THE COMMENSALIC CILIATES OF *NAUSITORA HEDLEYI*: SURVIVAL IN SEA-WATER IN RELATION TO INFECTIVITY

ABSTRACT

Survival of five species of ciliates from the shipworm *Nausitora hedleyi* in sea water under the laboratory conditions were studied. The results indicate that *Nucleocorbula adherens, Boveria teredinidi* and *Trichodina balakrishnia* are comparatively more adaptable to sea water than the other two species, *Thigmozoon fencheli* and *Nyctotherus marina*. The period of survival of the ciliates in healthy condition in sea water outside the body of the host in these tropical waters is short varying from 6 to 24 hours. This time limit seems to be reasonably adequate for a significant number of these ciliates to be ingested along with the inhalent current of water and thus reach their habitat.

SANTHAKUMARI (1971) reported that very small shipworms (below 9 mm) have not given any evidence either of the presence of ciliates or of their cysts in the mantle cavity of the host. This suggests that infection takes place only after a definite period of time and that there is a time lag between settlement of the host in wood and infection by the ciliates. This seems to imply that these commensalic organisms have the ability to live in sea water even outside the body of the host for varying periods of time. Information on this aspect of their life, activity and period of survival outside the body of the host is meagre. Since the ability of these ciliates to survive in sea water is therefore, related to the infection of new hosts, it was considered necessary to investigate the period they could remain free in the ambient water. According to Powers (1933), specimens of *Entodiscus borealis* when transferred to sea water appeared normal and lived for various lengths of time. In tropical conditions the survival rate of animals are shorter than that in higher latitudes. Kidder (1933) found that *Conchophthirus mytili* could live no longer than an hour or two in sea water away from the body of the host. Beers (1959) noticed that *C. mytili* has the ability to live freely in sea water for a long period. This is important since some will have to survive in this medium until it arrives in another host after expulsion from the mantle cavity of its host in the excurrent water. Beers later studied (1961) the survival rate, in sea water of *Entodiscus borealis, Madrinia indomita* and *Biggaria gracialis.*

The taxonomy of the ciliates found in *Nausitora hedleyi* has been studied by Santhakumari and Nair (1970), and Santhakumari (1973). In the present investigation each of the 5 species was dealt with separately in the following manner, as described for *N. adherens*. A clean petridish was placed on the stage of a binocular microscope and filled with sea water. Then 20 specimens of *N. adherens* from a recently collected shipworm *Nausitora hedleyi* were placed in the petridish. The ciliates dispersed rapidly. The condition of the ciliate was observed and recorded at the end of 2, 4, 6, 24, 30, 48, 54 and 72 hours reckoning from the beginning of the observation. The experiment was repeated twice using ciliates from different shipworms. The procedure that has been described for *N. adherens* was likewise repeated for *Boveria teredinidi, Trichodina balakrishnia, Thigmozoon fencheli* and *Nyctotherus marina* and the results are illustrated in Fig. 1.

Specimens of *N. adherens* upon transfer to sea water, showed neither any perceivable distortion in shape, nor any change in the size of the body and were seen moving vigorously in all directions. They were seen to move rapidly with the aboral end directed forward in a characteristic swerving motion and rotating in clockwise spiral and moving forward in greater speed than in any other direction. During such rapid movement, the bristle-like cilia on the oral end retract inwards. An

anti-clockwise rotation has also been noticed at times. In this type of movement, though the movement of the animal is constant, the pace is slow, describing an irregular circle. Several food vacuoles were discernible in their cytoplasm, most of

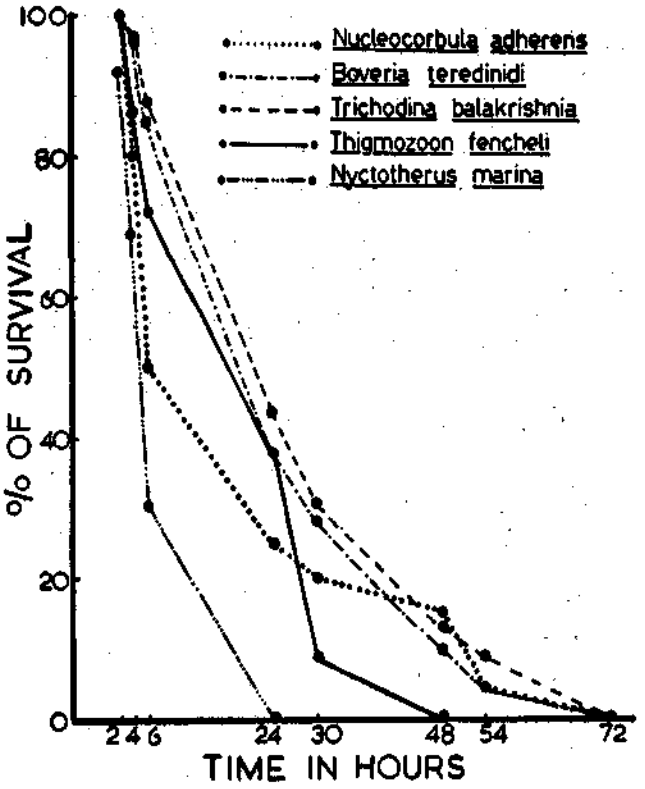

Fig. 1. Survival of ciliates in sea water outside the body of the host.

them containing injested ciliates such as *Trichodina balakrishnia* and *Boveria teredinidi*. At the end of 2 hours, all the 20 ciliates were alive and active but examination of the dish at the end of 4 and 6 hours showed the presence of only 16 and 10 live specimens respectively, thus reaching 50% mortality within a period of 6 hours. At the end of 24 hours only 5 specimens were alive reducing the survival to 25%. The surviving individuals, quite contrary to their activity at the start of the experiment, were either swimming at a slow pace or just attached to the bottom of the petridish. Many of the food vacuoles originally present in the ciliates had by now disappeared, and the cytosome appeared almost translucent. At the end of 30 hours, only 4 were found to survive and the stress of the new situation was quite evident from their smaller sizes when compared with that of the specimens during the commencement of the test. All were found attached to the bottom of the dish and showing feeble beats of the oral cilia. Only three were alive at the end of 48 hours, and their condition was apparently similar to that noticed at the end of 30 hours. The one that survived at the end of 54 hours was in a very poor condi-

tion, showing signs of great exhaustion. None survived 72 hours of exposure to sea water outside the body of the host.

Boveria teredinidi when removed from the host and placed in sea water showed spiral movements in all directions. It swims with the aboral end foremost with a slight flexion of the oral part of the body in a course which is spiral when viewed from the oral end of the animal. In general, the results of exposure to sea water closely paralleled those obtained with *N. adherens* though there were more survivors (27%) at the end of 30 hours. At the end of 48 hours the individuals were considerably diminished in size. Only 3 specimens survived exposure for 54 hours and none was found alive at the end of 72 hours.

When specimens of *Trichodina balakrishnia* were removed to sea water they exhibited rapid but erratic movements. This restless movement ceased 5 minutes after transfer from the host's body. All the specimens were alive and active at the end of 4 hours. At the end of 6, 24, and 30 hours there were 48, 24 and 17 specimens respectively. At the end of 48 hours only 9 were found alive. After 54 hours of exposure there were only 5 specimens surviving and at the end of 72 hours there were no survivors at all.

Specimens of *Thigmozoon fencheli* upon transfer to sea water swam rapidly for a few seconds, thence approached the sides of the petridish moving the body cilia in steady strokes. Several food vacuoles were discernible. All the specimens were alive at the end of 2 hours. After 4 and 6 hours the survival rate was 88.8% and 72.2% respectively. At the end of 30 hours there were only 2 specimens and by the end of 48 hours all were found dead.

Specimens of *Nyctotherus marina* upon transfer to sea water, performed normal rotating movements. After a few minutes of such movements, the ciliate began to dash erratically with the oral end directed forwards and occasionally exhibiting clockwise and more rarely anti-clockwise spinning of the body. After about 5 minutes this movement also ceased and the animal remained at the bottom of the dish. At the end of 2 hours, only one out of the 13 specimens was found to be dead. At the end of 4 and 6 hours there were 9 and 4 live specimens respectively. There were no survivors at the end of 24 hours.

The results of these test indicate that the rate of survival of the 5 species of ciliates show significant variations. All the species except *N. marina* seem to have the ability to live freely and in a healthy condition outside the body of the host for as much as 6 hours, as seen from the more than 50% survival in four out of five species. In the case of *N. marina* the survival was only 30.8% at the end of 6 hours. *T. fencheli* also appears to be a less hardy species since the rate of survival was only 38.8% at the end of 24 hours and none survived at the end of 48 hours. It would appear that 24 hours is reasonably adequate for a significant number of the remaining three species to be ingested along with the inhalent current of water by a host. This seems to be possible, especially on account of the density of the host population in this typical tropical estuary.

The oscillatory currents of the estuary should also be advantageous in dispersing the ciliates widely in different directions to increase the chances of their reaching the host species. Nevertheless, the period of survival of this ciliate in a healthy condition in sea water outside the body of the host in these warm waters of the tropics is relatively short, and ingestion by a shipworm along with the inhalent current of

water seems to be distinctly limited. When outside the host, mortality due to predation is also possible. Large quantities of water ebb and flow twice daily in this estuary where the tidal range is about one metre. Despite these inimical factors, it is interesting to note heavy infection of these ciliates in shipworms in this locality. The relatively poor survival of *T. fencheli* and *N. marina* in sea water outside the body of the host are significant. They are also seen in fewer numbers when compared the other three species in shipworms collected during different months of the year. Observations indicate that these ciliates have the ability to desert the body of the host when conditions become unfavourable. Many may be released on the death of the host through natural causes, such as the depletion of the substratum. The present study shows that these ciliates have the ability to exist for varying periods of time outside the body of the host, and the oscillatory movements of the water may help them to reach another host.

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