

of zinc added. The values of  $\bar{n}$  thus calculated are plotted against [L].

TABLE II  
Values for Rossotti Plot

[L] M	$\bar{n}$ exptl.	$\bar{n}$ (Calcd.)	$\frac{\bar{n}}{(1 - \bar{n}) [L]}$	$\frac{(2 - \bar{n})}{(1 - \bar{n})} [L]$
0.030	.26	.29	11.71	.070
.034	.33	.35	14.49	.085
.036	.37	.38	16.31	.093
.038	.40	.41	17.54	.101
.040	.43	.43	18.86	.110
.048	.54	.55	24.46	.152
.054	.62	.63	30.21	.196
.060	.70	.71	38.89	.260
.066	.74	.79	43.12	.320

These results were further confirmed by using a different concentration of zinc. Polarograms of solutions containing 1 mM Cd(II) and 0.22 M Zn(II) were taken at different concentrations of creatinine. The results are given in Table I and are represented graphically at *c* in Fig. 2.  $\bar{n}$  values calculated in the manner described above are also plotted with the previous set

of  $\bar{n}$  values. There is an excellent agreement between the values obtained for two concentrations of zinc. The values of  $\bar{n}$  obtained from the smooth curve of  $\bar{n}$  vs. [L] are solved for the overall stability constants by the method of Rossotti and Rossotti<sup>4</sup> (Table II). The existence of two complexes was revealed from the Rossotti plot. The stability constants are found to be:  $\log \beta_1 = 0.60$  and  $\log \beta_2 = 2.14$  (Approx.).

By using these  $\beta$  values  $\bar{n}$  values were calculated from Rossotti's equation. The calculated  $\bar{n}$  values are presented along with experimental values in Table II. The agreement between two sets of  $\bar{n}$  values is fairly satisfactory.

#### ACKNOWLEDGEMENT

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## THE KIRLIAN PHANTOM LEAF

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#### ABSTRACT

A leaf from which a small portion was excised was sandwiched between a pair of X-ray films and subject to AC pulses of about 10 KV and 20 KHz. The resultant Kirlian photographs contained, besides the expected images of the intact portion of the leaf, the 'Kirlian Phantom'—a luminous cap roughly of the same size and shape as the cut away portion of the leaf and occupying roughly the same area.

#### WHAT IS KIRLIAN PHOTOGRAPHY?

**D**URING the past three or four years there has been a considerable interest in an imaging technique known as Kirlian Photography—named after the Russian inventor Semyonof Kirlian<sup>1-5</sup>. It is also referred to as Corona Discharge Photography and High Voltage Photography. In this technique, the object to be imaged is placed in a high voltage, high frequency electric field. The image is recorded either directly on a photographic film placed in the electric field or through a camera if transparent electrodes are used<sup>2</sup>. The only source of illumination is provided by the electric fields. The Kirlian image resembles the conventional image—as regards the general shape and contours of the object, but, characteristically, is made up of a large number of luminous points or streaks referred to in popular

literature as 'balls of light' or 'aura'. The systematic studies of Professor Tiller and his associates at Stanford University attribute these luminous points to the streamers or coronas from the object points<sup>2</sup>.

The recent interest in Kirlian photography has been triggered by the reports that the Russians have discovered some very strange—almost incredible—phenomena with the aid of this technique and that they have tremendous possibilities. The most talked about Kirlian phenomenon is the 'Phantom Leaf Effect'—the subject of this investigation. In the wake of the initial excitement, the systematic studies in U.S.A., notably by Tiller's group, seem to indicate that some of these popular claims may be rather exaggerated<sup>2,4,6</sup>.

What kind of information can the Kirlian image of the object studied? Our systematic studies using

objects of varying structures and experimental configurations are aimed at answering this question empirically without getting into the complicated mechanisms of the streamer formation. This paper will, however, be confined to our work on the interesting Phantom Leaf Phenomenon.

#### EXPERIMENTAL TECHNIQUES

Figure 1 sketches schematically the Kirlian arrangement used by us at the IIT, Madras. A Tesla

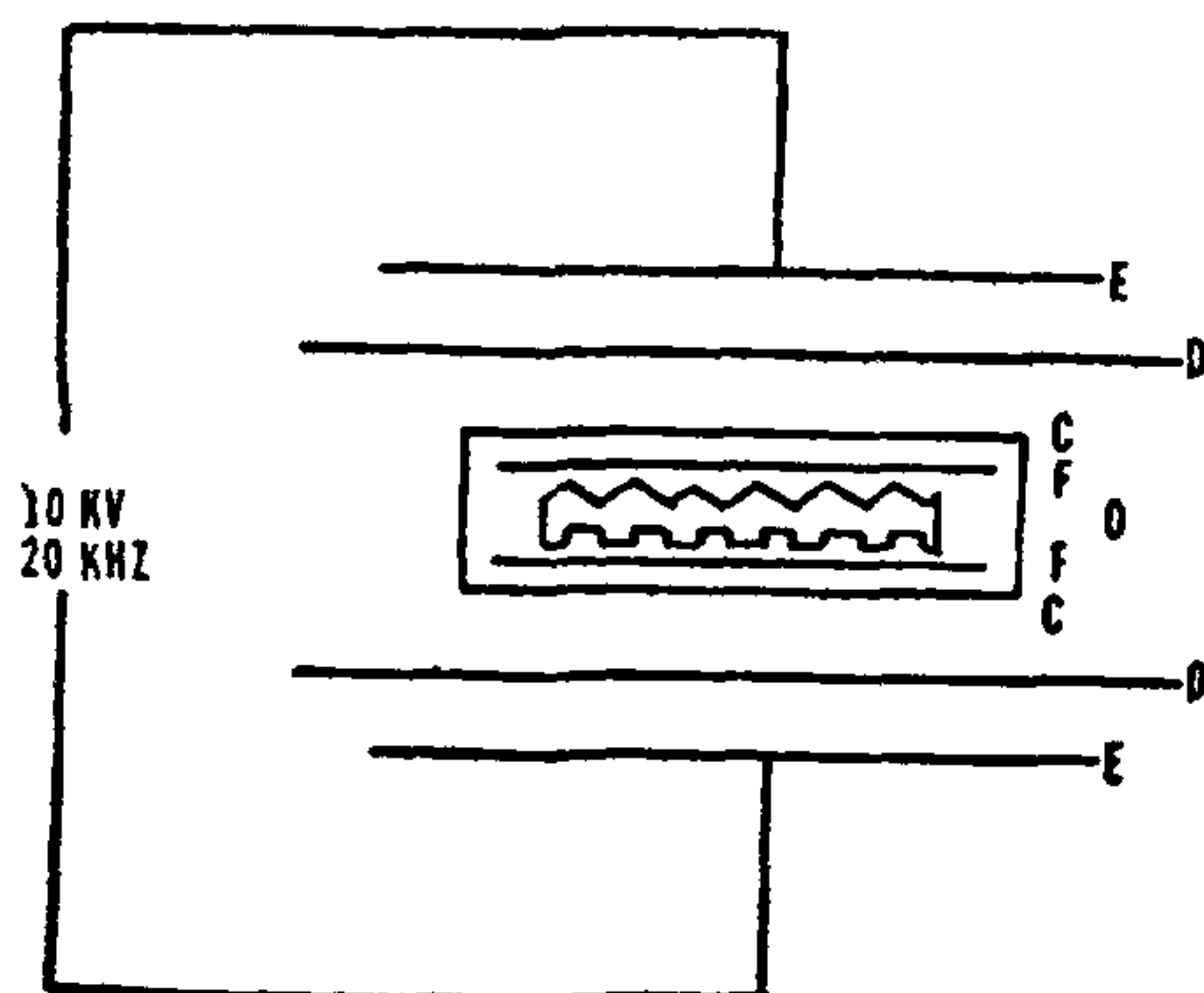


FIG. 1. Schematic representation of the Kirlian set up in the IIT, Madras. E, Electrodes with polished plane surfaces (Steel plate about 6 inches in diameter); D, Exposed X-ray films; C, Light proof black paper cassette; F, Photographic films; O, object (leaf in this instance). The electrodes are connected to a Tesla coil. The surfaces E, D, C, F and O are all in contact unless separated by spacers of known thickness.

Coil built by the High Voltage Section of the IIT Electrical Engineering Department provided the AC field—about 10 KV, 20 KHz in the form of pulses of roughly 1 m sec duration, repeated at intervals of about 1 sec. The electrodes E were generally stainless steel plates with polished plane surfaces. A pair of dielectric sheets D (usually, exposed X-ray films) were used to prevent the shorting of the electrodes and also to control the field between them. The object O (a leaf in this investigation) and one or more recording films F were tightly wrapped in a black paper cassette C: Normally, all the above surfaces were in contact. It was possible, however, to adjust the separation between one object surface and the photographic film closest to it by interesting spacers. The spacers were thin strips of exposed photographic films about 100 m'crons thick. Two Orwo X-ray films with emulsions on both sides were used for this investigation. The leaves used for our Kirlian

experiments were young leaves freshly plucked from trees or shrubs near the laboratory. The species was considered unimportant—at least at this stage. The leaves were ensured to be reasonably flat, i.e., free from curling. The best pictures were obtained with leaves about .1 to .2 mm thick. The maximum dimensions of the leaves were in the range—1.5 to 2.5". The lower limit was to ensure enough area for ease of observation. The upper limit was to ensure clear spaces in the photographic film of about 1" around the leaf boundary.

A small portion of the leaf was excised within minutes after plucking it from the plant. The excised portion was stored away and the cut leaf was sandwiched between a pair of Orwo X-ray films and wrapped in a black paper cassette and placed in the electric field. After two pulses, the films were developed. A contact shadowgraph of the cut leaf was made by placing it on a fresh photographic film and shining it with light from a tungsten lamp. A similar contact shadowgraph was also made of the excised portion of the leaf.

#### RESULTS

The image A of Fig. 2 is the contact shadowgraph of a cut leaf used in one of our Kirlian experiments. The images B and C are the Kirlian images of the same cut leaf—one on either side. In B and C, the profiles of the leaf and the veins can be recognized. The 'V' cut can also be easily identified. The pictures are positive prints—i.e., the luminous portions appear white and the shadows dark. If the Kirlian images and the shadowgraph are compared carefully, a luminous region enveloping the leaf boundary can be recognized. It can be seen as an intensely luminous cap above the 'V' cut—in the area where the cut portion of the leaf would have been located. This apparent 'filling up' of the missing portion of the cut leaf in the Kirlian image is referred to as the 'Phantom Leaf Effect'.

We have described one of our most successful experiments in imaging the Kirlian phantom leaf. Not all our experiments were so successful, however. We have not yet been able to identify the parameters which will help reproduce the phenomenon at will. For want of space we will not attempt a detailed discussion of all our results.

#### DISCUSSION

So far as we know, there is no published account of the phantom leaf phenomenon. The only information we have is derived from the references already cited<sup>1,3,5,6</sup> and from personal communications from Tiller and from Thelma Moss. None of these references, however, has reproduced any



Phantom Leaf Photograph. According to these reports<sup>5</sup>, the phantom leaf effect is extremely elusive and has so far never been reproduced at will. Occasionally a 'near miss' is obtained. Only rarely a convincing Phantom Leaf effect is obtained. According to Tiller<sup>6</sup>, most of these 'hits' and 'near misses' could be explained away as artefacts due to poor experimental procedures. He is satisfied with the experimental procedures only in two cases—a videotape result of Thelma Moss's group at UCLA and a sheet film result of Wagner (private communications). In both cases, the Phantom Leaf was seen: there was a light pattern in the cut away portion but it was of a distinctly different quality than in the remaining leaf region. We had no chance to see either of these two results as they have not been published. Our own Kirlian experiments were carried out with great care and all our experimental parameters have been specified in this paper. In particular, we must emphasize that the whole leaf was never brought close to the films, the cassette, the electrodes or the dielectric sheets. The leaf was placed in the film sandwich only after a portion of it was already excised.

To explain the phantom leaf effect the Russians are said to have postulated the existence of an 'energy body' or 'bioplasma' associated with living objects<sup>1-5</sup>. It is as if the Kirlian technique brings to light the 'energy body' which would otherwise not be recognized by our sense apparatus. In other words, the 'energy body' corresponding to the cut

away portion of the leaf persists for a while after the excision; it is not perceived by our normal senses but is revealed in the Kirlian image. The question, however, is—is there any compelling necessity at the moment to postulate concepts like 'bioplasma' that do not fit in with the accepted ideas of contemporary science? Have we exhausted alternate, simpler explanations based on known principles?

According to Tiller<sup>6</sup>, the luminous cap may be due to discharges from the ionized gas emissions from the solid leaf. These emissions may (a) be caused by vaporization by the arc channels and (b) by a complex process, be confined to the area of the excised portion. We are looking for an explanation in terms of the shape of the air gap around the cut away portion without invoking gaseous emissions from the solid leaf. However, as of now, these suggestions do not account for the shape and size of the luminous cap and as such, do not amount to a concrete explanation. We do hope that further work in our laboratory and elsewhere will soon lead to a better understanding of the nature and significance of this interesting phenomenon.

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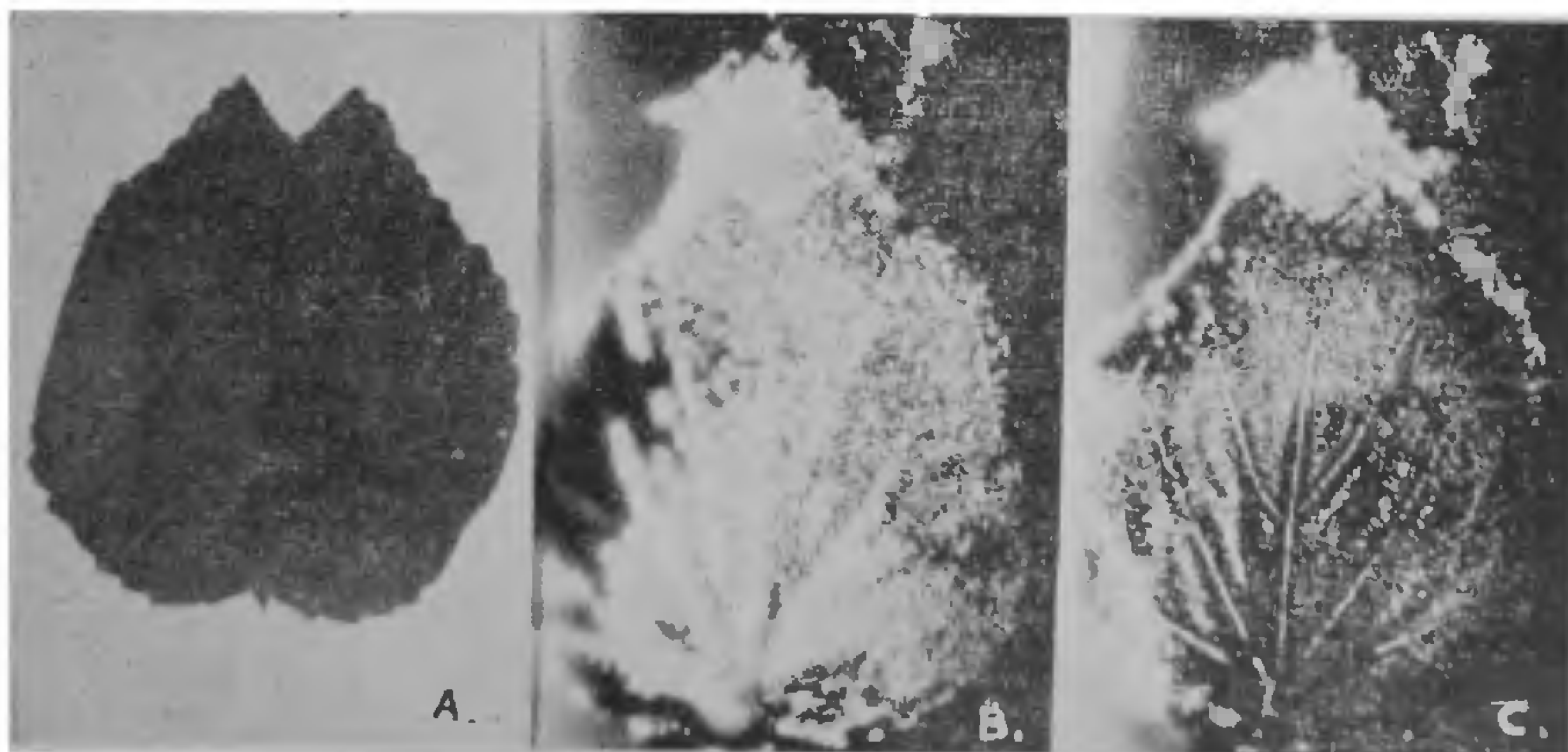


FIG. 2. Kirlian Photographs of a leaf. A, Contact shadowgraph of the cut leaf; B, Kirlian image of the front side of the cut leaf; C, Kirlian image of the rear side of the cut leaf. The pictures are positive prints: luminous portions appear white and shadows appear dark. The intensely luminous portion above the 'V' cut in B and C is the 'Kirlian Phantom Leaf'.



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## NEURAL REGULATION OF PROTEINS IN THE SKELETAL MUSCLES OF FROG, *RANA HEXADACTYLA* (LESSON)

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### ABSTRACT

Electrophoretograms of normal and denervated gastrocnemius and peronius muscles of frog showed the existence of 6 bands, which are discernable into four relatively slow moving and two relatively fast moving types. Following neurectomy, the changes in the protein fractions were conspicuous in both the muscles. The atrophy effects were more prominent in the peronius than in the gastrocnemius muscle. The probable significance of the protein characters on neurectomy have been discussed.

THE effect of innervation on the biochemical, metabolic and physiological properties of the muscle has received considerable attention<sup>1-7</sup>. However there are only few reports on the changes in the electrophoretic pattern of cell proteins following peripheral nerve section. The present study of the denervation induced changes in the protein fraction of the muscle was undertaken to have a better understanding of the range of control exerted by the nervous system on the innervating tissues, since this will throw light on the mechanism of the neural regulation of the biochemical attributes of skeletal muscle<sup>8,9</sup>.

Two muscles were chosen for the present study, namely, (1) the gastrocnemius, which is a mixed muscle with high proportion of slow fibres and (2) the peronius, which is essentially a fast muscle, both being innervated by the common sciatic nerve<sup>10</sup>.

### MATERIALS AND METHODS

*Rana hexadactyla* were subjected to unilateral denervation by severing about one centimeter of the sciatic nerve from its origin on one side of the leg, while the contralateral muscle was considered as the control. They were fed 'ad lib' with earthworms and water was changed regularly. One month post-operatively, they were sacrificed by pithing, the gastrocnemius and the peronius muscles were isolated with least injury and washed in amphibian Ringers' medium<sup>11</sup>. The cell proteins were extracted as previously described<sup>12</sup>.

Polyacrylamide disc electrophoresis was conducted by the method of Davis and Orstein<sup>13</sup>. 0.1 ml protein extract was directly applied, followed by a small quantity of 40% sucrose solution. A direct current of 1.5 m Amps per tube was applied for 60 minutes at 4° C in 0.05 M tris-glycine buffer at pH 8.9. After electrophoretic run, the gels were removed and stained in 1% amido black in 7% acetic acid. The excess stain was removed by repeated washings with 7% acetic acid until the non-protein part of the gel became transparent.

### RESULTS AND DISCUSSION

The electrophoretic mobility patterns of cell proteins of the gastrocnemius muscle revealed the existence of 6 bands. 3 of the bands are relatively slow moving type (a, b and c), one is intermediary (d) and the remaining two are fast moving types (Fig. 1). The pattern remains similar in the denervated muscle suggesting that the major classification of the cell proteins remains unchanged. However some of the protein bands indicate physical changes involving electromobility and the quantitative aspects. The bands 'd', 'e' and 'f' in the denervated peronius showed a tendency of increased electromobility while in the gastrocnemius similar changes could not be evinced on denervation. However on the quantitative point of view, as visualized in terms of the density of the band it is likely that bands 'd' 'e' and 'f' could be increasing on denervation in both the muscles. Thus the increase in