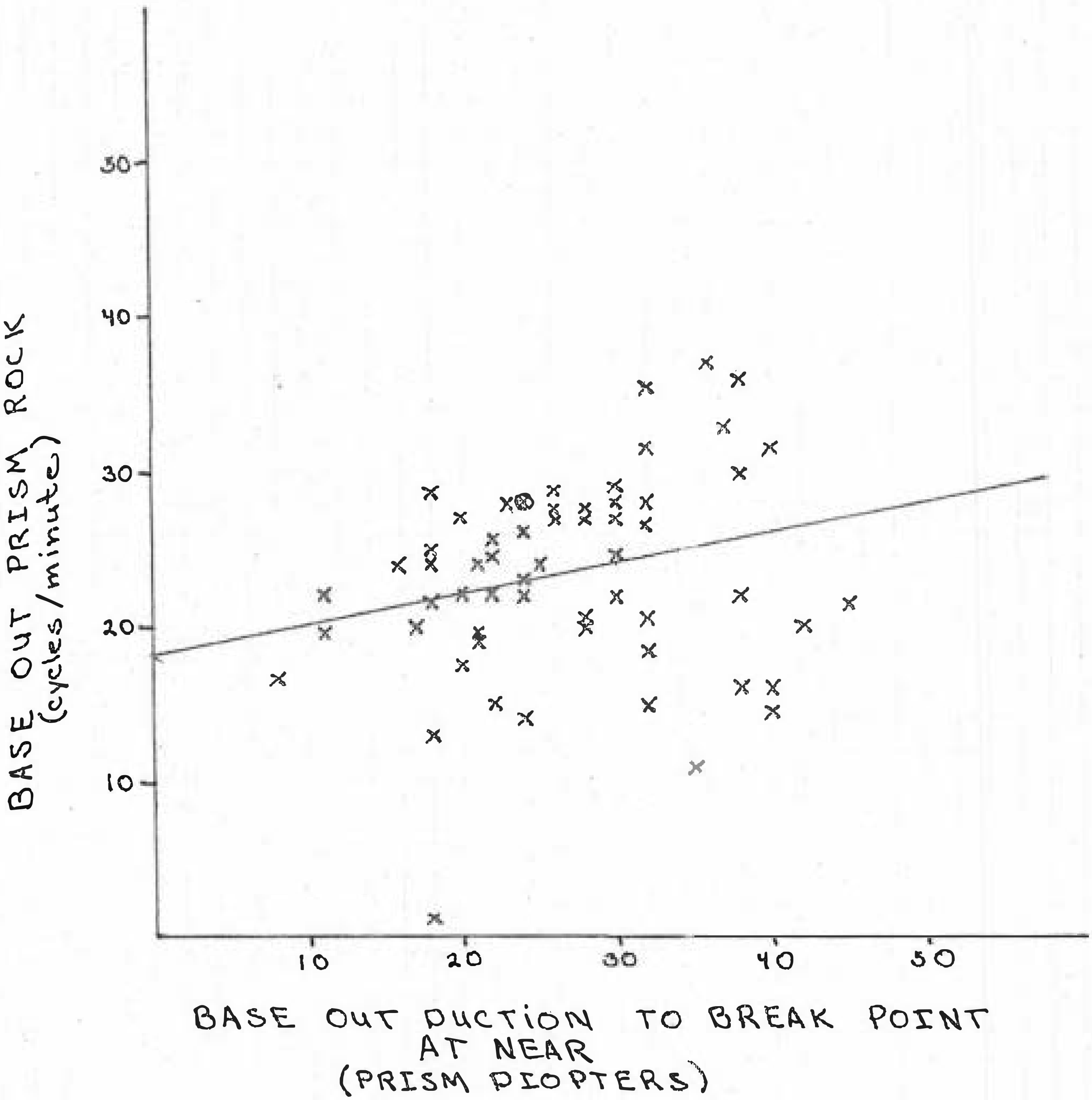

BASE IN PRISM ROCK
(cycles/minute)
10
20
30
40
50
10
20
30
40
50
BASE IN DUCTION BREAK POINT AT NEAR
(PRISM DIOPTERS)

V

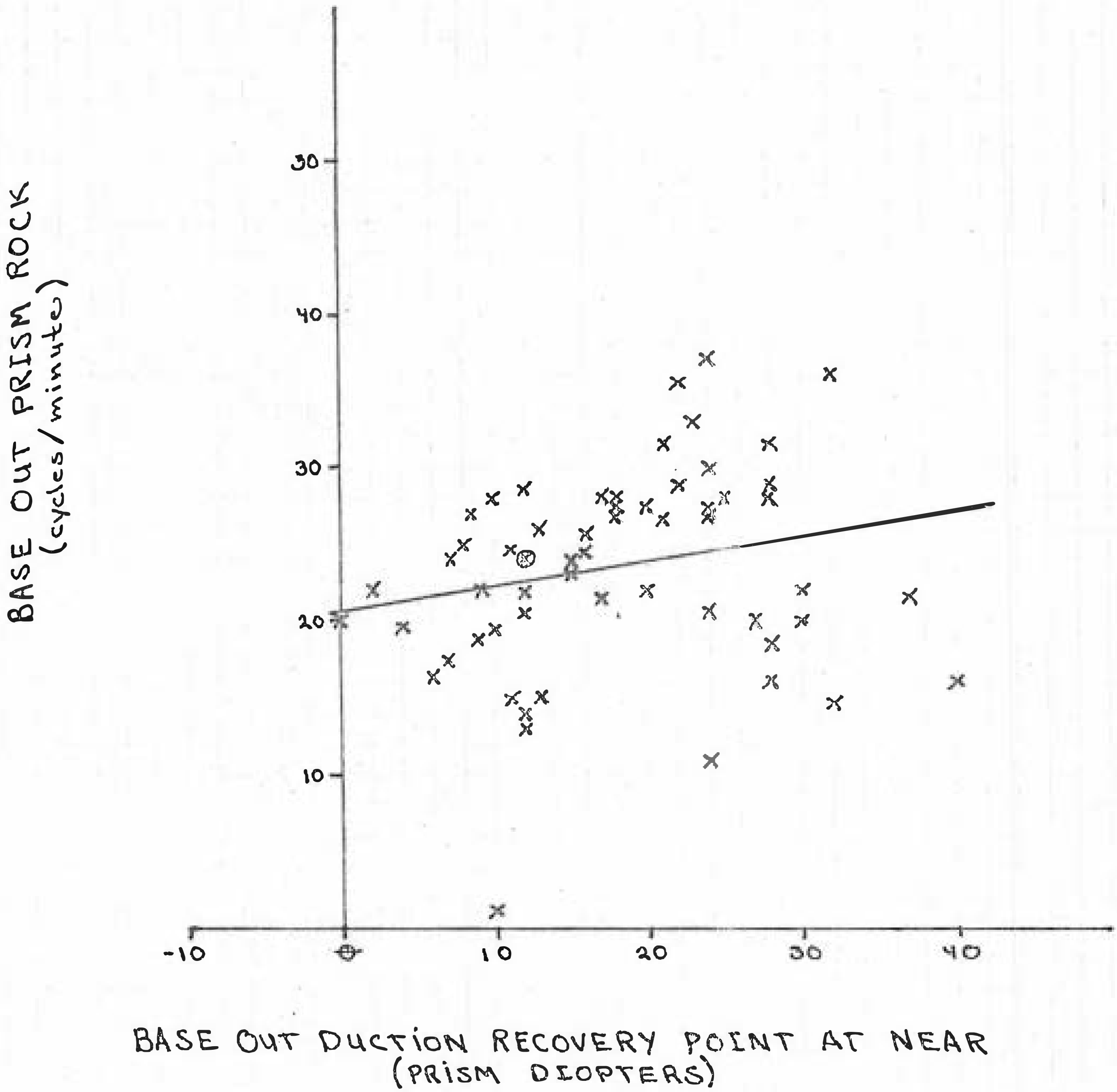

BASE IN PRISM ROCK
(cycles / minute)
50
40
30
20
10
-10
0
10
20
30
40
BASE IN DUCTION RECOVERY POINT AT NEAR
(PRISM DIOPTERS)


VI
BASE OUT PRISM ROCK
(cycles / minute)
30
25
20
15
10
5
-15
-10
-5
0
5
10
15
EXO
ESO
PHORIA AT NEAR
(PRISM DIOPTERS)

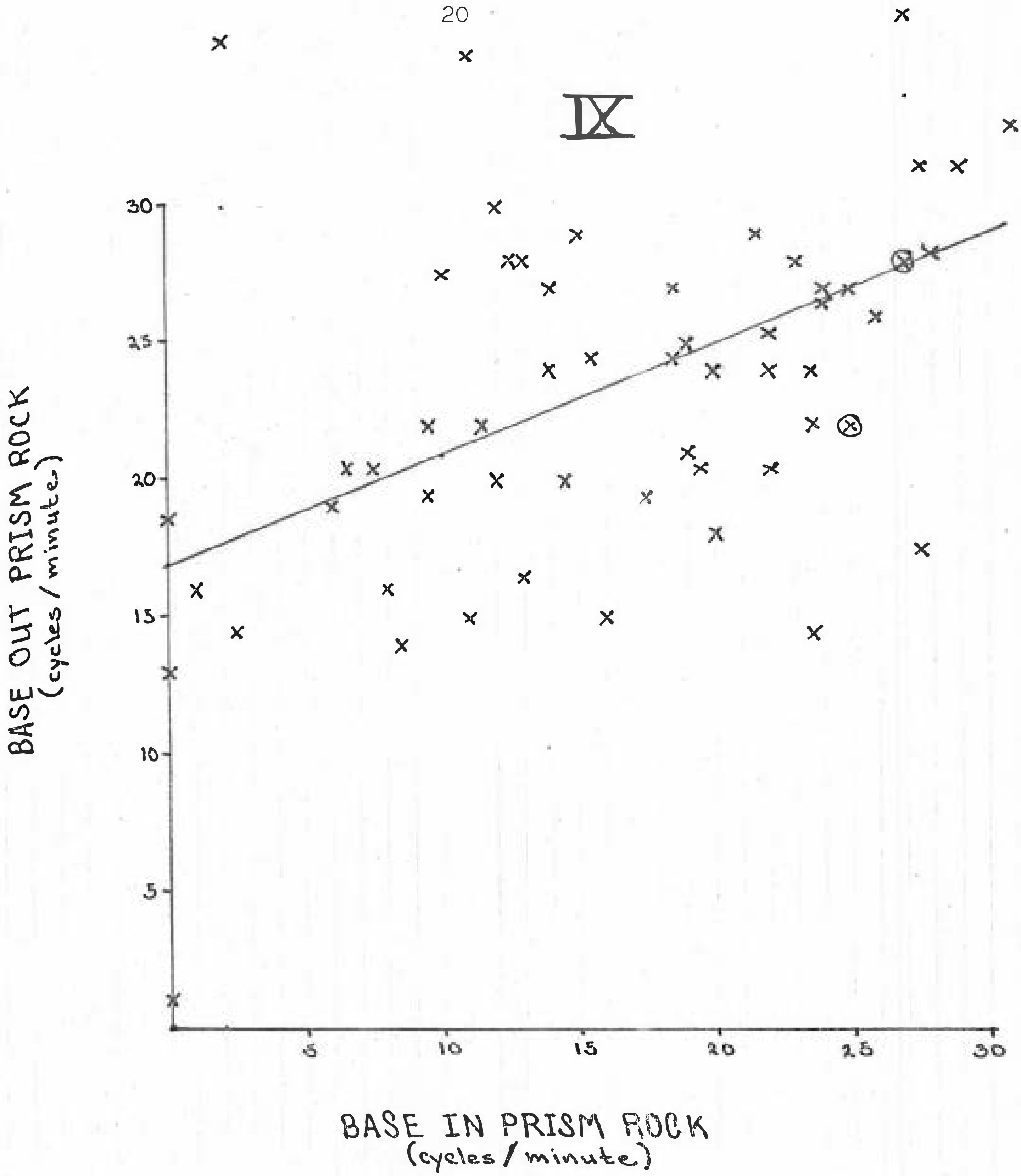
VII


BASE OUT PRISM ROCK
(cycles/minute)
10
20
30
40
30
10
20
30
40
50
BASE OUT DUCTION TO BREAK POINT
AT NEAR
(PRISM DIOPTERS)

VIII


BASE OUT PRISM ROCK
(cycles/minute)
30
40
30
20
10
-10
0
10
20
30
40
BASE OUT DUCTION RECOVERY POINT AT NEAR
(PRISM DIOPTERS)

IX


BASE OUT PRISM ROCK
(cycles / minute)
30
25
20
15
10
5
5
10
15
20
25
30
BASE IN PRISM ROCK
(cycles / minute)

DISCUSSION OF THE RESULTS

The outstanding finding of our study was that far and near phorias and near base in ductions were positively correlated with base in prism rocks (greater than 0.6) wheras no significant correlations (less than 0.25) were found with the base out findings. We know of no theoretical reason for this result. Another correlation of interest is that the base out prism rock was positively correlated (0.51) with the base in prism rock. This is compatable with the findings of Berreth and Smith.[1]

The high incidence of esophores as measured by the near phoria (#13A) could possibily be attributed to the volunteer college population that is subject to much near point demand. This prevalence of esophoria at near seems covariant with the lowered near base in ductions. We have no evidence to suggest that the sample has effected the correlation coefficient.

The correlations found supports the notion that convergence and divergence from a given fixation plane is mediated by separate response systems. This notion is further supported by the fact that base out and base in prism rocks correlate at 0.51 when the test or retest reliability is equal to or greater than 0.84.

ABSTRACT

Fifty-nine volunteer college students were used as subjects. Phorias and base in ductions were correlated with base in prism rock performance. Base out ductions and phorias at near and far were not correlated with base out prism rock. Base out prism rock findings were positively related to base in prism rock performance. Correlation between base out and base in prism rock was not high enough to warrant individual prediction. There appears to be separate systems at work for divergence and convergence.

1 Berreth and Smith, Normative study of the prism rock test, using eight prism diopters in both base out and base in directions, Pacific University Thesis files, 1960

2 Cameron and Yoshimura, A study on predicting cycles per minute with changes in prism magnitude, Pacific University Thesis files, 1965

3 Westheimer and Rashbash, Dysjunctive eye movements, J. Physiol. 159: 339-360

4 Westheimer and Mitchell, Eye movement responses to convergence stimuli, Arch. Ophth. Vol. 55, Jan-June, 1956, p.848

5 Krishnan, Farazian, and Stark, An analysis of latencies and prediction in the fusional vergence system, Am J Opt 50(12) 933-939 Dec 1973

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7 Donaldson, Ricker, Samuelis, A normative study of students selected at random on the combined prism and sphere rock test, Pacific University Thesis files, 1962

8 Allen, An investigation of the time characteristics of accommodative and convergence of the eyes, Academy Journal Vol 30, 1953 p. 78

9 Greene, The prism hurdle test, Opt J Rev Opt 109(5) 34-35 March 1, 1972

10 Rashbash and Westheimer, Independence of conjunctive and disjunctive eye movements, J. Physiol. 159: 361-364, 1961

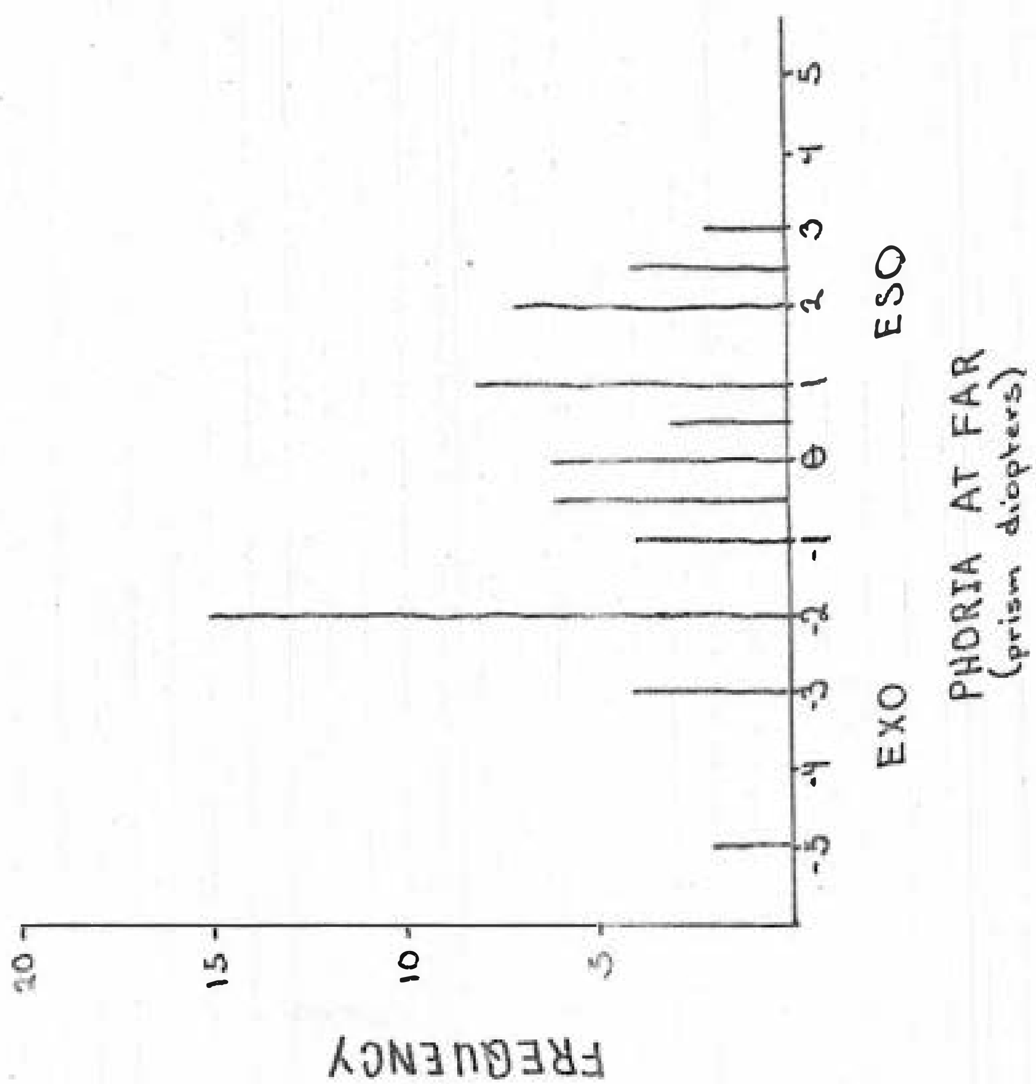
APPENDIX

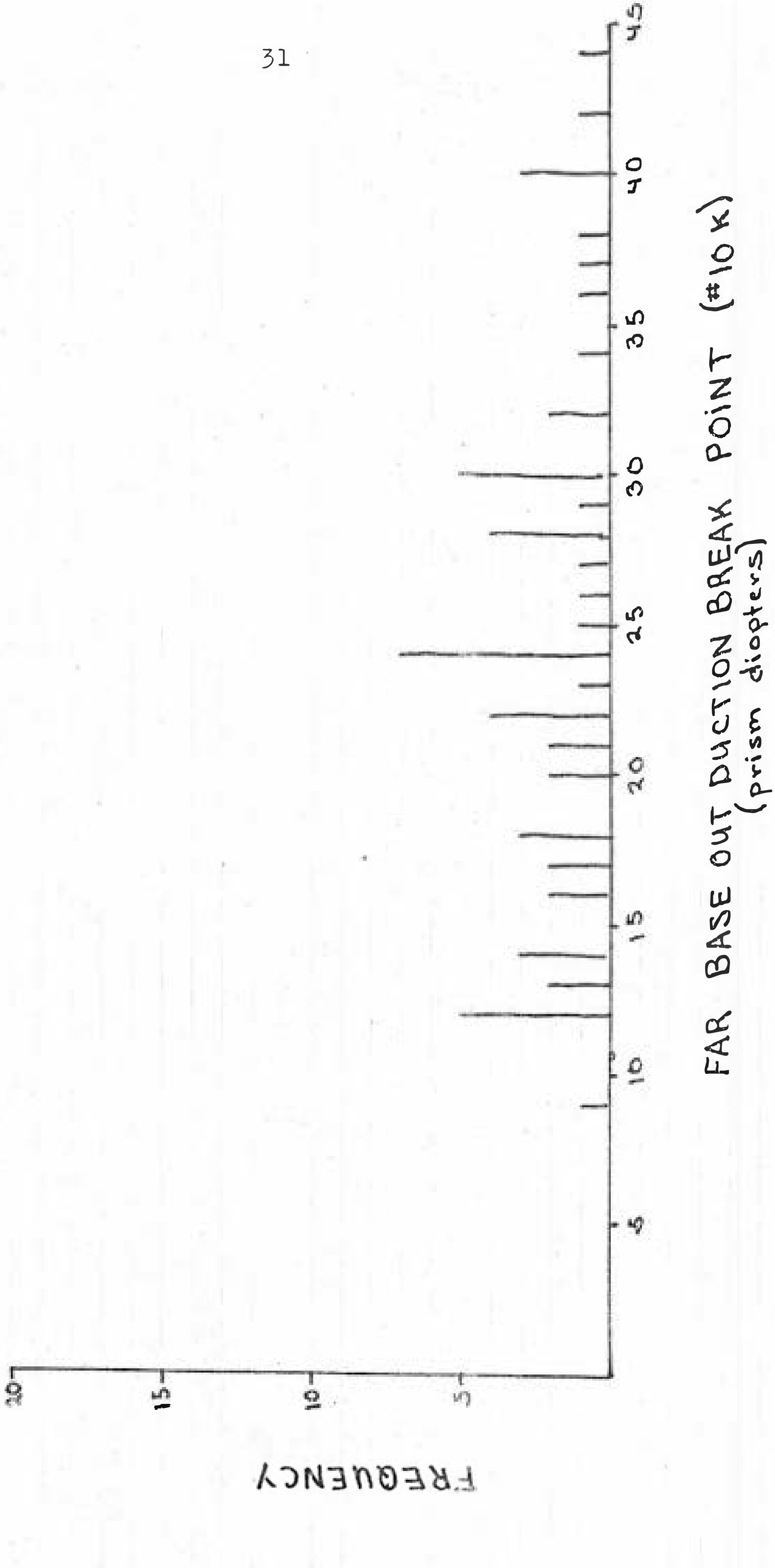
Sub.#	Hab. Rx	#3	#10K	#10R	#11K	#11R	#13A	#16K	#16R	#17K	#17R	Ph/A	BO Δrx	BI Δrx
1	-2.25-.50X120 -2.50-1.50X60	+3	40	40	10	6	+12	28	24	14	12	9.6	20.5	7.5
2	-1.50-.50X90 -1.50-.50X90	-5	20	14	10	6	-4	18	12	18	8	6.4	28.5	28
3	-2.25-.50X167 -2.25 Sph	-0.5	25	10	7	4	-6	32	21	17	9	3.8	26.5	24.5
4	-2.50-.25X85 -2.75-.25X105	+1	27	23	6	4	-1	30	20	8	6	5.2	22	11.5
5	PL	-2	14	4	8	6	-7	17	Ø	27	18	4	20	14.5
6	PL	-2	21	6	8	4	-7	22	16	10	8	4	24.5	18.5
7	PL	-3	22	10	10	7	-5	32	21	14	10	5.2	31.5	27.5
8	PL	+2	37	22	6	4	Ø	45	37	18	11	5.2	21.5	19.5
9	-5.50-1.25X132 -6.50-1.25X38	-3	14	11	10	7	-6	18	17	22	14	4.8	21.5	22
10	PL	-2	16	12	7	6	+2	22	16	10	8	7.6	25.5	22
11	PL	+3	30	6	8	5	+2	32	12	12	8	5.6	20.5	6.5
12	-4.50-.25X04 c +.75 -4.50-.37X30	+1	44	40	9	4	+8	40	32	10	3	8.8	14.5	2.5
13	-1.75-1.25X163 -2.00-1.50X86	Ø	24	18	6	3	+5	38	28	10	4	8	16	1
14	-4.25-.75X15 -3.50-.75X80	-3	48	40	10	4	-5	40	28	20	8	5.2	31.5	29
15	-2.00-.50X150 -1.50 Sph	+2	30	18	9	4	-2	32	28	12	10	4.4	18.5	Ø

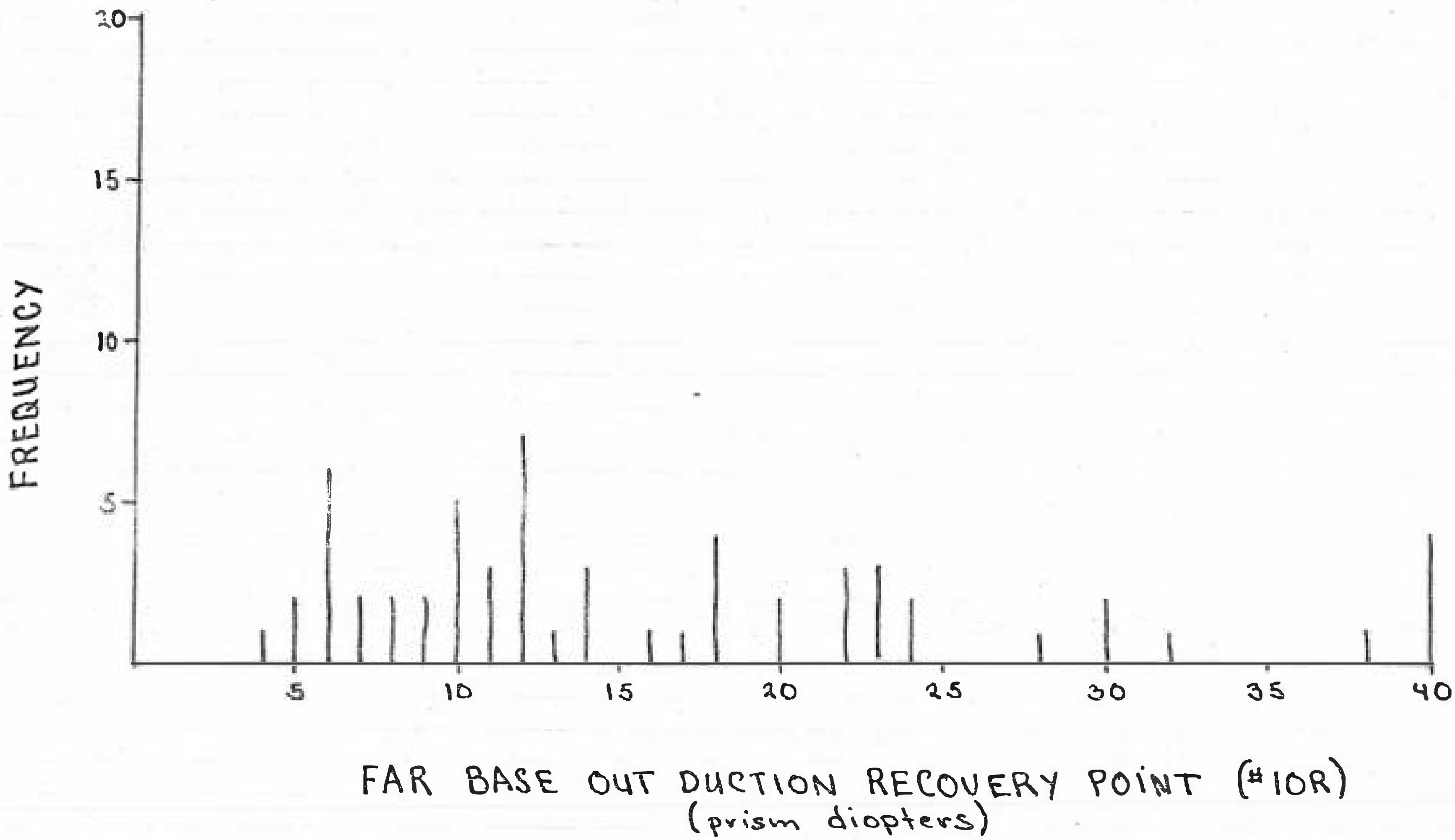
Sub.#	Hab. Rx	#3	#10K	#10R	#11K	#11R	#13A	#16K	#16R	#17K	#17R	Ph/A	BO Δ r-k	BI Δ r-k
16	-.75-.25x86 -.75 Sph	+0.5	24	12	4	1	+4	24	19	9	8	7.4	22	9.5
17	-3.25-.25x90 -3.50-.25x90	-1	24	10	6	4	-5	26	18	11	9	4.4	27.5	10
18	PL	+1	12	6	7	3	+1	18	10	6	4	6	1	Ø
19	-2.00 Sph -1.00 Sph	Ø	12	6	6	3	-2	21	10	12	6	5.2	19.5	9.5
20	-2.75-.87x73 -2.50-.87x115	-2	12	8	8	6	-6	23	17	27	19	4.4	28	23
21	+.50 Sph +.50 Sph	+2	18	6	7	5	-2	32	13	19	5	4.4	15	16
22	-2.00 Sph -.50 Sph	-2	17	12	8	6	-7	21	12	22	18	4	24	20
23	-4.25-.50x60 -4.25-.50x120	-3	12	12	6	3	-2	11	2	16	12	6.4	22	25
24	-4.00-.50x55 -4.00-.50x112	-2	30	18	6	4	+6.5	24	12	10	9	9.4	14	8.5
25	-1.75-.50x155 -1.75-.50x37	-0.5	18	13	5	2	-2	20	8.5	23	14	5.4	27	25
26	-1.25 Sph -2.00-.50x180	+1	32	28	7	5	+11	30	28	22	15	10	29	15
27	-1.75-.50x80 -1.75-.50x80	-1	30	30	9	6	-2	24	18	21	14	5.6	28	27
28	PL	-1	18	17	7	4	-6	18	12	17	7	4	24	22
29	PL	+2.5	40	40	7	2	+12.5	40	40	8	4	10	16	8
30	PL	+2	14	9	4	2	-4	8	6	15	8	3.6	16.5	13

Sub.#	Hab. Rx	#3	#10K	#10R	#11K	#11R	#13A	#16K	#16R	#17K	#17R	Ph/A	BOΔrk	BIΔrk
31	-5.00-.50x45 -5.00-.50x120	-2	29	18	10	6	-5	30	18	22	12	4.8	27	18.5
32	PL	+2.5	28	12	8	6	+10	30	11	16	12	9	24.5	15.5
33	PL	+0.5	17	5	4	3	+1	22	12	12	11	6.2	22	19
34	PL	-2	13	5	13	12	-1	20	7	23	18	6.4	17.5	27.5
35	PL-1.50x90 PL-1.50x90	-2	28	14	9	7	-8	28	20	20	15	3.6	27.5	22.5
36	PL	+1	24	24	2	2	+8	28	24	7	6	8.8	27	14
37	PL	+1	36	32	8	6	+2	32	28	12	12	6.4	28	12.5
38	PL	-0.5	42	36	10	7	+1.5	36	24	20	17	6.8	37	27
39	-3.25-.25x180 -3.25-.50x09	+2	32	30	3	1	+12	28	27	7	-2	10	20	12
40	-1.75-.25x90 -1.00-.25x90	⊖	16	12	8	6	-5	16	15	20	18	4	24	23.5
41	-1.50-1.00x155 +.25-2.00x15	-0.5	13	12	7	4	+0.5	11	4	16	11	6.4	19.5	17.5
42	-.50 Sph -.50 Sph	⊖	8	7	16	7	-6	24	15	22	15	3.6	23	23.5
43	PL	+1	22	14	4	4	-1.5	26	22	12	11	5	29	21.5
44	-.50 Sph -.50 Sph	⊖	20	10	7	6	-0.5	26	24	14	13	5.8	27	24
45	PL	-1.5	22	6	6	5	-2.5	25	7	14	13	5.8	24	14

Sub#	Hab Rx	#3	#10K	#10R	#11K	#11R	#13A	#16K	#16R	#17K	#17R	Ph/A	BOΔrk	BIΔrk
46	-3.25-1.00×180 -4.00-1.25×14	θ	21	9	9	6	+5	24	10	11	10	8	28	13
47	PL	+2	22	11	4	3	+6.5	21	9	7	-1	7.8	19	6
48	-1.00 Sph -1.00 Sph ͨ +.50	+2.5	23	16	4	2	-1.5	18	8	7	6	5.5	25	19
49	PL	+2.5	38	24	8	5	+10.5	32	22	10	10	9.2	35.5	11
50	PL	-0.5	28	11	8	5	+2	22	11	12	10	6.6	15	11
51	PL ͨ +1.50	-2	24	22	8	6	-6	24	13	20	18	11	26	26
52	-3.75 Sph -3.75 Sph	-2	30	23	8	5	-6	30	25	16	13	4.4	28	27
53	-3.75 Sph -3.75 Sph	+1	24	22	7	4	+0.5	38	24	7	3	5.8	30	12
54	-5.00 Sph -4.25-1.00×26	+0.5	12	10	7	4	+6	18	12	7	1	8.2	13	θ
55	-3.75-.75×90 -3.75-.75×90	-5	28	20	11	8	-1	35	24	23	16	7.6	18	20
56	-3.50 Sph -4.50 Sph	-2	34	23	8	6	-4	38	30	18	14	5.2	22	25
57	-.50 Sph -.50 Sph	-2	26	8	9	6	-2	37	23	23	18	6	33	31
58	PL	+2	24	7	8	3	+17	38	32	6	-12	12	36	2
59	-2.75-.75×120 -2.25-.75×75 ͨ +1.50	-2	40	20	8	6	+1	40	30	20	14	18	20	18


FREQUENCY
20
15
10
5
-5
-4
-3
-2
-1
0
1
2
3
4
5
EXO
ESO
PHORIA AT FAR
(prism diopters)


FREQUENCY
20
15
10
5
5
10
15
20
25
30
35
40
45
FAR BASE OUT DUCTION BREAK POINT (#10 K)
(prism diopters)


FREQUENCY
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15
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25
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35
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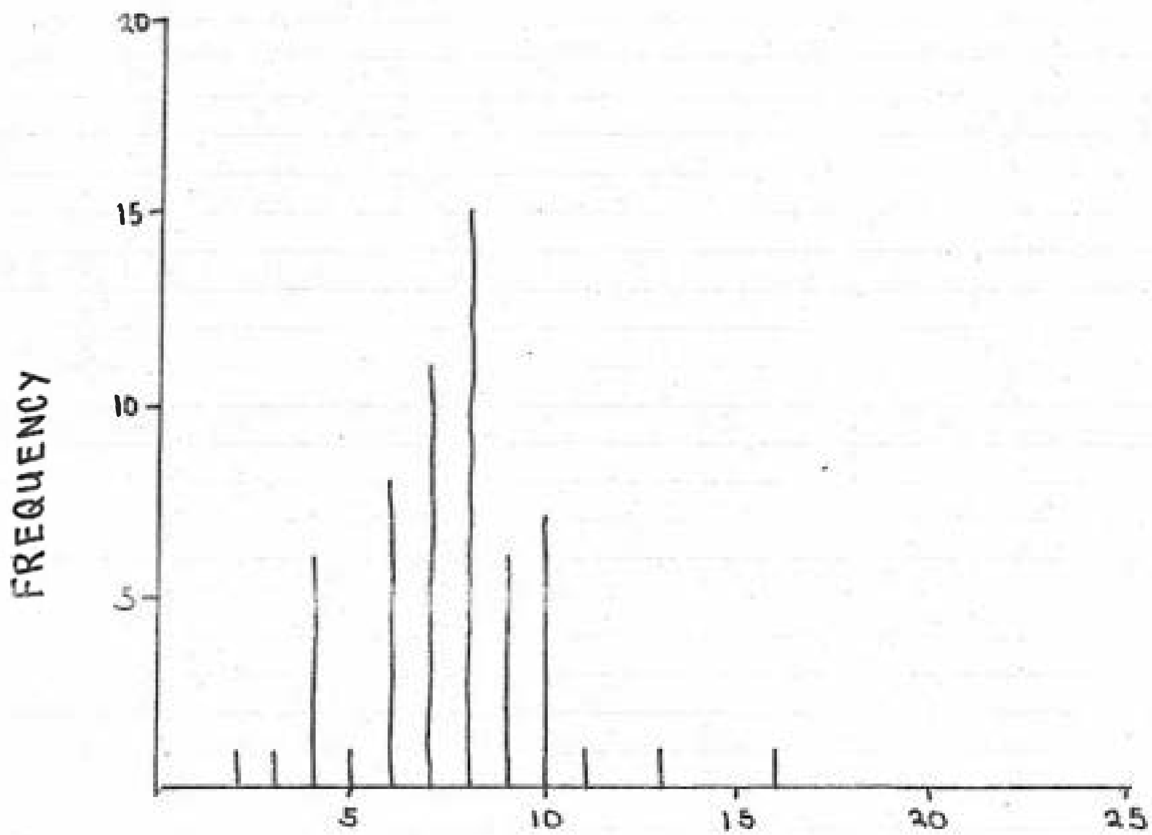
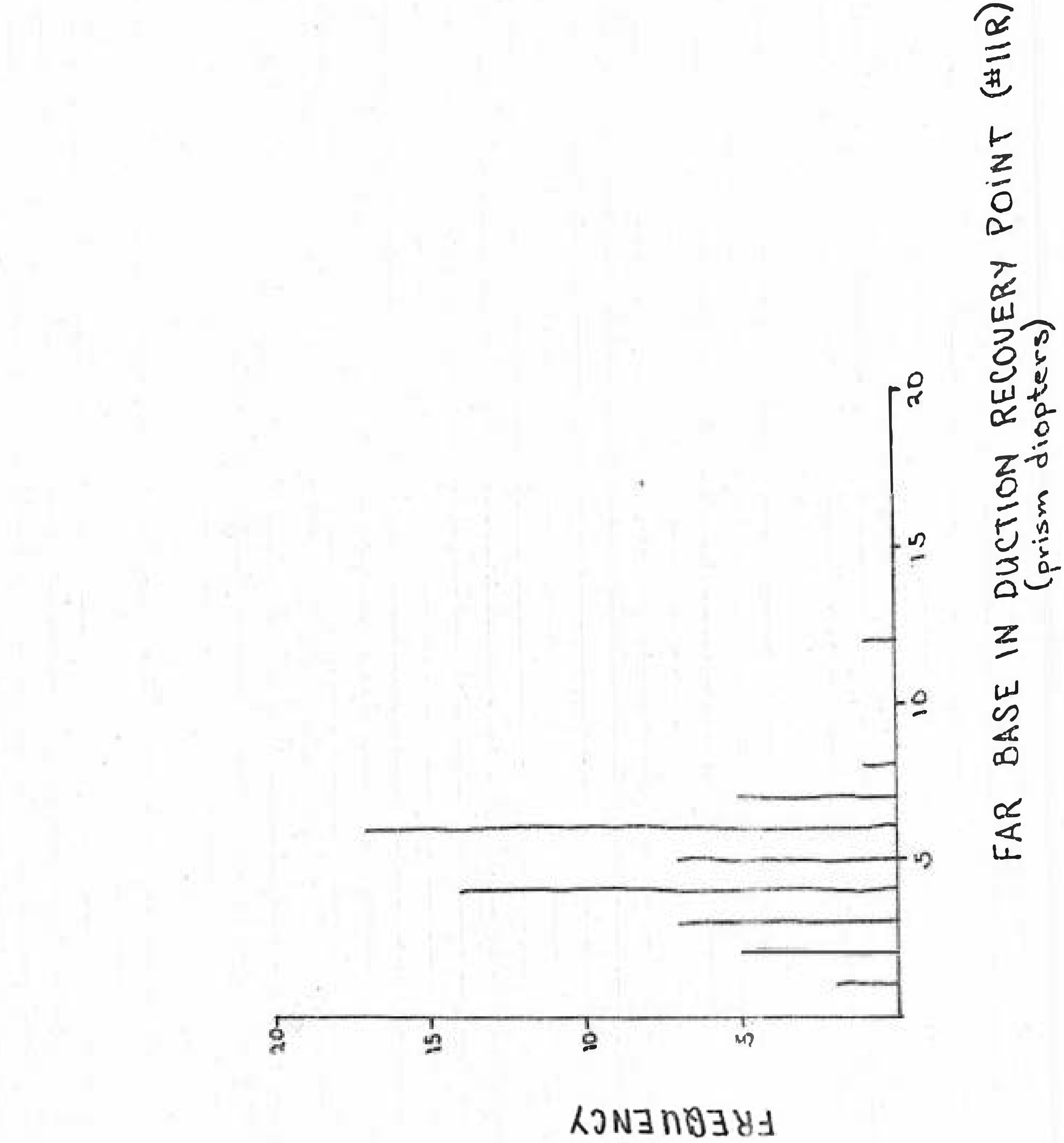
FAR BASE OUT DUCTION RECOVERY POINT (#10R)
(prism diopters)



FAR BASE IN DUCTION BREAK POINT (#11K)
(prism diopters)


FREQUENCY
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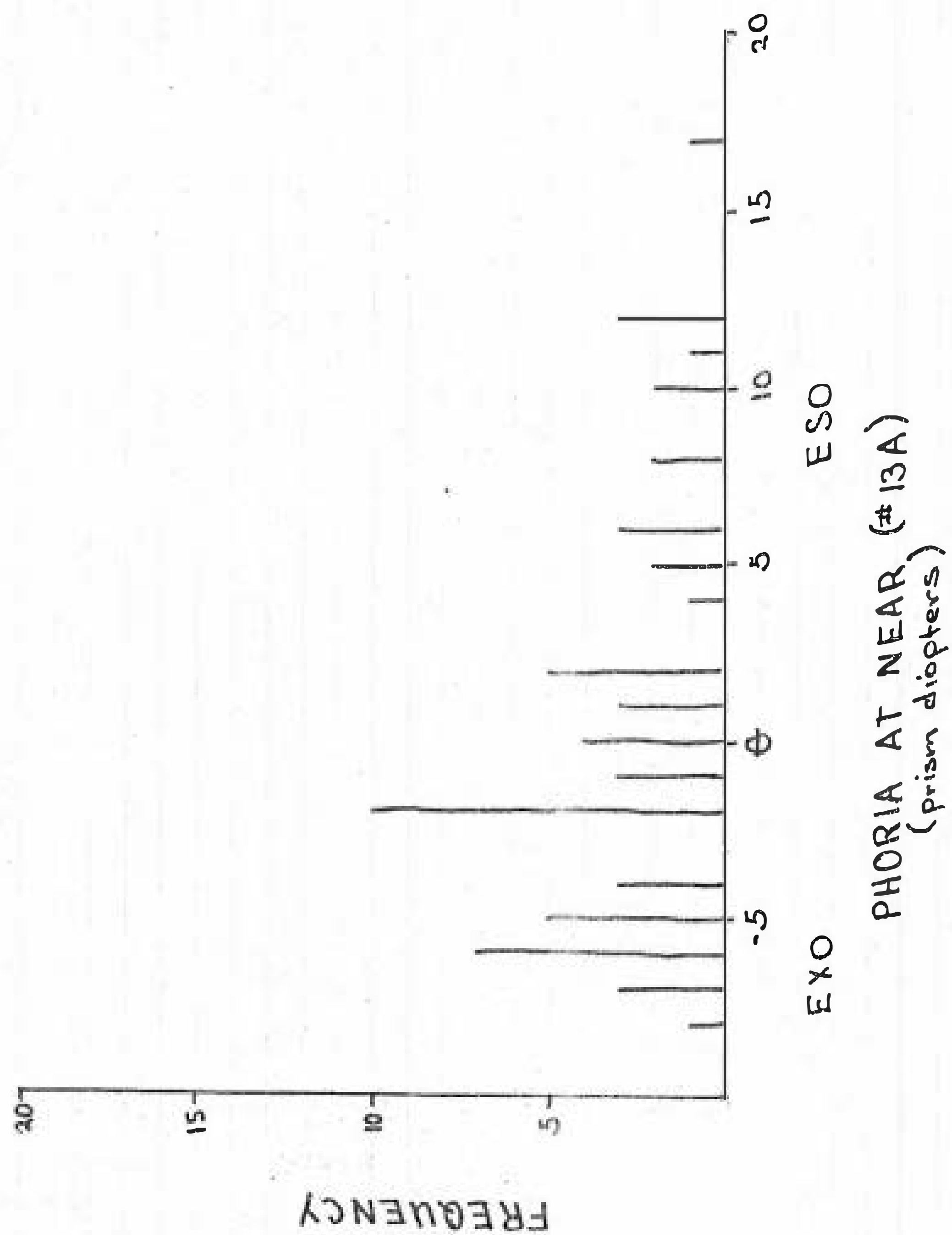
5
10
15
20
FAR BASE IN DUCTION RECOVERY POINT (#11R)
(prism diopters)


FREQUENCY
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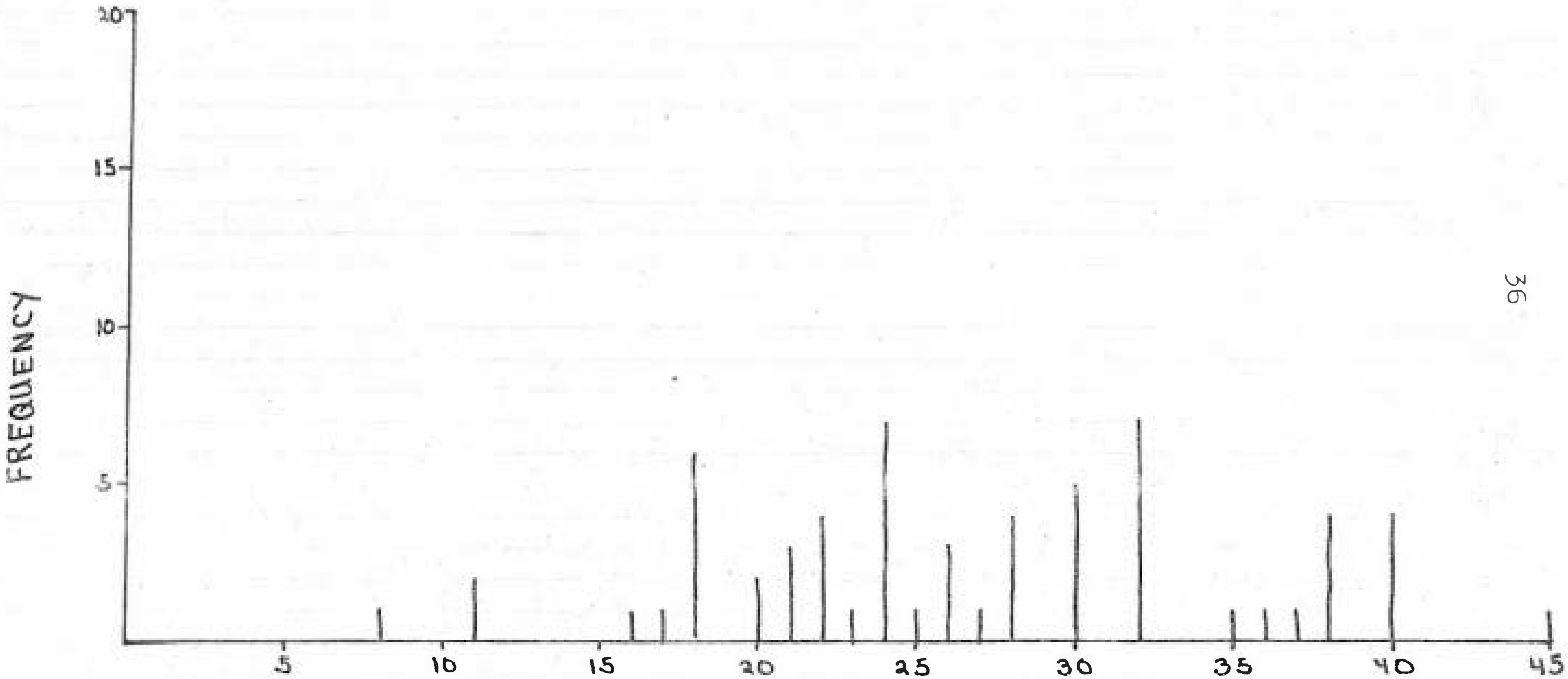
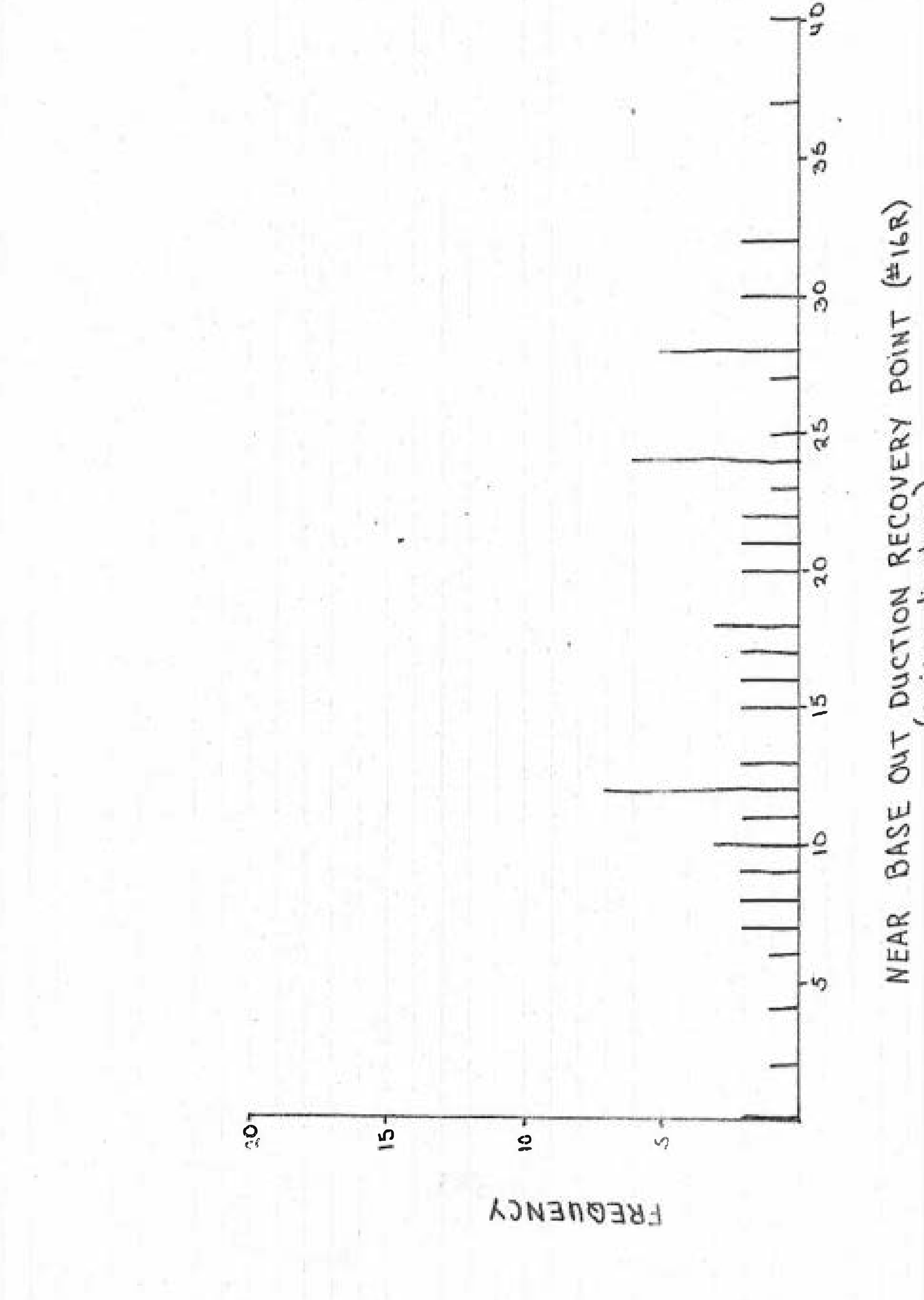
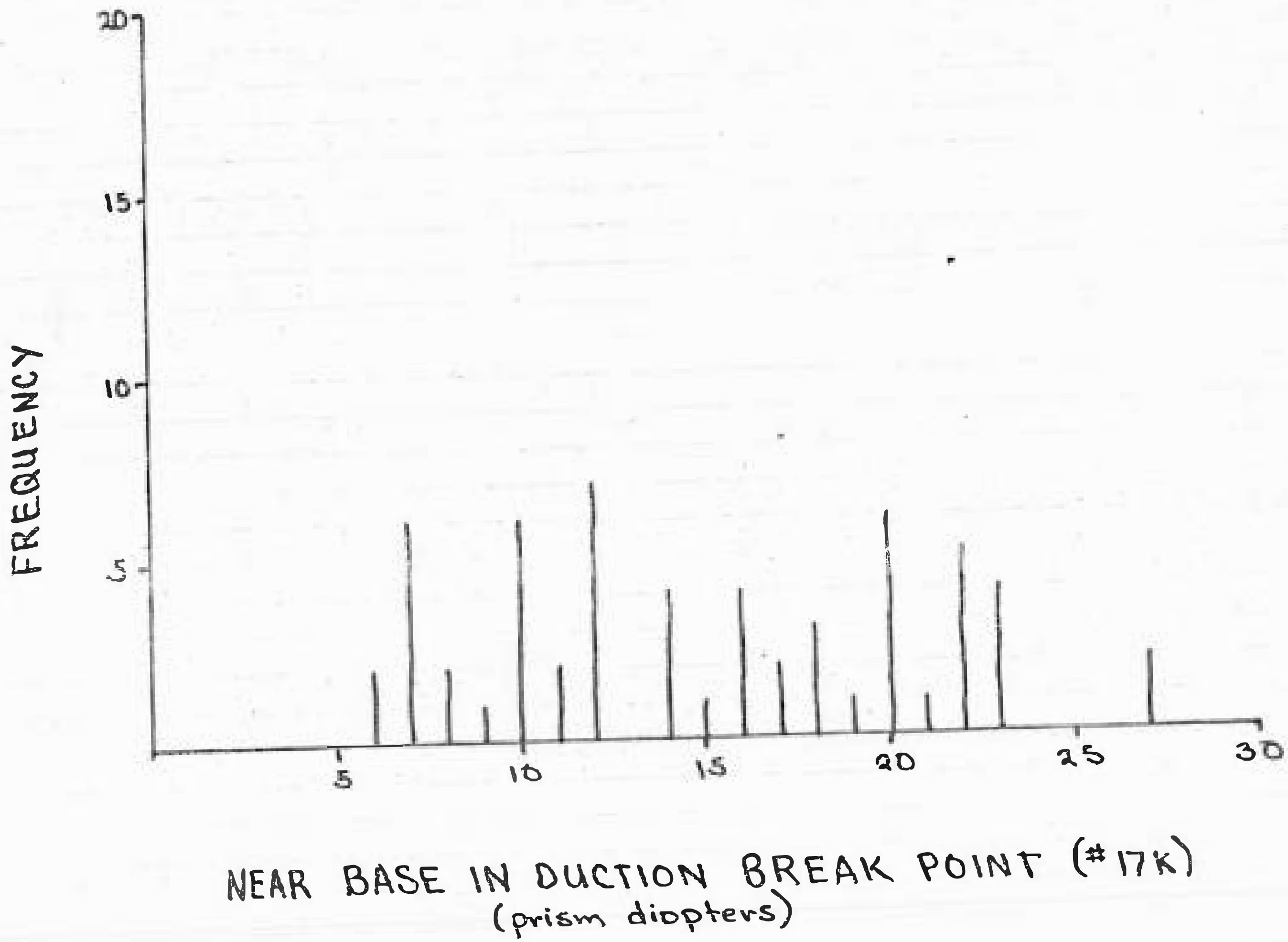
15
10
5
EXO
ESO
-5
0
5
10
15
20
PHORIA AT NEAR (#13A)
(prism diopters)



NEAR BASE OUT DUCTION BREAK POINT (#16K)
(prism diopters)


NEAR BASE OUT DUCTION RECOVERY POINT (#16R)
(prism diopters)
5
10
15
20
25
30
35
40
FREQUENCY
5
10
15
20


FREQUENCY
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15
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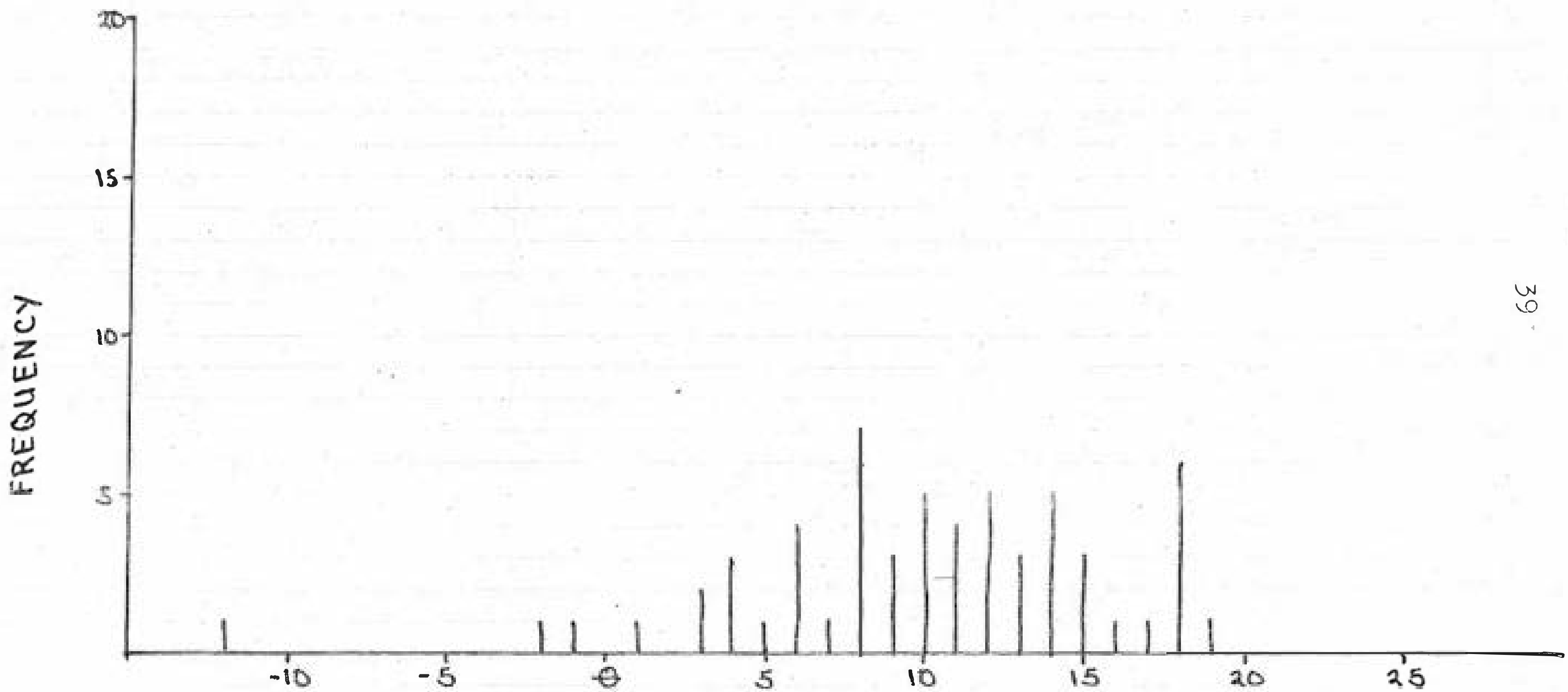
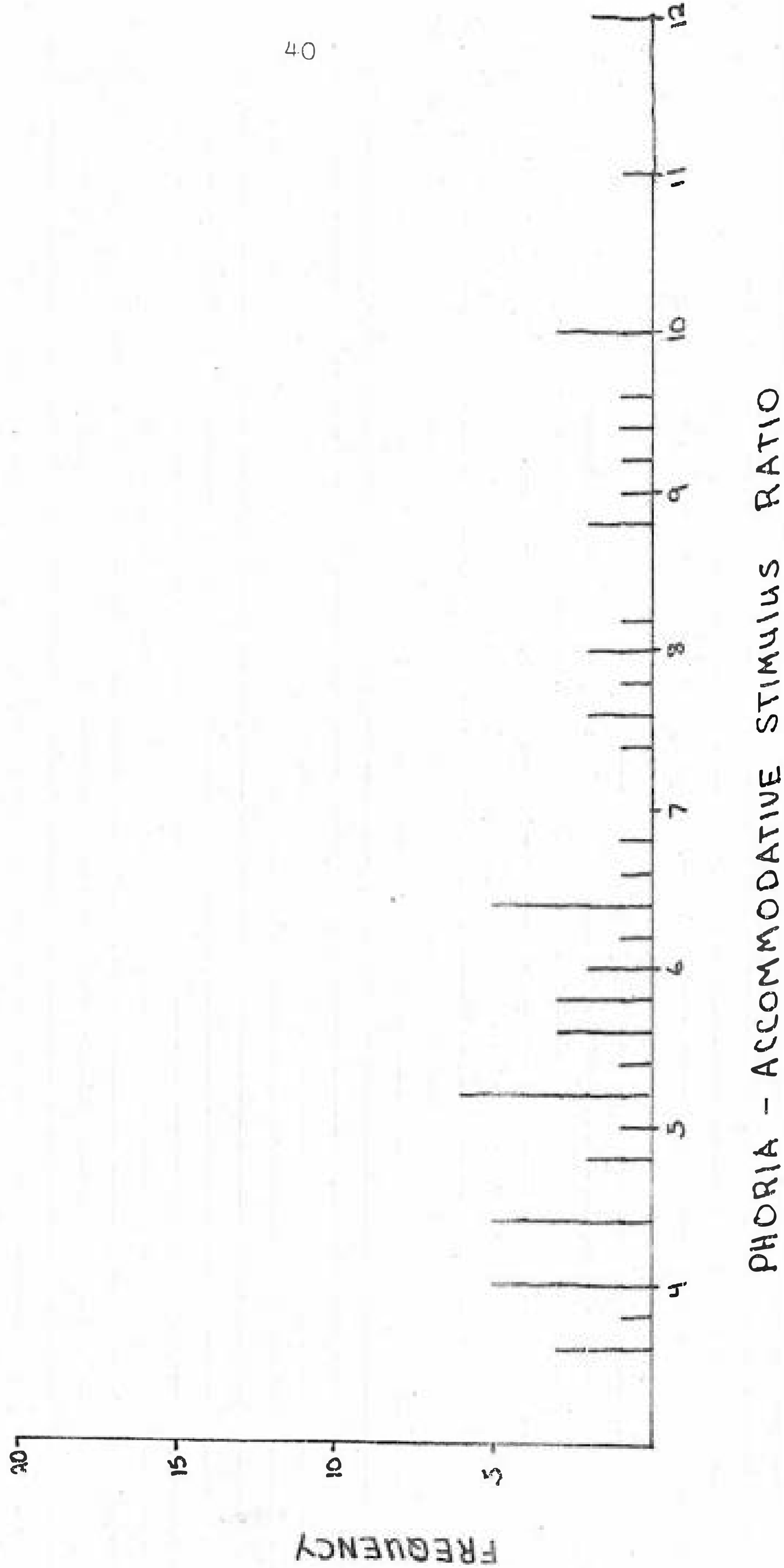
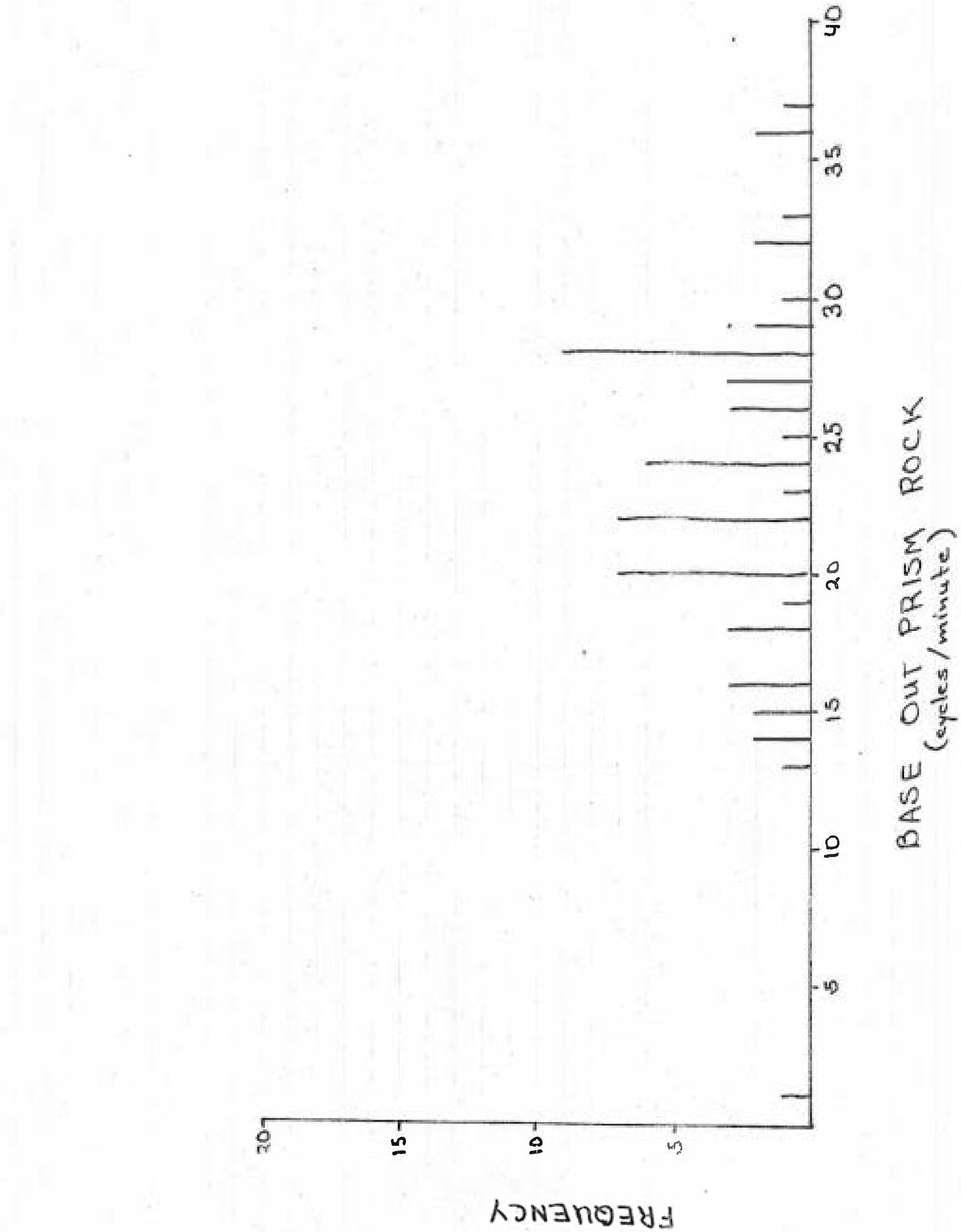
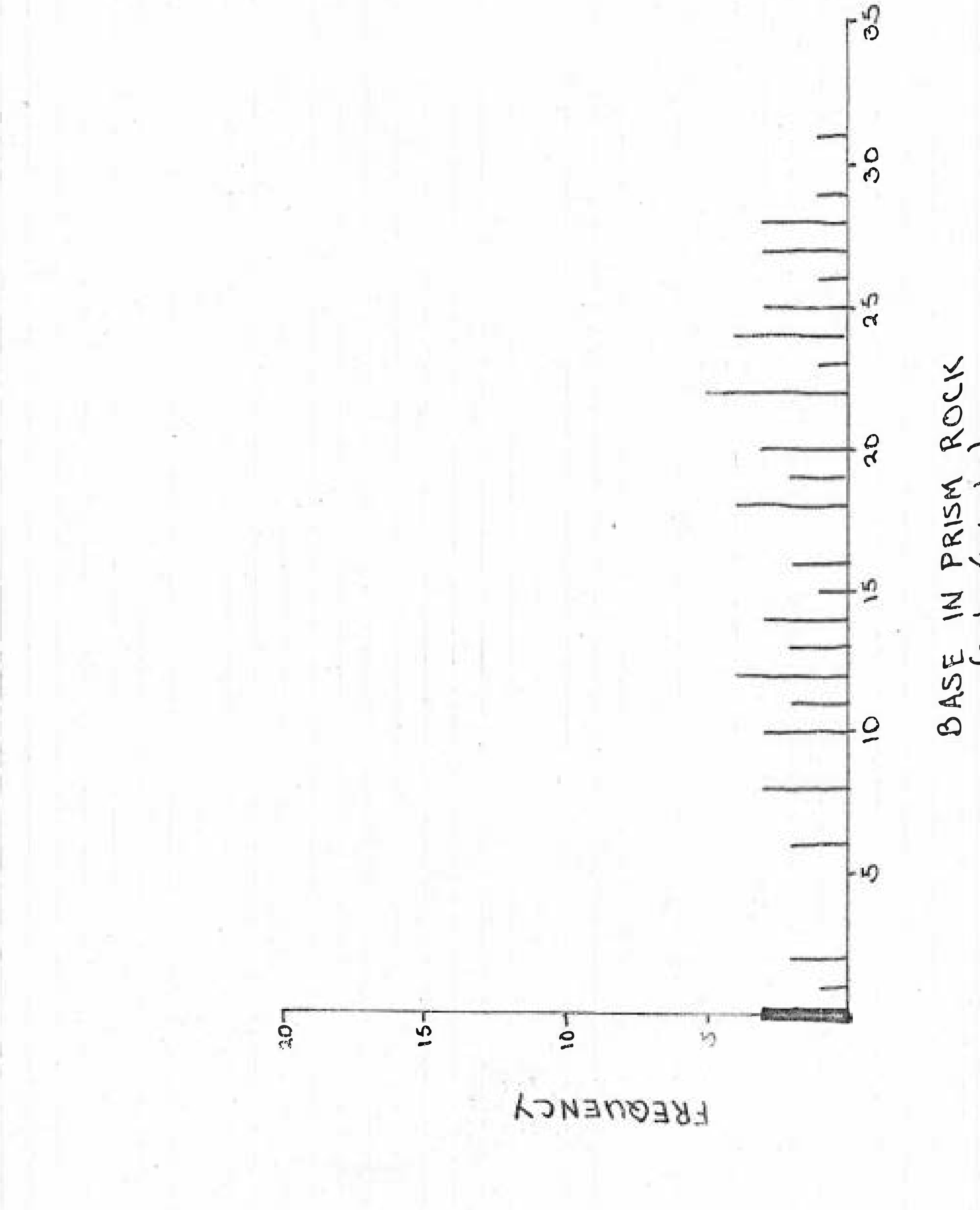
5
5
10
15
20
25
30
NEAR BASE IN DUCTION BREAK POINT (#17K)
(prism diopters)



NEAR BASE IN DUCTION RECOVERY POINT (17R)
(prism diopters)


PHORIA - ACCOMMODATIVE STIMULUS RATIO
FREQUENCY
4
5
6
7
8
9
10
11
12
5
10
15
20


FREQUENCY
5
10
15
20
5
10
15
20
25
30
35
40
BASE OUT PRISM ROCK
(cycles/minute)


FREQUENCY
20
15
10
5
5
10
15
20
25
30
35
BASE IN PRISM ROCK
(cycles/minute)