chloride, nitrobenzene, di-ethyl aniline, pyridine, and carbon tetrachloride.

Results are much better when the chemicals of the first list are used.

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SILK CELLOPHANE FOR LANTERN SLIDES

RECENTLY Warren,[1] Walden,[2] and Wells[3] suggested the use of plain cellophane as a recipient of carbon in projection lantern slides. As a further suggestion, special du Pont Number 300 white silk cellophane takes ink directly from the typewriter ribbon without smudging and, after momentary drying, the record is permanent. If the original impressions are gone over for the second typing, legibility is enhanced. The cost of this special silk cellophane is less than one cent per slide.

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SPECIAL ARTICLES

THE RELATIONSHIP OF BACTERIUM GRANULOSIS TO TRACHOMA

THE question of the relationship of *Bacterium granulosis* to the etiology of trachoma has been discussed in a recent publication.[1] As stated in that article the organism of Noguchi "merits consideration as the etiological factor" in the disease. This view was expressed in spite of the accumulation of negative evidence of many workers, including the writer, and the doubts which have been expressed by some who have been the most sanguine in their expectation of the solution of the trachoma problem following the isolation of this organism with which a transmissible granular condition may be produced in monkeys. Such doubts are based on the failure of many investigators to isolate the organism from trachoma in different parts of the world and the considerable number of negative results which have been obtained in attempting to produce trachoma by inoculation of human subjects with the organism.

I reported that the granular condition originally induced with difficulty in *Macacus rhesus* monkeys by inoculation with cultures of *Bact. granulosis* was very readily transmissible and that transmission could be accomplished by merely rubbing a sterile swab over the affected conjunctiva and then rubbing it over the conjunctiva of a normal animal, thus demonstrating the fact that it is not necessary to excise tissue and to inject this subconjunctivally. In other words, as described by one worker, the granular condition may be described as one which is "highly infectious."

The question arose: "Is human trachoma as readily transmissible?" There are a number of clinicians who, after long experience with trachoma, still question the ready communicability of the disease. On the other hand, Taborisky[2] inoculated the conjunctiva of 5 blind subjects with the conjunctival secretion of trachoma cases and all acquired the disease.

In order to obtain a comparison between the granular condition induced in monkeys by inoculation with cultures of *Bact. granulosis* and that induced by direct transfer of secretions from trachoma cases, a series of monkeys was started in the early part of 1932 in which granular lesions were produced by repeated swabbing of secretions from trachoma cases in Rolla, Missouri. A number of attempts had previously been made to accomplish this without success. A granular condition which developed slowly was obtained in 2 monkeys and from one of these was transmitted to another monkey by repeated swabbing. As reported recently[3] two parallel series of monkeys (8 in each series) were then considered, one in which attempts were made to transmit the granular condition originally induced by inoculation with cultures of *Bact. granulosis* and the other in which attempts were made to transmit the granular condition originally induced by transfer from trachoma cases. Four monkeys in each series had been previously inoculated with a vaccine of *Bact. granulosis* with the idea that the test might show whether there were immunological differences in the two conditions. In the "culture" series 5 of the 8 animals developed the granular condition after one swabbing from an infected monkey, and one after two swabbings, and one died. In all these the granular condition occurred spontaneously in the uninoculated eye. In the "direct transfer" series all the monkeys were swabbed 3 times (on consecutive days) and one of the 8 developed a granular condition in both eyes, 6 remained unaffected and one died. Of the 6 unaffected, 5 have since been swabbed from infected monkeys, one a single time, one 2

[1] K. L. Warren, SCIENCE, 76: 573, December 16, 1932.
[2] B. H. Walden, SCIENCE, 77: 91, January 20, 1933.
[3] F. L. Wells, SCIENCE, 77: 91, January 20, 1933.
[1] Ida A. Bengtson, *Pub. Health Rep.*, 47: 1914, September 19, 1932.
[2] J. Taborisky, *Graefe's Arch. f. Ophth.*, 123: 140, 1930.
[3] Ida A. Bengtson, *Pub. Health Rep.*, 47: 2281, December 9, 1932.

times and three 3 times (on consecutive days). In 4 of these lesions have developed gradually and in one of these the uninoculated eye has become affected. In neither series was protection afforded by the vaccine, since more were affected in the vaccinated than in the unvaccinated groups. Regarding the gross appearance of the lesions there was no great difference. The condition was rather less active in the "direct transfer" series than in the "culture" series. The results obtained indicate that the condition induced by direct transfer from trachoma in Missouri was less easily transmissible than that induced by inoculation of cultures of *Bact. granulosis*. Quoting from the report "Whether this difference is significant and whether it would constantly be true can not be said without further tests." It may be that as in other diseases certain strains of the organism concerned may be more virulent than others.

The results reported by Olitsky, Syverton and Tyler in SCIENCE, for January 6, 1933,[4] lend support to the view that *Bact. granulosis* is concerned in the etiology of trachoma. Of significance is the use of tarsectomized tissue in the experimental work carried out by these investigators. The chances for successful transmission of the condition to animals and for isolation of the organism concerned are without doubt greatly enhanced by the use of large amounts of material. The great amount of negative evidence in certain localities as reported in the literature and in unpublished work concerning which information has been received by the writer, may possibly be explained on this basis. It is apparent that most workers have not used tarsectomized tissue, which is difficult to obtain because many ophthalmologists consider the tarsectomy operation as of questionable value for the cure of trachoma.

Another phase of the problem is of interest. If the work of Olitsky and collaborators can be confirmed in certain other parts of the world where only negative results have been reported, using the sort of material and the methods employed by them and it is definitely established that *Bact. granulosis* is the etiological factor in trachoma, then the isolation of an organism which is non-filtrable and which grows on the ordinary culture media, from a disease which is characterized by the presence of inclusion bodies, takes on a certain significance. A revision of the rather generally accepted view of the nature of the infective agent in at least some of the group of diseases in which inclusion bodies occur (diseases usually classified as belonging in the "filtrable virus" group) would be necessary. As I reported in 1928[5] in a study of inclusion bodies in over 200 cases of trachoma these bodies were present in nearly 50 per cent. of the cases. More recently, Taborisky[6] has reported that observations during a period of 20 years justify the belief that there can be no trachoma without inclusion bodies at some period, if cases are followed from the beginning. As the result of the microscopical study I reported that the inclusion body in the early stages was composed of rod-shaped organisms. A photograph of a very unusual preparation is shown in this publication, in which the nucleus of an epithelial cell is surrounded by numerous rod-shaped organisms which morphologically at least could very well be said to correspond with *Bact. granulosis*, though identification on this basis is obviously impossible. The definite rod-shaped forms are seen very rarely. Usually the inclusion body appears as a more or less structureless mass, in which at a later stage very minute coccoid bodies staining reddish with Giemsa appear. Apparently the group of organisms forming the inclusion body is acted on by the living cytoplasm of the epithelial cell and transformed into these small bodies which are the "elementary bodies" of Halberstaedter and von Prowazek. These are visible when occurring in the cell, but it may be that they occur outside the cells also, in which case they are indistinguishable or very nearly so. The difficulty of cultivating such forms can be readily understood. As stated in an article now in press, these "elementary bodies" are probably for the most part non-cultivable and they may constitute the active infectious agent, the so-called "virus," while the rod forms which are cultivable occur only rarely. In a word the organism when developing in the tissues may occur in a different form than when growing on artificial culture media. The supposition offers an explanation of the difficulty of cultivating the organism unless large amounts of material are used, in which the chances of encountering the definite rod forms are increased.

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[4] P. K. Olitsky, J. T. Syverton and J. R. Tyler, SCIENCE, 77: 24, January 6, 1933.

[5] Ida A. Bengtson, *Pub. Health Rep.*, 43: 2210, 1928; *Amer. Jour. Ophth.*, 12: 637, 1929.

THE ACTION-CURRENT AS MEASURE OF MUSCLE CONTRACTION

IT has been considered impossible to show a definite quantitative variation of the action-current with the contraction of human muscle. Upon contraction the oscillations of the oscillographic curve, which are always running even with resting muscle, coarsen and widen, but it is impossible to correlate changes of frequency or changes of amplitude with the degree of contraction, for the good reason that the oscillations during the contraction have no definite frequency and no definite amplitude; detailed study of the curve

[6] J. Taborisky, *Graefe's Arch. f. Ophth.*, 124: 453, 1930.