

Some Observations on the Division of five Species of Commensalic Ciliates in Relation to Water Propulsion

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ABSTRACT

A study was made to understand whether there is any correlation between the physiological or morphogenetic activities of commensalic ciliates and the cycles of water propulsion of their hosts. Commonly occurring species ciliates, *Boveria teredinidi*, *Trichodina balakrishnia*, *Nucleocorbula adherens*, *Thigmozoon fencheli* and *Nyctotherus marina* from the hosts *Teredo furcifera* and *Nausitora hedleyi* were used. The total number and the individuals in division for each species of ciliates were noticed. The results obtained indicate that there is no correlation between the activities of these ciliates and cycles of water propulsion. The data were statistically analysed. It was found that shipworms below 8 mm. in size were not infected with these ciliates. This shows that infection takes place, not from the parent's body but from the outside water after a definite period of growth of the host. An increase in number of commensals in relation with the increase in size of the host was observed. There is a decline in numbers in the oldest hosts. The number of dividing individuals also follows the same pattern of occurrence.

INTRODUCTION

The reactions of some commensalic ciliates to environmental factors, particularly with respect to their occurrence and division in relation to the cycles of water propulsion within the mantle cavity of the host, and their ability if any, to live in sea water when

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removed from the host, have been examined. RAO (1954) observed that the rate of water propulsion through the mantle cavity of *Mytilus* "corresponds in time and degree to the tidal levels in the locality". BEERS (1959), who studied the number of ciliates per mussel and their division in relation to water propulsion in *Conchophthirus mytili*, came to the conclusion that the division of *Conchophthirus* in the Mount Desert Island region is not correlated with the cycles of water propulsion of the host.

During the period of normal activity there will be a constant flow of water in the mantle cavity of the bivalve. This physiological current of water contains fine suspended particles which can be used as food, and also oxygen for the respiration of the bivalves. The ciliates live within the mantle cavity of the host. Naturally, therefore, the question arises whether any of the physiological or morphogenetic activities of the ciliates are correlated with the cycles of water propulsion and food intake of the host. That is, whether the ciliates feed, grow and multiply when the host is actively feeding, or divide when the host is out of the water and thus not actively feeding. Or is there no relation between the growth and division of the ciliates and the cycles of water propulsion? A study was therefore undertaken with a view to answering at least in part, the above mentioned questions. The commonly occurring species (SANTHAKUMARI & NAIR, 1970 & 1973): *Boveria terendinidi* NELSON, *Trichodina balakrishnia* SANTHAKUMARI & NAIR, *Nucleocorbula adherens* SANTHAKUMARI & NAIR, *Thigmozoon fencheli* SANTHAKUMARI & NAIR and *Nvctotherus marina* SANTHAKUMARI & NAIR were taken for this test. The occurrence, relative abundance, and morphogenetic condition of the respective ciliates within the body of the host under varied conditions of activity were noted during the premonsoon period (February to May) in *Teredo furcifera* and during the monsoon period (June to September) in *Nausitora haedleyi*.

MATERIAL AND METHOD

For these studies, test panels were installed at two positions, one below the low water mark (referred to as the "bottom panels") and the other at the mid tide level, (referred to as the "intertidal panels"). Thus the former were always submerged while the latter were subjected to periodic submersion and emersion. The infested test panels were collected when desired and the shipworms were carefully removed from their burrows. The length of the burrow was recorded in every instance to represent the length of the host. The ciliates were removed from the mantle cavity with the help of a

sterilised pipette and transferred to a counting slide. In each counting three samples from different regions of the mantle cavity were taken and the values presented in the tables represent the average number. Care was taken to see that the specimens in each instance were opened and utilised within an allotted time after their removal from the block. Counting was carried out when their activity slackened on the slide.

The forms undergoing division were recognised as follows: - (1) advanced stages of division by the usual transverse cytosomal constriction and (2) early stages by the elongation of the conspicuous macronucleus in the longitudinal axis of the ciliate. However, it was difficult to distinguish very early stages of division. So here the divisional stages were recorded only when the macronucleus

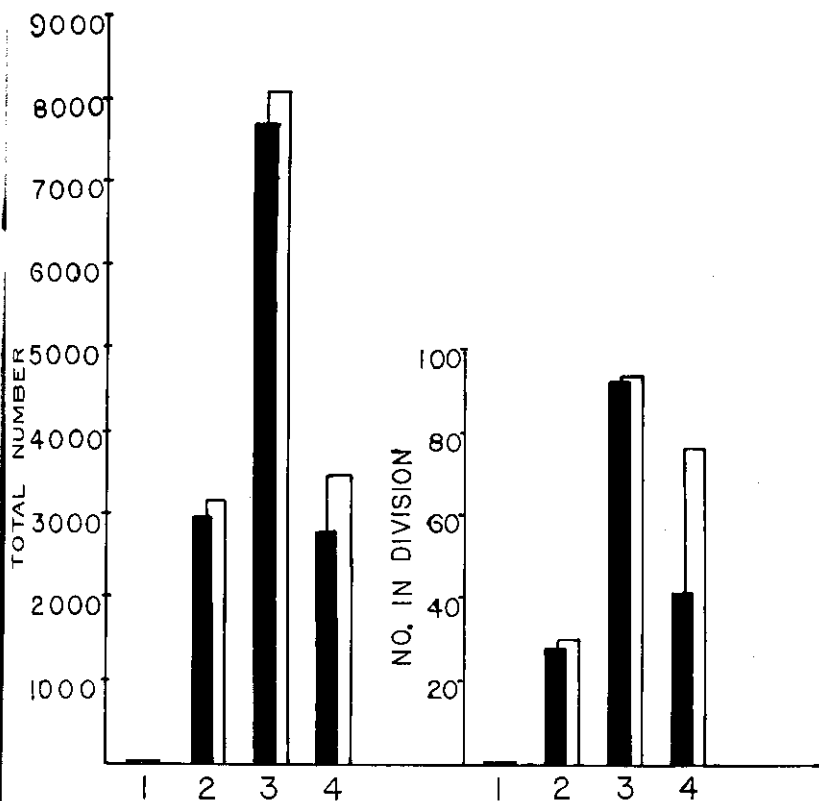


Fig. 1. 1, 2, 3, & 4 refers to the size groups of the Shipworm, *Teredo furcifera*. 1 = 6-8 mm. 2 = 8 to 20 mm. 3 = 20 to 50 mm, 4 = 50 to 75 mm. Total number and numbers of dividing individuals of *Boveria teredinidi* (Explanation of signs 1 to 4 is the same for figures 1 to 5. In all figures open blocks refer to bottom panels and black blocks refer to intertidal panels).

showed signs of elongation for division followed by cytosomal constriction. The data were statistically analysed.

RESULTS

The results are presented in Figures 1—10. It is evident that of the five species found in the host *T. furcifera*, *B. teredinidi* was far the most common with regard to the number of individuals represented, followed in order by *T. balakrishnia*, *N. adherens*, *T. fencheli* and *N. marina*. A noteworthy feature is the apparent absence of these ciliates in shipworms belonging to the lower length groups, as may be seen from the fact that no ciliate has been noticed in shipworms below 8 mm in length.

Boveria teredinidi was the dominant species and peak occurrence was noticed in the 20—50 mm size groups in the host *T. furcifera* (Fig. 1.) while it was found in the 80—125 mm size group in *N. hedleyi* (Fig. 6.). So also a greater number of dividing individuals were found in the above mentioned size groups. It is very clear that there is no significant difference in the number of individuals from

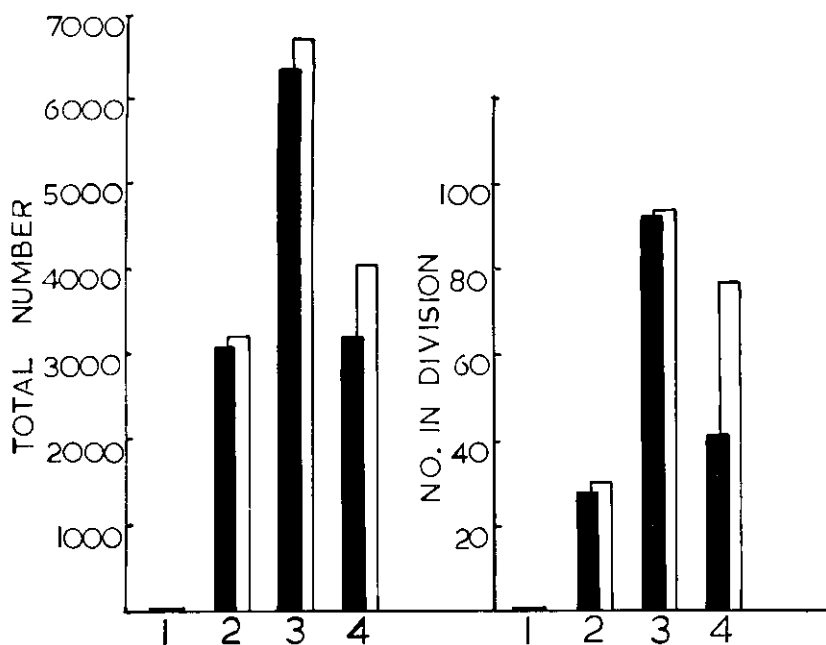


Fig. 2. Total number and number of dividing individuals of *Trichodina balakrishnia*.

intertidal panels and bottom panels. The maximum number was noticed in the bottom panels. *T. furcifera* and *N. hedleyi* yielded 8102 and 58523 ciliates respectively. A decline in number is seen in the oldest host.

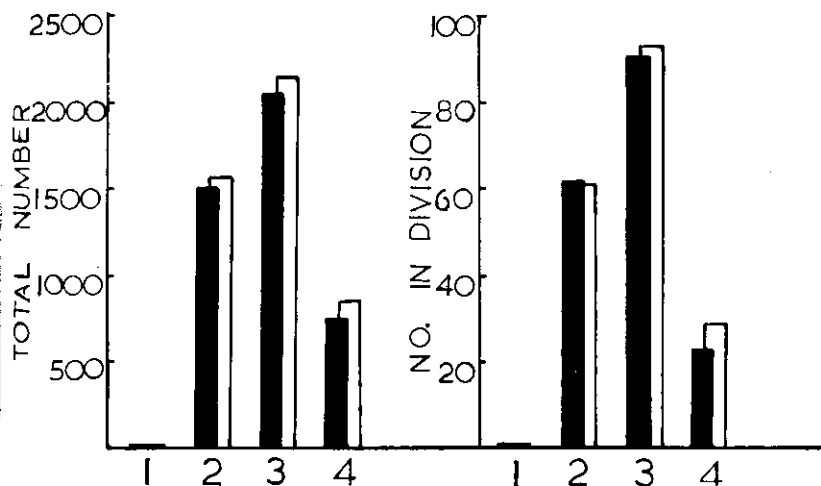


Fig. 3. Total number and number of dividing individuals of *Nucleocorbula adherens*.

In numerical abundance *T. balakrishnia* ranks second. The pattern of occurrence in different size groups is the same as that of *B. teredinidi*. The maximum number from *N. hedleyi* is seen in the intertidal panel and amounted to 58510.

N. adherens is a larger form than others. Even though it ranked only third place in number, this species occupies a major area in the mantle cavity of the shipworm. The nature of occurrence is the same as in the other two cases and the maximum number is observed in the bottom panels in the 20–50 mm and 80–125 mm size groups in *T. furcifera* and *N. hedleyi* respectively (Fig. 3 & 8).

Contrary to the occurrence of other species *T. fencheli* occupies the maximum number in *T. furcifera* (Fig. 5 & 9).

N. marina was absent in the 6–8 mm and 8–20 mm size groups in the host *T. furcifera*. The numbers of this species increased with increase in size of the host, *T. furcifera* (Fig. 5). But it followed the general trend of occurrence in *N. hedleyi* (Fig. 10).

With regard to the division of each species the percentage of dividing stages followed the trend of occurrence. The highest percentages of dividing individuals were noticed in *N. adherens* in *T. furcifera* (Fig. 3).

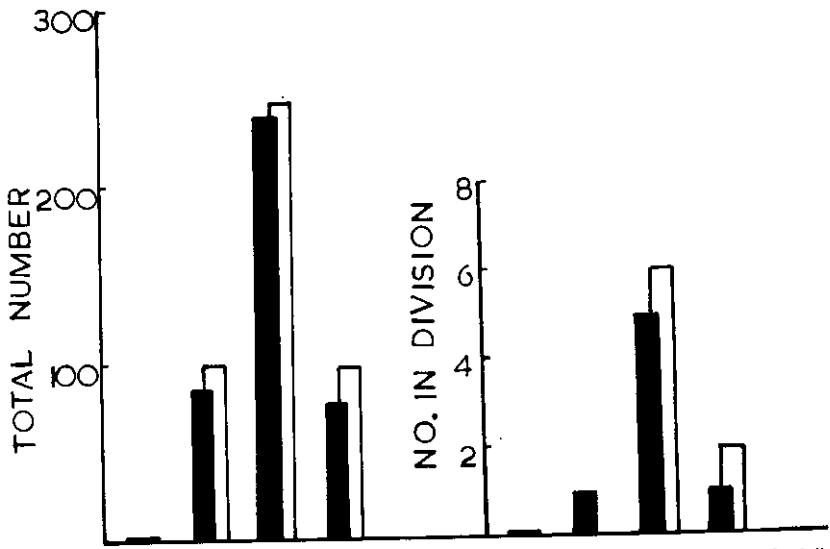


Fig. 4. Total number and number of dividing individuals of *Thigmozoon fenchei*.

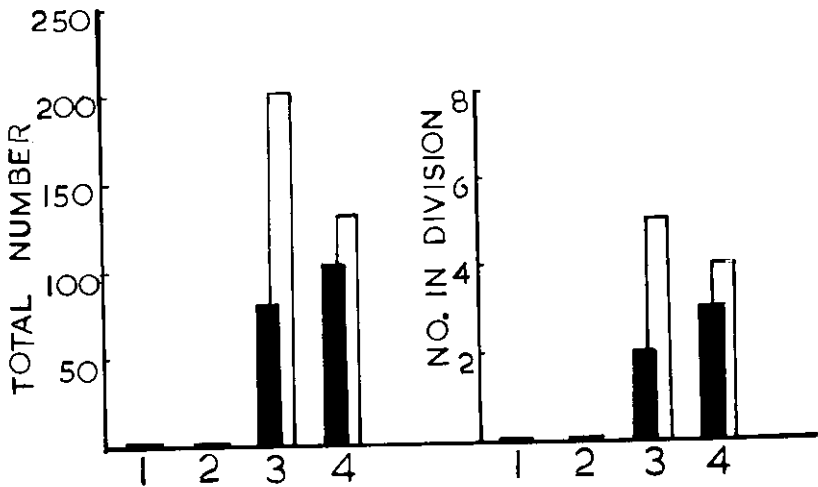


Fig. 5. Total number and number of dividing individuals of *Nyctotherus marina*.

To find out whether there existed any difference between the total number obtained from the intertidal panels and bottom panels, the difference of the means of the respective observations were tested using Students' "t" test. The result obtained showed that the difference is not significant.

Using analysis of variance methods the complete data were analysed to study the nature of variation between different species

TABLE I
 Analysis of variance table of Ciliates from *Teredo furcifera*

Source of variation	Sum of Squares	Deg-rees of free-dom	Mcan sum of squares	F. Ratio	Prob-ability	Species	Sum of squares	Deg-rees of free-dom	Mean Sum of squares	F. Ratio	Prob-abil-ity.
Between sizes groups.	57753512	3				<i>Nucleocorbula adherens.</i>	4928941	3	1642780.3	40.03	<.005
Between species	92998648.85	4				<i>Boveria terebranti</i>	63728089.4	3	21242696.5	517.59	<.005
Inter-action	54817263.35	12	4568105.28	111.30	<.005	<i>Trichodina balakrishnia</i>	43720269.75	3	14574323.25	355.09	<.005
Between 20 cells.	205569425.1	19				<i>Thigmozoon fencheli</i>	59921.38	3	19973.46	0.49	> 0.1
Residual	820824.0	20	41041.20			<i>Nyctotherus marina.</i>	33553.5	3	11184.5	0.27	> 0.1
Total	206390249.1	39									

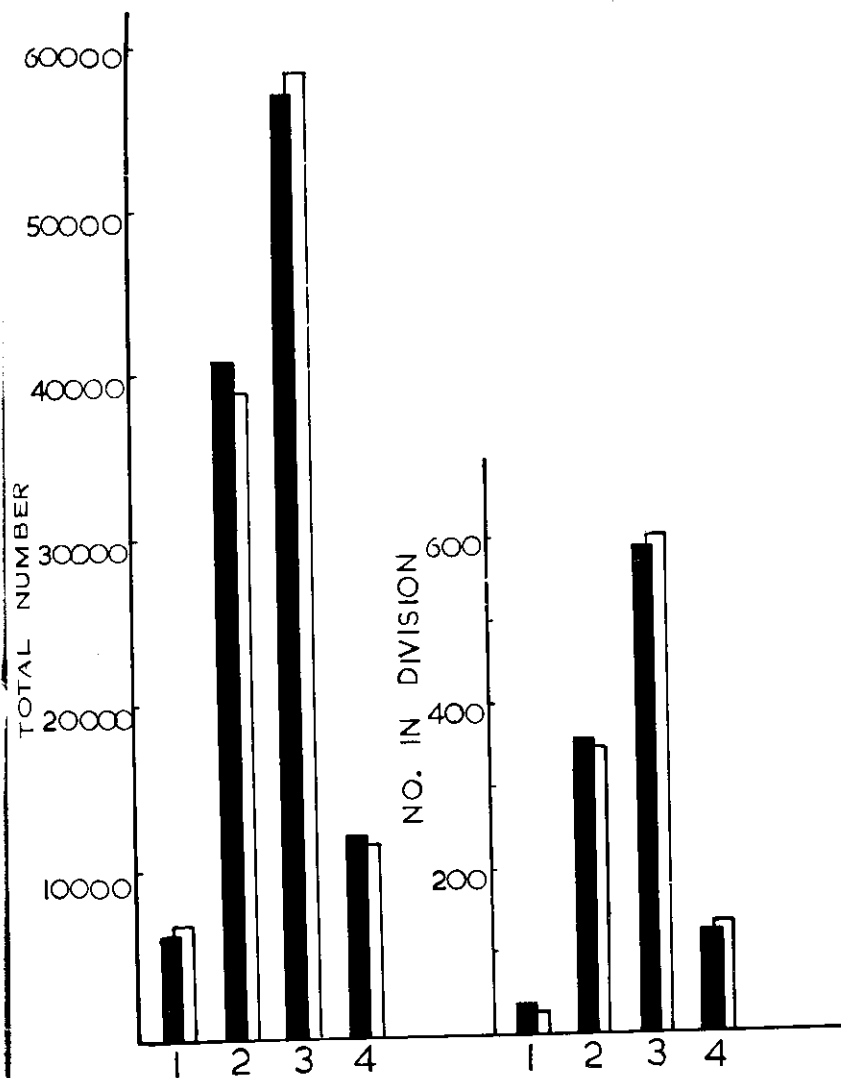


Fig. 6. 1, 2, 3, and 4 refers to the size groups of the shipworm *Nausitora hedleyi*. 1 = 9 to 40 mm; 2 = 40 to 80 mm; 3 = 80 to 125 mm; 4 = 125 to 170 mm. Total number and numbers of dividing individuals of *Boveria Teredinidi* (Explanation of signs 1—4 is the same for figures 1 to 5).

and between different size groups. The interaction between these two characteristics was also taken into considerations and found to be highly significant (Tables I and II). Because of this, each species was separately treated in order to evaluate possible size group differences. The result showed that the species *B. teredinidi*, *T.*

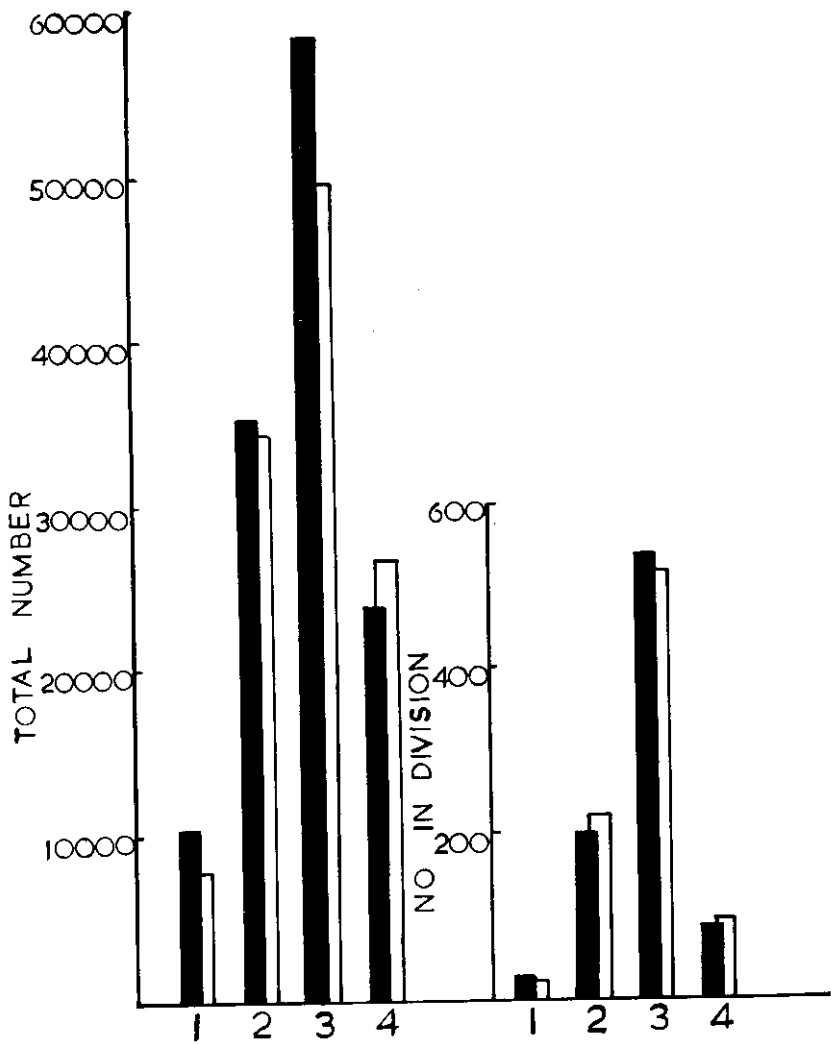


Fig. 7. Total number and numbers of dividing individuals of *Trichodina balakrishnia*.

balakrishnia and *N. adherens* varied significantly among different size groups, whereas the species *T. fencheli* and *N. marina* showed little variation.

DISCUSSION

It is not clear whether the apparent absence of these ciliates in the mantle cavity of hosts of smaller size is due to the paucity of infec-

tion from internal sources or whether there is a certain time lag essential for the establishment of these organisms during the growth of the shipworms. Another possible interpretation can be that the infection by the ciliates takes place not from the parent's body but quite independently after the metamorphosis of the veliger, through the physiological current of water taken in through the inhalent siphon. In larger shipworms the ciliates were proportionately larger. From this, at least one point seems to be clear: infection of new hosts takes place not by adult ciliates but by juveniles.

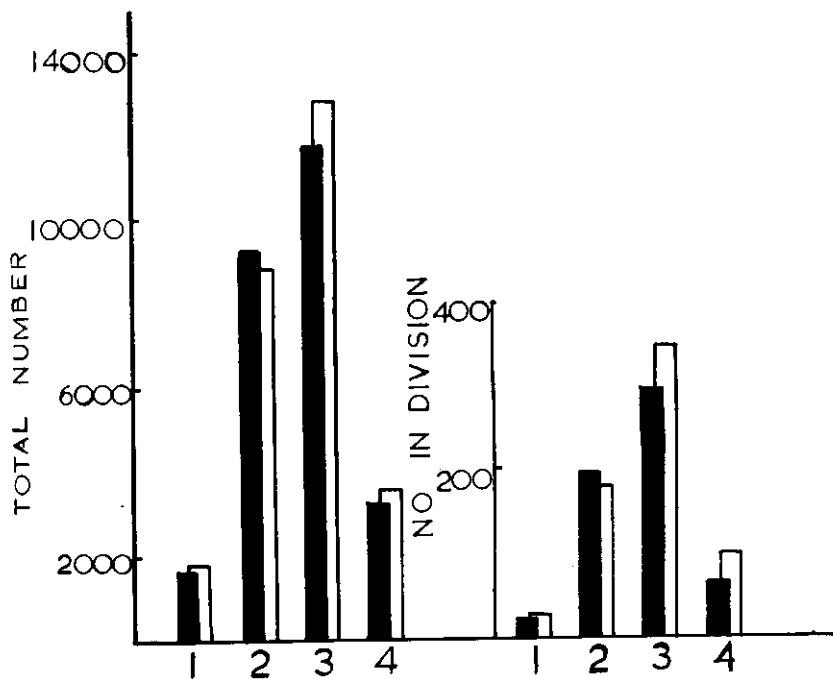


Fig. 8. Total number and numbers of dividing individuals of *Nucleocorbula adherens*.

A distinct relationship between the size of the host and the number of ciliates within the mantle cavity is not evident from the available data. In the case of all species, with an exception of *Nyctotherus marina*, an increase is noticeable in the number of ciliates present in *Teredo* of the size groups 8—20 mm to 20—50 mm. The figures, however, show a downward trend in the still larger size groups of 50—70 mm. The same pattern of occurrence is found in *Nausitora*. In the case of the fish three spined stickle-back (*Gasterosteus aculeatus*), CHAPPELL (1969) observed that the incidence of

Schistocephalus solidus increased with fish size, while the intensity fluctuated and decreased in the largest fish. He further stated that the upper limit of the range of infection tended to decrease in the larger fish, perhaps in relation with dietary and behavioural changes in older fish. Similarly RAKOVA (1953) recorded an increased burden in larger ide fish (*Leuciscus idus*), but found a diminished parasite load in older fish. Only in the case of *Nyctotherus marina* the number of individuals represented within *Teredo* shows a steady increase with the increase in size of the body of the host (Fig. 5).

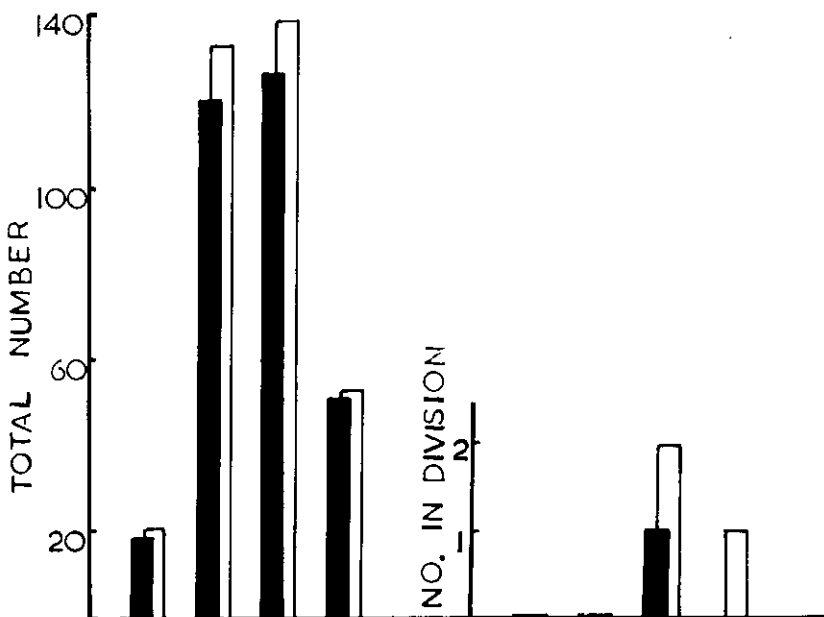


Fig. 9. Total number and numbers of dividing individuals of *Thignozoon fencheli*.

CHAPPELL (1969) also found the same phenomenon in the case of *Trichodina* sp. living in three spined stickle-backs. Of the five species of ciliates from *N. nedleyi*, *B. teredinidi* was represented by the largest number of individuals followed in order by *T. balakrishnia*, *N. adherens*, *N. marina* and *T. fencheli*. One difference noticeable with regard to the incidence of these ciliates is the occurrence of a greater number of *Nyctotherus marina* than *Thignozoon fencheli* in *Nausitora*. It may also be seen that in general, each species was represented in much greater numbers in *Nausitora* than in *Teredo*. From this it seems that two factors are involved in the nature of occurrence of the ciliates. (i) A bigger host species is likely to contain a greater number of commensals than a smaller host species

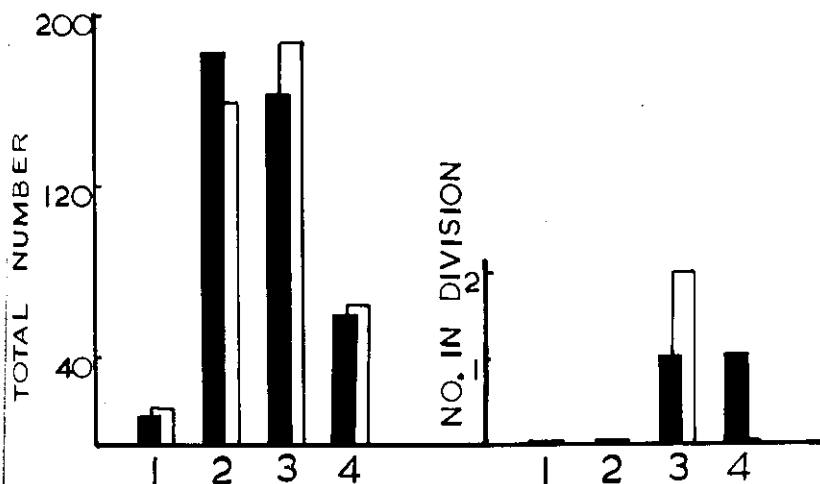


Fig. 10. Total number and numbers of dividing individuals of *Nyctotherus marina*.

and (2) a low salinity is apparently tolerated to a greater extent than high salinities.

A scrutiny of the figures observed in the intertidal and bottom panels suggests the following:

(1) A significant difference in the number of ciliates in the two categories of blocks is not evident, although slight differences in the number of the respective species were formed.

(2) With reference to the ciliates in division the trend was almost the same in both hosts, with the exception that the percentage of the ciliate *Nucleocorbula adherens* in division in the host *Teredo* was significantly higher than that in *Nausitora*. According to BEERS (1959) growth and division of the ciliate *Conochophthirus mytili* are continuous and independent of water propulsion and tidal conditions rather than rhythmic processes and are, therefore, independent of water propulsion and tidal levels.

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REFERENCES

- BEERS, C. D. - 1959 - Some observations on the autecology of the ciliate *Conchophthirus mytili*. *J. Elisha Mitchell sci. Soc.* 75: 3—10.
- CHAPPELL, L. H. - 1969 - The parasites of the three spined stickle back *Gasterosteus aculeatus* L. from a Yorkshire Pond. II. Variation of the parasite fauna with sex and size of fish. *J. Fish Biol.* 1: 339—347.
- RAKOVA, V. M. - 1953 - Invasion dynamics in the ide fish according to age. In contributions to Helminthology. Israel Program for Scientific Translations, Jerusalem, English Translation 1966.
- RAO, K. P. - 1954 - Tidal rhythmicity of rate of water propulsion in *Mytilus*, and its modifiability by transplantation. *Biol. Bull.* 106: 353—359.
- SANTHAKUMARI, V. & NAIR, N. B. - 1970 - *Nucleocorbula adherens* gen. and sp. Nov. (Ciliata, Thigmotrichida) from shipworms. *Ophelia*. 7: 139—144.
- SANTHAKUMARI, V & NAIR, N. B. - 1973 - Ciliates from Marine wood-boring molluscs. *Treubia* 28 (2): 41—58.