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The Action of Quinine on *Paramaecium caudatum.*

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The action of a drug can be studied on unicellular organism like *Paramaecium* to determine its antiseptic effect. The object of this line of study is to find out, at what strength of solution a particular kind of drug is suitable for exerting antiseptic action on a particular variety of unicellular organism. But we can study the action of drugs on unicellular organism from another point of view, viz., from the point of view of selective action, that is, whether these drugs act selectively on certain portions of the one-celled animal. It is difficult to understand the selective action of a drug on a single-celled organism like *Paramaecium* unless we consider this latter to be an organism of complicated structure inspite of its single-celled body. The fact that this is really so has been established by the researches of KRIZ (1921), who says, "Rees has shown clearly that the *Paramaecium* possesses a neuro-motorapparatus. The nervous elements at the periphery consist of fine branching fibrils. These converge to a neuro-motor centre. At the periphery these are connected with the basal granules of the cilia. If we accept the statements made by some investigator that the cilia are the ends of myloid fibrils and that the physiological behaviour of these elements is similar to that of skeletal muscle, we may say that the selective action of drug involves the idea of mutual antagonism or inhibition among the fibrils of the different portions of the body of the ciliate. I find it profitable to consider that the neuro-motor centre inhibits or correlates the action of a number of more or less

independent functional units of the cell and that this correlation is responsible for the typical movements of the animal in swimming- this is a forward movement with a greater tendency to turn to the left than to right. There is also a tendency of the animal to turn over and over on its long axis as it swims, but this occurs very seldom under normal conditions. The functional units of the animal differ chemically among themselves the criterion being the selective action of certain drugs. Certain drugs affect some part of the cell more than others and this results in the special forms of reaction of the animal."

The experiments which were carried out by the writer to test the effect of quinine salt solutions on *Paramaecium* support the view stated above regarding the structural complexity of an unicellular organism like *Paramaecium caudatum.*

While making experiments with quinine salt solutions of different strengths on *Paramaecium caudatum, Stylonychia, Vorticella* and *Amphileptus fasciola,* it was most marked towards *Paramaecium caudatum* and it gradually lessened as we passed on to the next protozoa mentioned in the above list. Even regarding the *Paramaecium,* the death time of a particular culture of this infusoria showed wide variation due to different factors as (1) different cultures showed marked difference in time, (2) the same culture showed difference from day to day (3) the individual members of infusoria, in the same field of observation also showed marked difference, (4) The amount of carbonic acid present in the culture fluid also caused difference in the death time. So the time of death, when using a solution of particular strength, was fixed by the death of the majority of specimens in the field of observation.

I state briefly the results of some of the experiments on *Paramaecium caudatum* with quinine sulphate solution of varying dilutions.

In a solution of 1 in 40,000 of quinine sulphate in distilled water the culture becomes *Paramaecium* free generally within an hour.

But in a solution of quinine sulphate of 1 in 100,000 it takes about 24 hours before all the *Paramaecium* are dead. In solution of 1 in 200,000 *Paramaecium* are found alive even after 3 days.

The following experiments prove that the vitality of *Paramaecium* gradually diminish when a culture is kept in quinine sulphate solution of high dilution such as 1 in 200,000.

A culture of *Paramaecium* is found to be killed in 13 minutes by solution of quinine sulphate of the strength 1 in 25,000. A portion of the same culture of *Paramaecium* is placed in a solution of the strength 1 in 200,000. Ciliates are allowed to stay in this solution for

nine hours and then a quantity of *Paramaecium* is taken from it and the death time tested with the solution of the strength 1 in 25,000. The death time varied between 5 to 7 minutes. After 24 hours the death time was found to vary between 2 to 5 minutes. Subsequent experiments showed no further diminution of the death time, as even after being for 40 hours in 1 : 200,000 solution, the death time in 1 in 25,000 solution was found to remain the same, viz., between 2 to 5 minutes. But, in this case, larger number died in 2 minutes than in 5 minutes. On the third day all the *Paramaecia* in the solution of quinine sulphate of 1 in 200,000 strength were found to have died out. Some of the *Paramaecia* kept in this solution were found to be uniformly swollen up.

The gradual diminution of the resistance of *Paramaecium* culture in quinine sulphate solution of 1 in 300,000 is also noticed in the same way as above. It is however, noteworthy that in some of this series of experiments a few *Paramaecia* were found to have developed resistance against the lethal action of quinine as will be seen from the experiments given below.

A number of *Paramaecia* from a culture which has been kept in the quinine sulphate solution of the strength 1 in 300,000 for 10 hours when tested with the solution of the strength 1 in 25,000 showed the death time to be 20 minutes.

After 15 hours standing the death time was between 11 to 20 minutes.

After standing 24 hours in the solution of the strength of 1 in 300,000, there was marked diminution in the number of *Paramaecium* in the culture which rendered further experiments some what difficult. But still those present, when tested with some of the *Paramaecium* found in the solution of the strength 1 in 25,000, indicated that some died in 3 minutes, majority in 15 minutes, while others struggled for as long as 30 minutes.

A curious phenomenon was however, observed during the examination of the effect of quinine sulphate of the strength 1 in 25,000, upon those *Paramaecia* that had lived for 10 hours in the solution of the strength 1 in 200,000 and 1 in 300,000. In the majority of cases some fluid transuded in the outer layer of these organisms forming a bleb like projections on their outer surface. Again in some the anterior end of the organism is found to have acquired conical shape. The elongation of the anterior end of the ciliate which also becomes pointed has been noticed frequently even without the formation of the blebs on the outer surface. Sometimes

a constriction around the gullet is also noticed. The swelling up of the body is also of very common occurrence.

The movement of *Paramaecium* when put into a solution of quinine salt also presents some peculiarities. The *Paramaecium* moves in an uncocerned manner, when the quinine salt solution has not been mixed to the culture fluid in which it is living in sufficient strength, so as to bring about its death within a few minutes. But after the mixture it begins to develop a startling movement. Then the *Paramaecium* may move in shorter circles at first, which increases later into wider circles. The anterior end of the organism moves in an wider circle than its posterior end. After a time, if the animal is not already dead, this circular motion is replaced by a clockwise turning movement along the long axis of the organism. The cilia at the posterior end of the animal are often the last structures to cease movement. There is sometimes a movement like that of summersault i. e. turning on the short axis. These movements of the organism show, that there is a selective action of quinine salt, on the different parts of the organism.

For making experiments on *Paramaecium caudatum* with more concentrated solutions of quinine salt, the solutions of quinine bihydrochloride were used. This is a salt which is readily soluble in water. The peculiarities about the movement of *Paramaecium* as well as the formation of blebs described above are readily observed by using the solutions of strength varying from 1 in 200 to 1 in 20,000.

When the solution of quinine bihydrochloride of concentrated strength such as 1 in 200 or 1 in 400 is mixed in equal quantities with a culture containing *Paramaecium*, there is formation of one bleb of a large size on each side of the *Paramaecium*.

Summary.

All the experiments described in this paper fully support the view of Kriz that "Certain drugs effect some part of the cell more than others and this results in the special forms of reaction of the animal". Functional units of *Paramaecium caudatum* differ chemically as demonstrated by the variations found in the nature of response made by the body plasm of this organism to the selective action of quinine sulphate and quinine bihydrochloride of different strengths.

Reference.

Kriz, R. A. (1921): Selective action of Strychnine and Nicotine on a single cell. American Naturalist Vol. 58 p. 464—469.