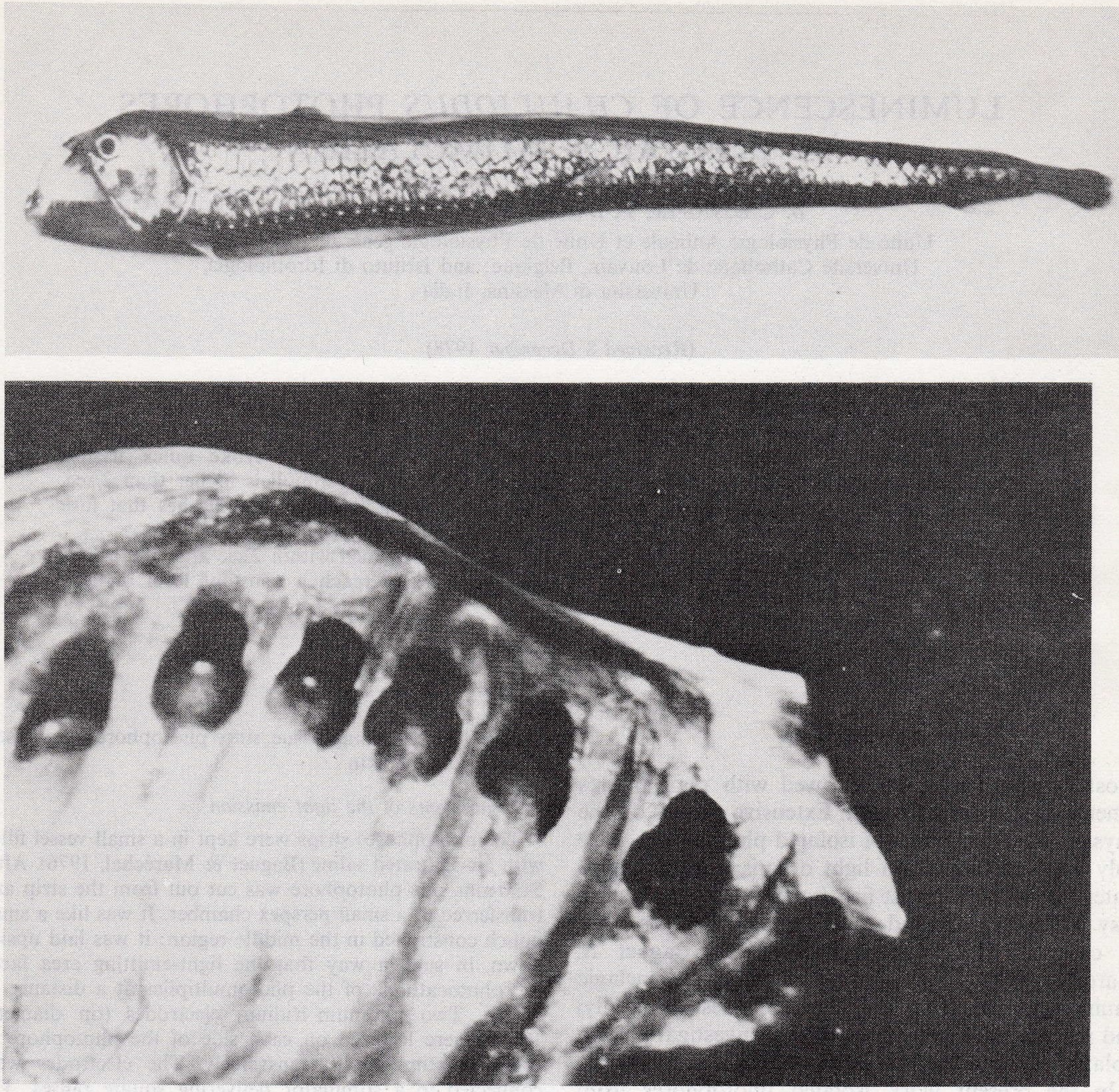

Fig. 1. Photograph of a freshly captured specimen of *Chauliodus sloanei* uppermast showing the lateral and ventral rows of photophores. The length of the entire animal is 17 cm. Detailed view of the lateral photophores.

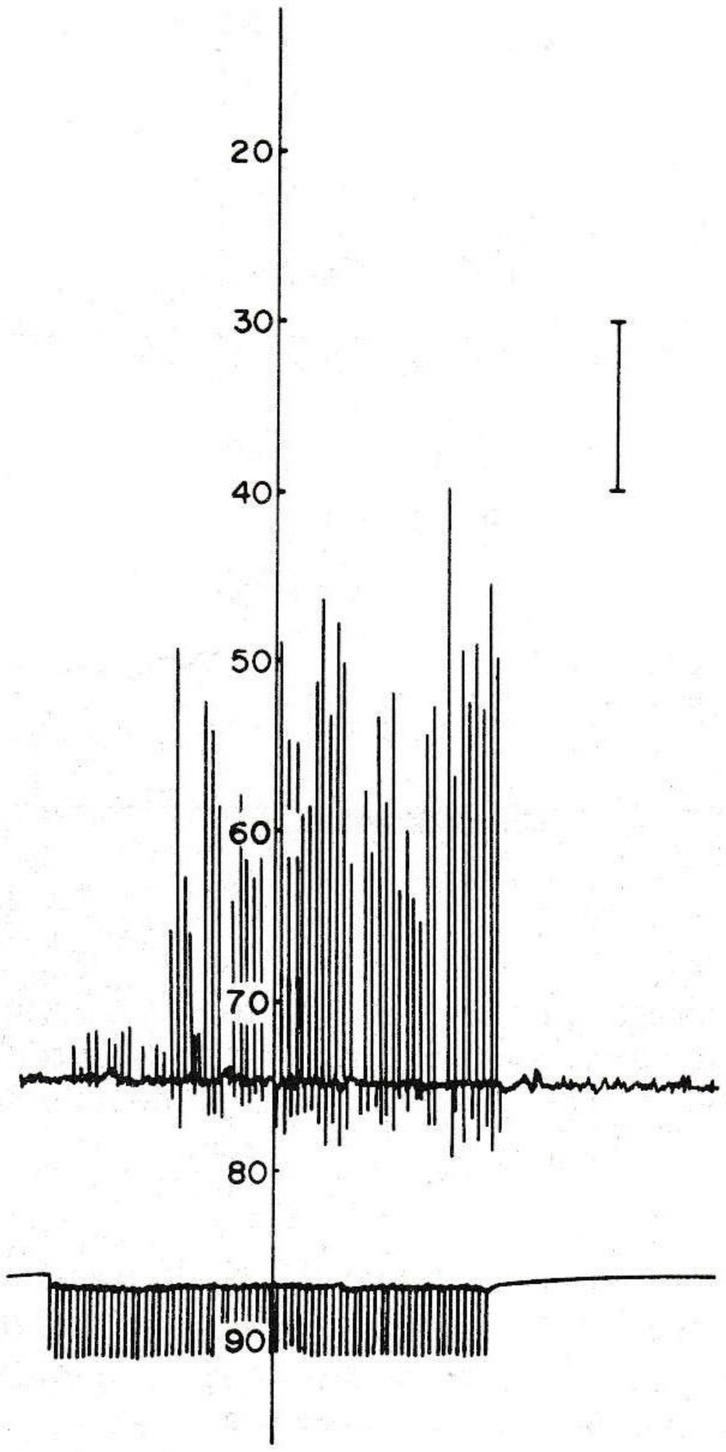

Fig. 2. Original record of flashes emitted by an isolated photophore (upper trace) stimulated during 65 sec with anodic stimuli (4 msec, 50 V) at 1 sec interval (lower trace). Vertical bar 18 Mquanta/sec.

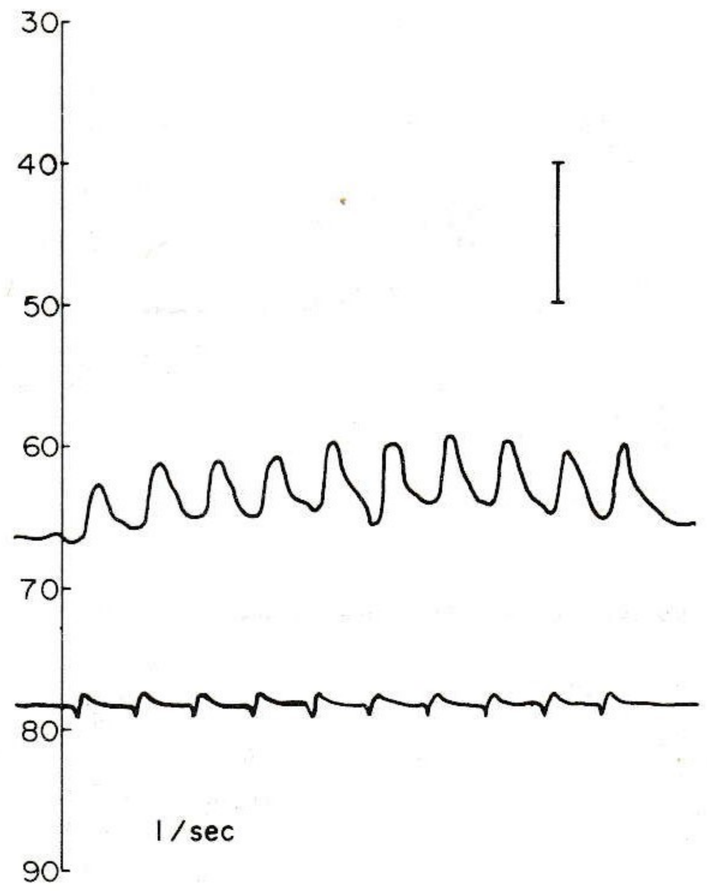

Fig. 4. Time course of successive flashes evoked by 10 anodic shocks (1 msec, 10 V) given at 1 sec interval. Vertical bar 18 Mquanta/sec.

term "tetanus", we call "luminus" a response similar to those shown in Fig. 5. The term was first proposed by Baguet & Maréchal (1976) to describe the light response of epipelagic fish *Porichthys*.

Effects of the stimulus frequency on the luminus

Seven photophores were stimulated with a 10 sec train of 7 msec, 10 V stimuli applied at seven different frequencies: 1, 2, 4, 8, 20, 50 and 100/sec. In order to minimize possible effects of the order of application of these frequencies, the treatments were randomized

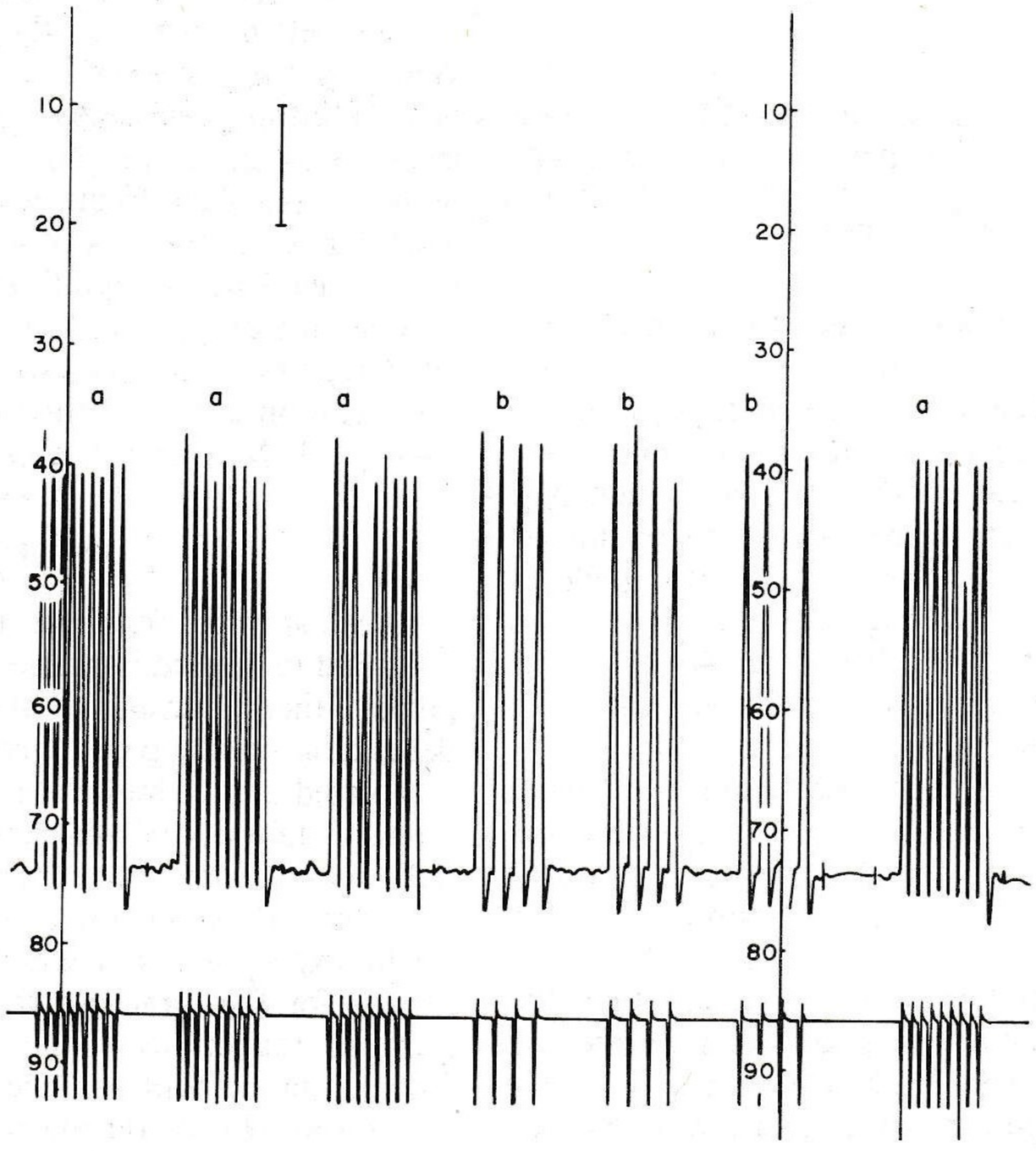

Fig. 3. Seven series of flashes (upper trace) evoked by stimuli (8 msec, 65 V) given at 1 sec (b) and 0.5 sec (a) interval. Vertical bar 42 Mquanta/sec.

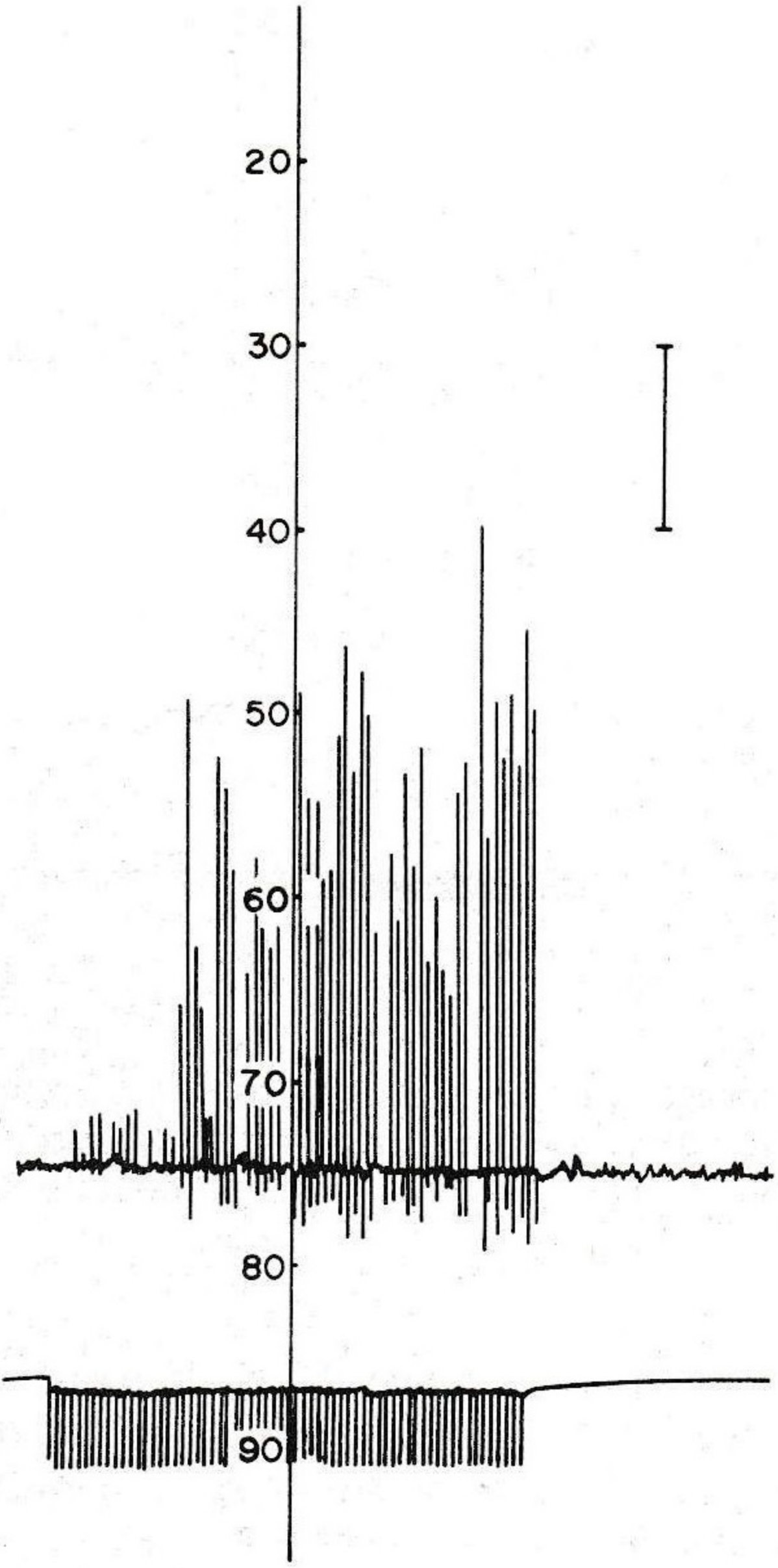

Fig. 2. Original record of flashes emitted by an isolated photophore (upper trace) stimulated during 65 sec with anodic stimuli (4 msec, 50 V) at 1 sec interval (lower trace). Vertical bar 18 Mquanta/sec.

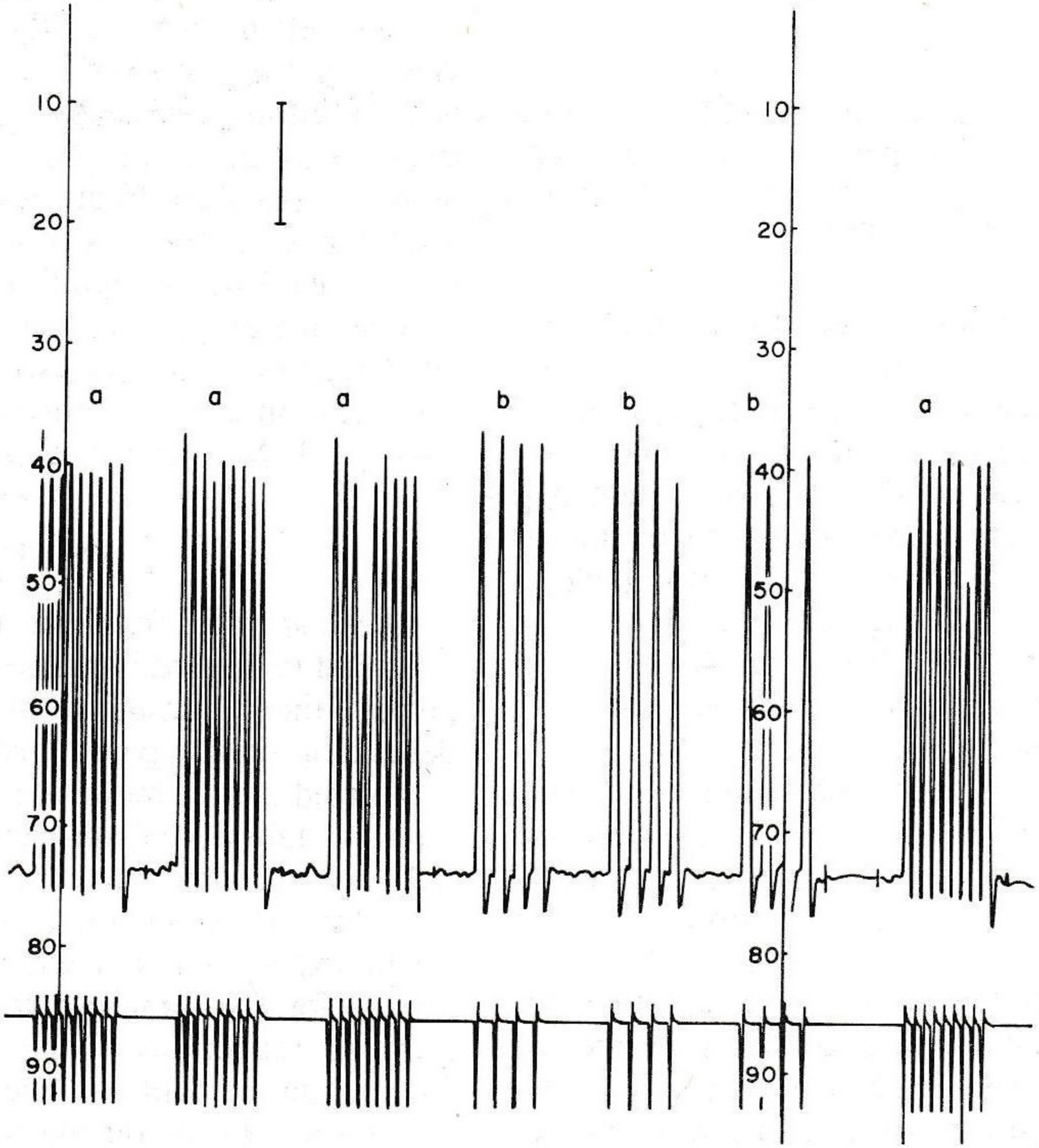

Fig. 3. Seven series of flashes (upper trace) evoked by stimuli (8 msec, 65 V) given at 1 sec (b) and 0.5 sec (a) interval. Vertical bar 42 Mquanta/sec.

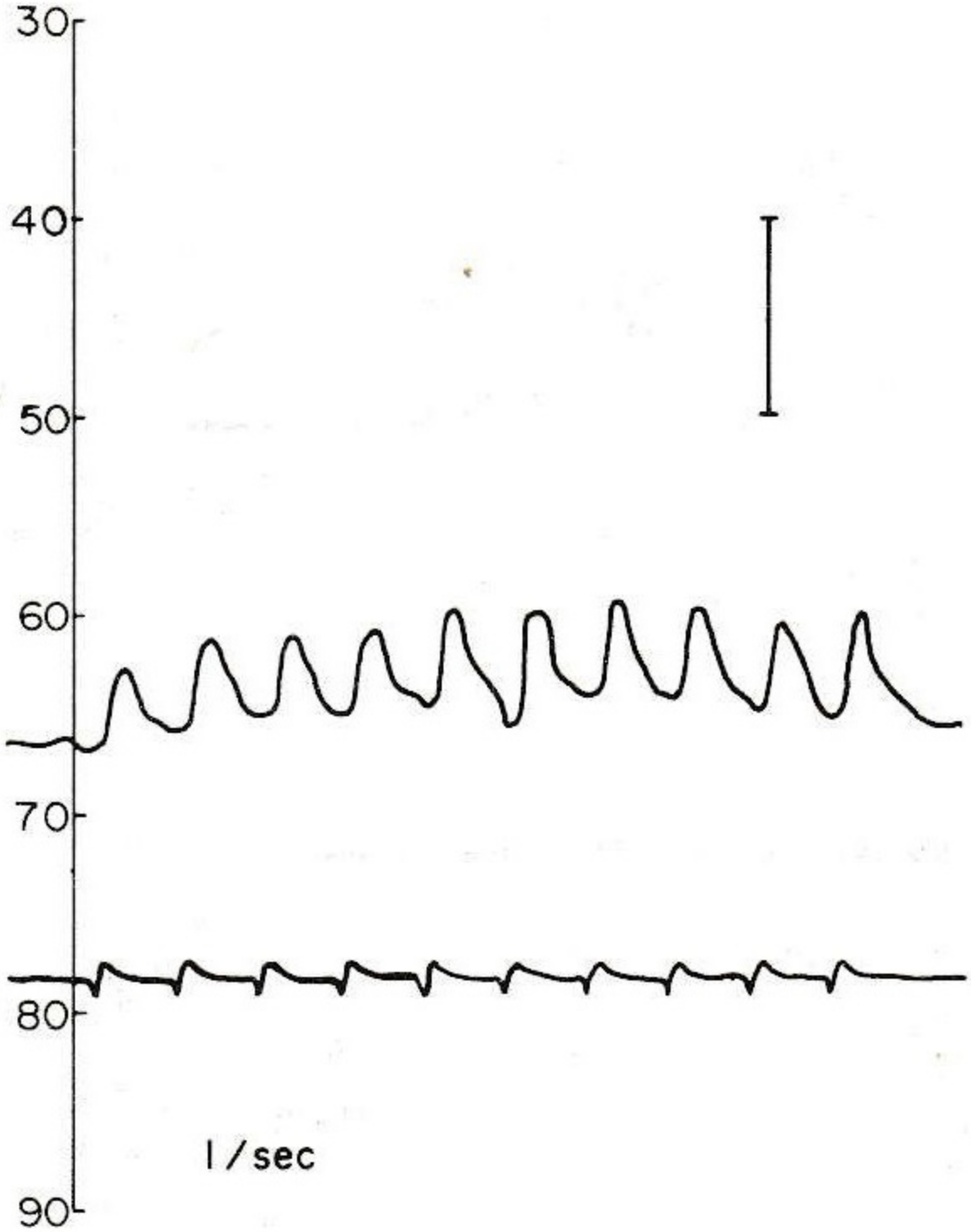

Fig. 4. Time course of successive flashes evoked by 10 anodic shocks (1 msec, 10 V) given at 1 sec interval. Vertical bar 18 Mquanta/sec.

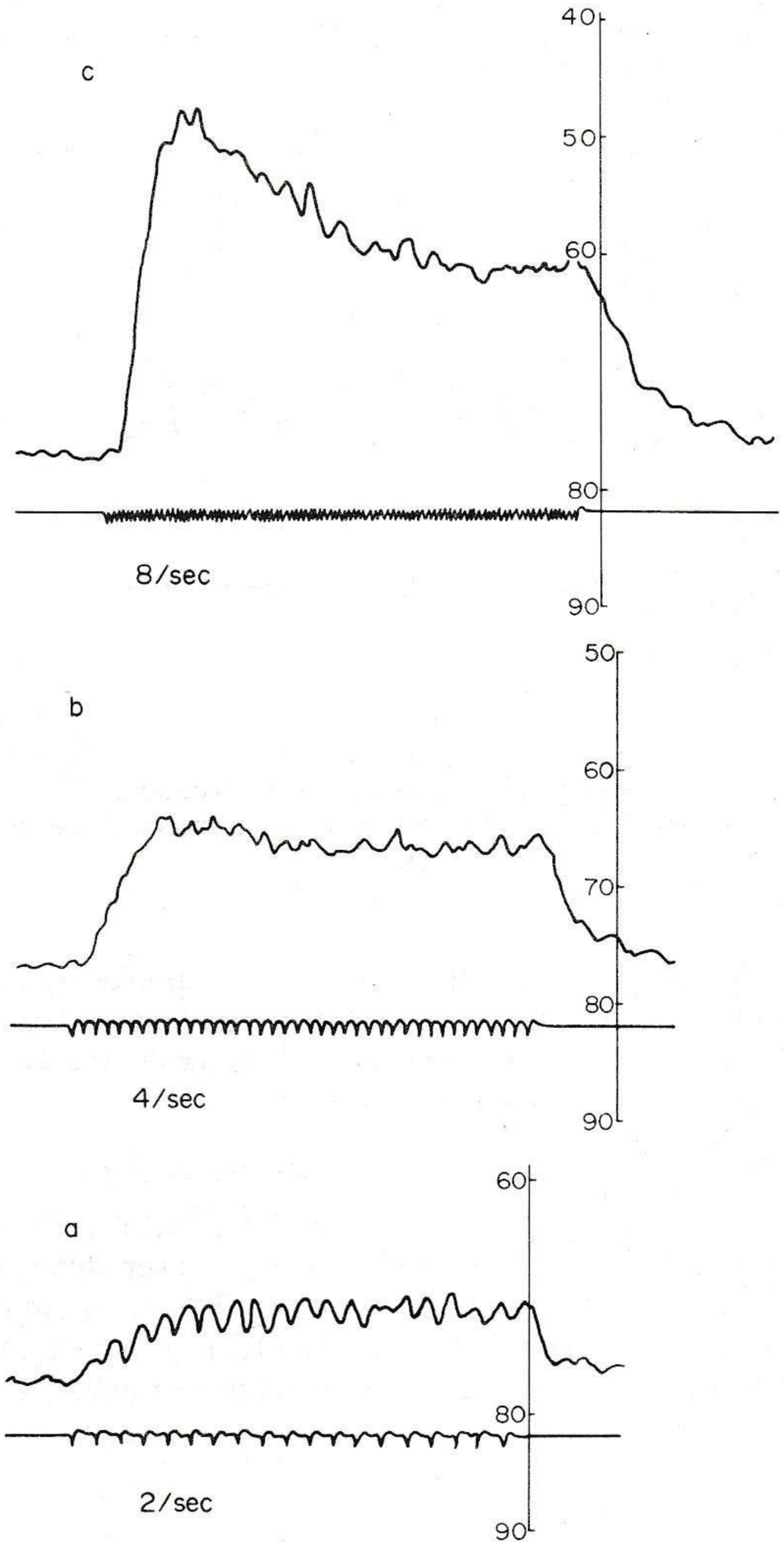

Fig. 5. Time course of three luminus evoked by a 10 sec train of stimuli (1 msec, 15 V) applied on the same preparation at the frequency of 2/sec (a), 4/sec (b) and 8/sec. Vertical bar 18 Mquanta/sec.

according to a latin square design (Cochran & Cox, 1960).

Light production. The luminus peak (L_{max}) increases with the stimulus frequency until a maximal value (28.9 $\pm$ 1.9 Mquanta/sec) observed for a frequency of 20/sec, there being no further increase for higher frequencies (Table 1). The time to reach the peak of light (time to L_{max}) is long at low frequencies (4.5 $\pm$ 0.7 s at 1/sec to 4.0 $\pm$ 0.7 sec at 4/sec). It decreases abruptly to 1.7 $\pm$ 0.7 at 8/sec, where it remains up to 100/sec.

After the peak, the light decreases somewhat exponentially, there being no significant differences between the frequencies tested. It reaches a stable level (L_b) within 8.5 $\pm$ 0.1 sec at 1/sec and 10.0 $\pm$ 0.1 sec at 100/sec (Table 1).

It can be concluded from these results that the lowest stimulus frequency necessary to generate the largest luminus is 20/sec. Higher frequencies do not improve the light performance of isolated photophores.

Extinction. Quite soon after cessation of stimulation, the light production decreases without observ-

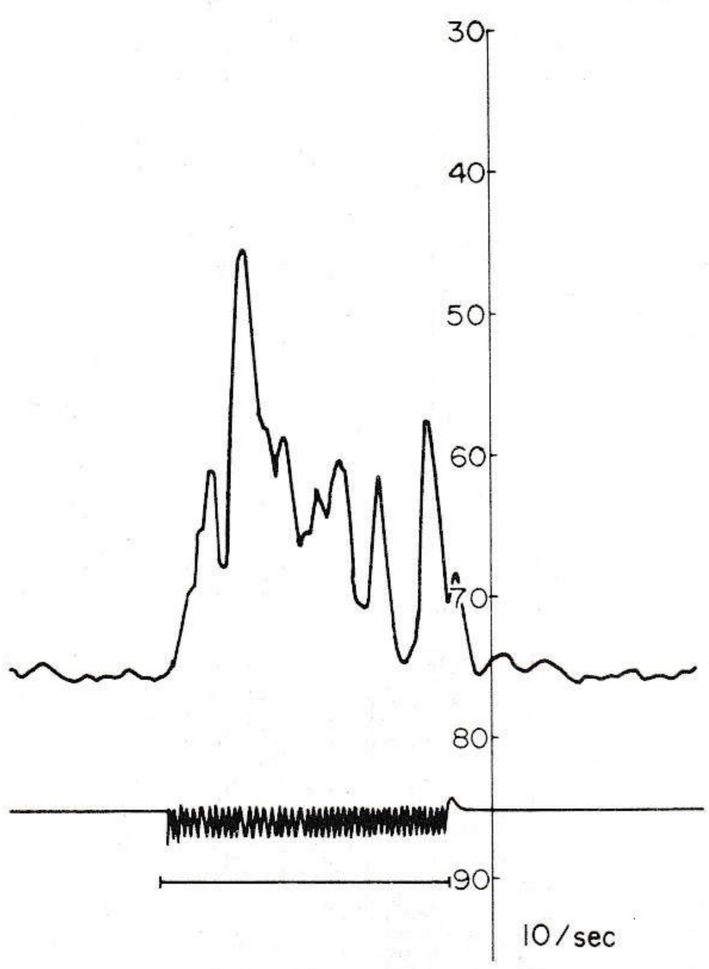

Fig. 6. Typical luminescent response evoked by a 5 sec train of stimuli (10/sec) of long duration (4 msec) and high voltage (45 V). The sensitivity of the photomultiplier is the same as in Fig. 5.

able extinction latency time. The half extinction time, i.e. the time for the light to decay to half of the value measured at the end of stimulation period ranges from 0.30 $\pm$ 0.1 sec at 1/sec to 0.84 $\pm$ 0.1 sec at 100/sec (Table 1). The time for complete extinction is three times longer at 1/sec (1.0 $\pm$ 0.3 sec) and about six times longer at the other frequencies (2.7–4.7 $\pm$ 0.3 sec).

In the case of photophores isolated from mesopelagic fish *Porichthys*, it is known that the extinction time of a luminus is directly related to the luminescence level measured at the end of the stimulation. When all the values of the extinction time of *Chauliodus* photophores are plotted in function of the light level measured at the 10th sec of stimulation (*Lb*), without taking the frequency of stimuli into account, a similar relationship is observed. Regression analysis puts in evidence a significant ($P < 0.01$) correlation between the two parameters. The slope *b* of the calculated regression line gives a quantitative measure of the relationship: in this case, it indicates that 4.44 $\pm$ 0.30 Mquanta disappear in 1 sec of extinction.

DISCUSSION

Chauliodus photophores excised from living animals and immersed in saline (20°C) respond to anodic pulses either by flashes or by sustained luminescences, depending on the parameters of the stimulation.

Isolated anodic stimuli (4–8 msec; 50 V) evoke high intensity (about 10^8 quanta/sec) flashes lasting a few milliseconds, similar to those described by Baguet & Maréchal (1976). Owing to its explosive character we might expect a rapid exhaustion of the substrates needed for the luminous reactions and consequently a rapid reduction of the amplitude of successive flashes. On the contrary, photophores produce flashes of high amplitude during 60 sec or more as long as the interval between the stimuli is over 500 msec.

At frequencies higher than 2/sec, the stimuli evoke sporadic or partly fused flashes, rapidly failing. It

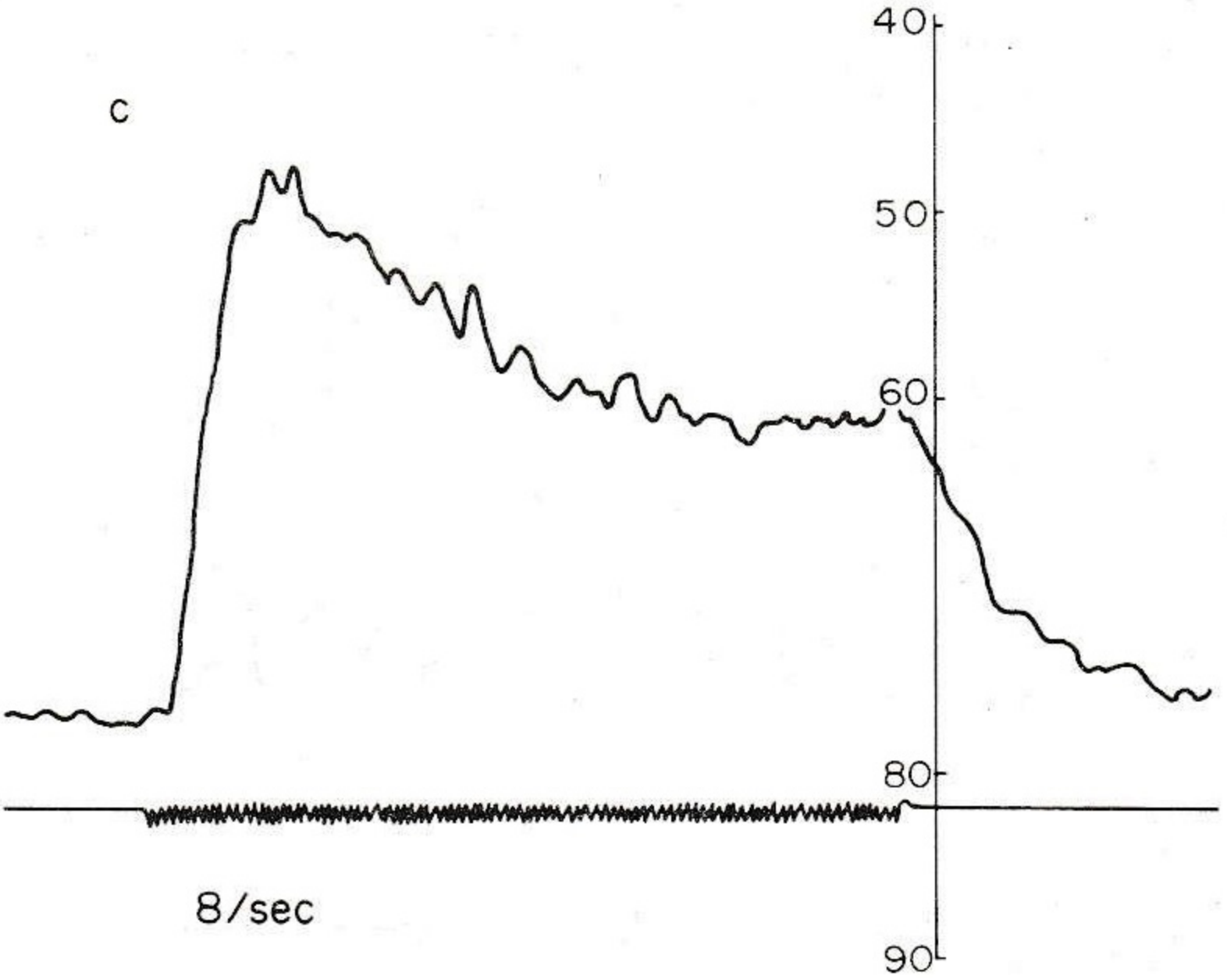

Fig. 5. Time course of three luminus evoked by a 10 sec train of stimuli (1 msec, 15 V) applied on the same preparation at the frequency of 2/sec (a), 4/sec (b) and 8/sec. Vertical bar 18 Mquanta/sec.

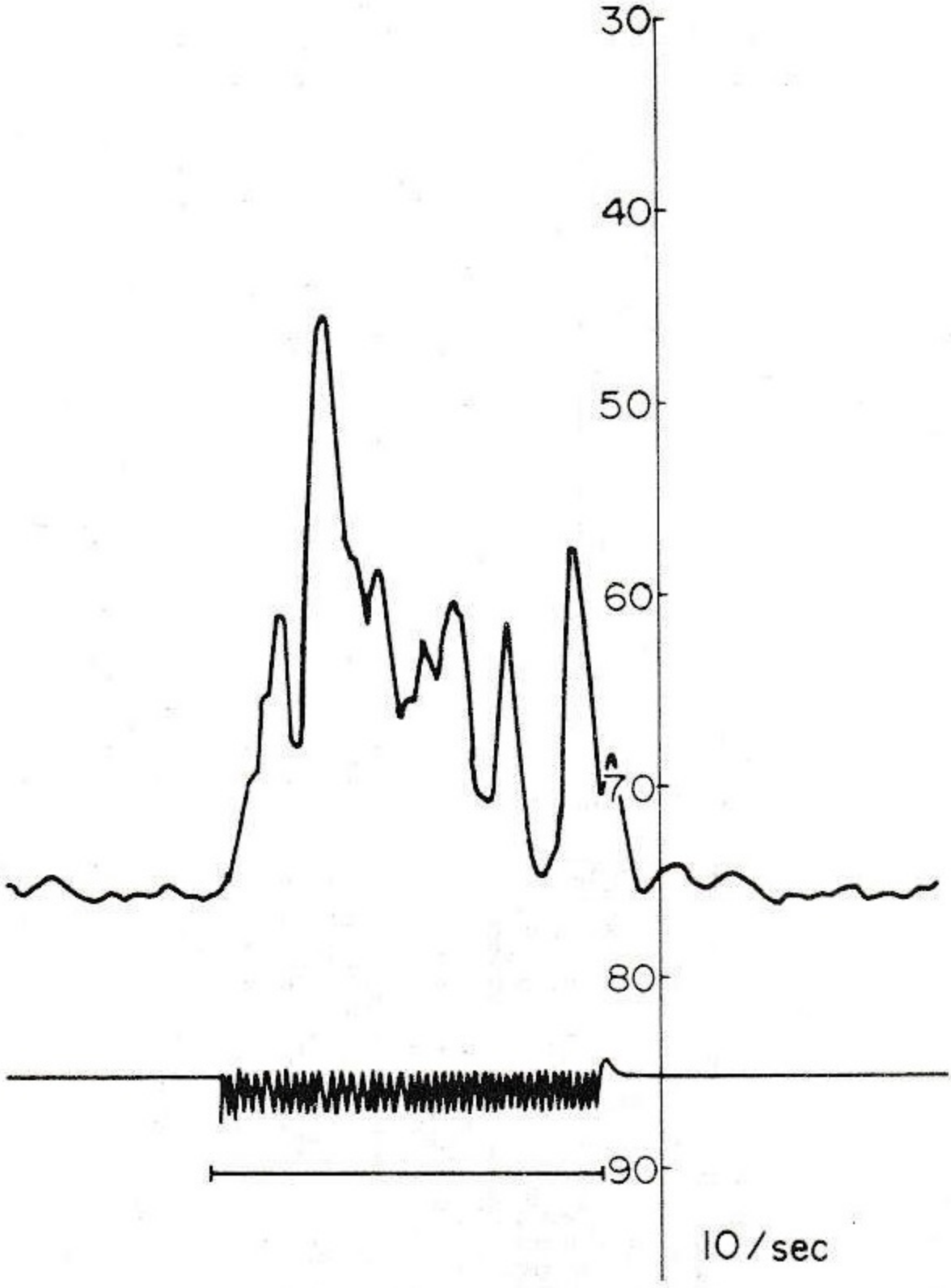

Fig. 6. Typical luminescent response evoked by a 5 sec train of stimuli (10/sec) of long duration (4 msec) and high voltage (45 V). The sensitivity of the photomultiplier is the same as in Fig. 5.