PROTOZOA ECOLOGY AND ITS DISTRIBUTION IN A SEMI-URBAN AREA IN THE CENTRAL PLAIN OF THAILAND

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ABSTRACT

This paper attempted to study the structure of protozoa communities as well as their organization. An artificial substrate in the form of polyurethane foam was used to attract as many as 165 species in 87 genera of protozoa in natural water ways of Thammasat University,Rungsit campus situated in a semi-urban area in the central plain of Thailand. A 2x2 chi-square method of interspecific association analysis of 13,530 pairs of protozoa species and the Shannon-Weiner method of diversity index analysis were made. The results showed that the percentage distribution of the three types of stations sampling units was 37.05%, 43.35% and 19.60% for (+),(-), and (0) types, respectively. Similarly, in the case of periods sampling units the percentage distribution was 41.45%, 37.87% and 20.68% for (+),(-), and (0) types, respectively. It is obvious that the results from both cases show no significant difference for the species which are present and absent in all sampling units which is considered indeterminant (type (0)). As for the diversity index, it was found that the mean value calculated from each station ranged from 1.108 to 1.334 with a standard deviation from 0.11 to 0.34. The maximum deviation was found at station no. 5 which has a large open water surface. It could be concluded from this study that protozoa communities in different areas of Thammasat University, Rungsit campus, were not made up of different aggregation of species.

INTRODUCTION

Protozoa, the smallest single celled animal, has the minimum size of approximately 7.5 microns. It has not only an important role in being a parasite causing diseases in human being and animal but also a decomposer in the ecosystem. Protozoa may live as a free-living organism or in an aggregate manner or as a fresh water protozoa community. Relatively little study was carried out in the field of autecology of protozoa in comparison with other living organisms. However, Picken (1937) was the first to note that an assemblage of protozoans is a complex community of herbivorous, carnivorous, omnivorous and detritus feeders which form a closed social structure.

Later studies concentrated on how communities were functioned and structured as well as the community organization. The biologists gradually placed their interests on the distribution, species diversity,the structure of protozoa communities which were formed under varying habitats and their interspecific association. Cairns (1982) pointed out topics required further study on protozoa community. His statement on "Do communities in different areas made up of different aggregation of species respond in a similar way to an identical habitat or do communities of different maturity respond similarly to an identical habitat" is taken up as a theme of this study.

In order to be able to effectively carry out a comparative study of protozoa community in a natural water body, an artificial substrate was introduced in the study. Cairns ed al (1979), using an artificial substrate made of polyurethane foam and by directly sampling in the natural environment, demonstrated that the majority of protozoa species eventually colonized in the polyurethane foam units. Also, Cairns and Pratt (1986) showed that the utilization of an artificial substrate provided a statistically reliable data. These polyurethane foam units are characterized as open-cell foam which resembles an intricate lattice work of pillars and interestited spaces under the scanning electron-microscope. The three dimensional character of the foam permits ready colonization by wide variety of microorganism free swimming forms to easily invade the interstices of the foam which sessile forms attached the solid pillars. It is essentially an inert substance which can be autoclaved without altering its effectiveness as a sampling device.

MATERIALS AND METHODS

This study attempted to identify and quantify protozoa species by the use of an artificial substrate in the form of polyurethane foam. The sampling of protozoa was made in 8 natural water ways (8 stations as located in ditches, ponds and an oxidation treatment pond) in Thammasat University, Rungsit campus situated in a semi-urban area in the central plain of Thailand (Fig.1) with the aim to study protozoa ecology and its distribution.

Three artificial substrates of sizes 6 x 7 x 3.5 cm were installed at a depth of 20-30 cm under water surface at 30 cm apart at each station. They were installed 2 weeks prior to sampling in order for the protozoa to colonize. These substrates were collected every two months at each station over a study period of 10 months starting from March 1991 to December 1991.

Protozoa Analysis

The triplicate samples of artificial substrates collected at each station were placed in the beakers filled with 100 ml of distilled water. They were shaked well until the protozoa became detached and would be again stirred. The dropper was then used to take 1 ml of stirred water to place on the prepared slide. This had to be done fast within 1-2 days to ensure the longivity of protozoa. The species and number of protozoa were identified, counted and photographed.

Interspecific Association Analysis

The results of the species identification and quantification of species presence-absence data of all species found in the sampling units (both for the cases of stations and periods sampling units) were made by computing chi-square values for all possibilities of the 2x2 contingency tables.

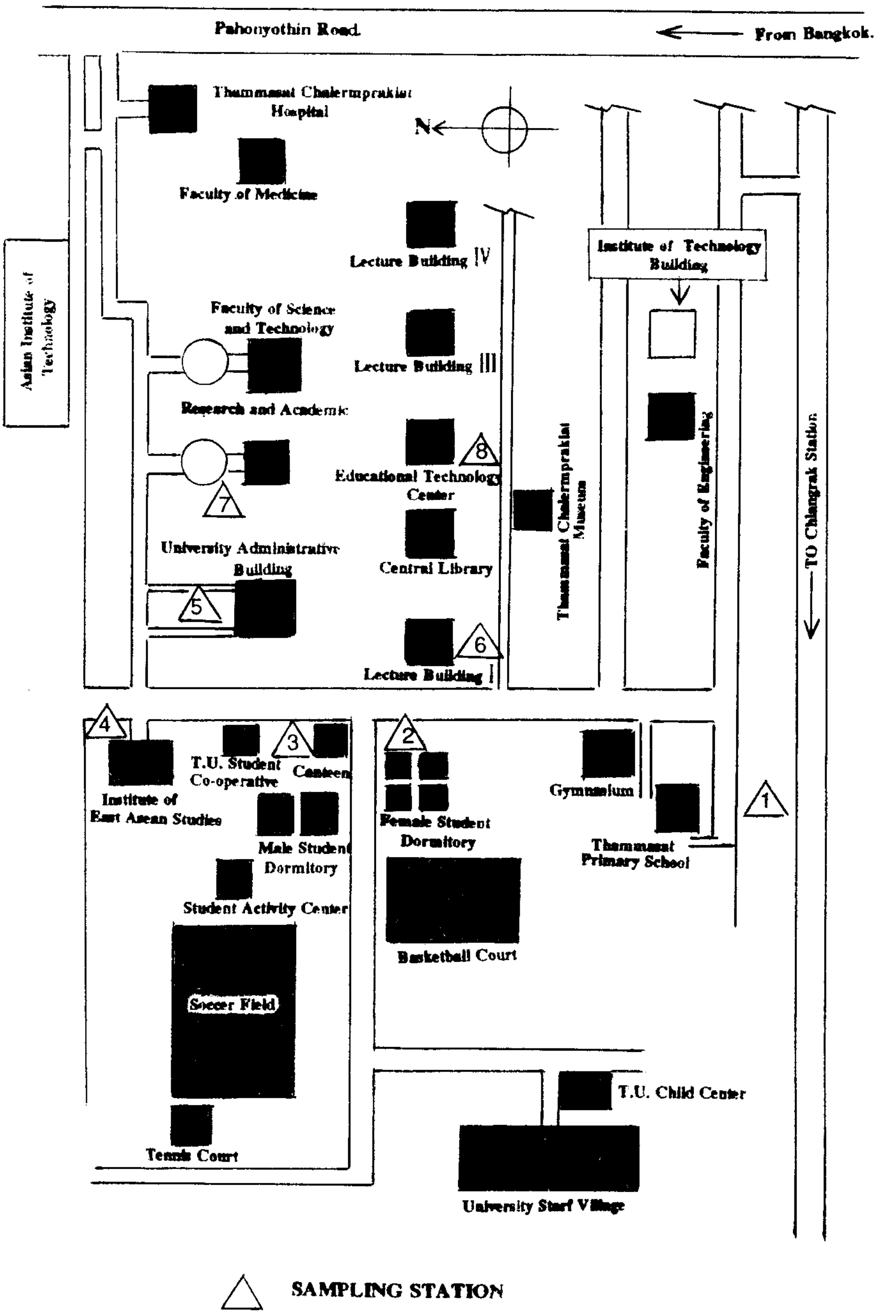

Fig. 1. Diagram shows sampling station in Thammasat University, Rangsit campus.

Species Diversity Analysis

Again, from the results of the species identification and quantification the species diversity was calculated based on Shannon-Weiner diversity index in order to describe the relative importance of species richness and evenness of the protozoa species community distribution .

RESULTS

Interspecific Association

The results of the analysis of protozoa sample collected 5 times at 8 stations over a period of 10 months showed the number of protozoa to be 165 species in 87 genera. Fig. 2 shows the typical pictures of protozoa taken from a microscope of 40 times magnification. Tables 1 and 2 show the distribution of protozoa at various stations and at various periods, respectively.

The interspecific association among 165 species was calculated by employing a 2 x 2 chi-square statistical test which was based on species presence-absence data from both the cases of stations and period sampling units. The calculated results showed that there were altogether (165) x (165-1) / 2 = 13,530 pairs of species which could be grouped into 3 species association types, namely, the positive association species type (+), the negative association species type (-) and the indeterminant species type (0).

Figs. 3 and 4 were plotted to show the interspecific association among 165 species for the cases of stations and period (s) sampling units, respectively.

The results of the calculation also provided the distribution of the three interspecific association types as shown in Table 3 for both the cases of station and period sampling units. In the case of station sampling units, it was found that the percentage distributions of the three types were 37.05 %, 43.35 % and 19.60 % for the (+) , (-), and (0) types respectively. Similarly, in the case of period sampling units, the percentage distributions were 41.45 % , 37.87 % and 20.68 % for (+), (-), and (0) types , respectively. It is obvious that the results from both cases show no significant difference for the species which are present or absent in all sampling units. Thus, such species are considered indeterminant resulting in the inability to compute the chi-square value.

Species Diversity

The Shannon-Weiner diversity index was calculated at each station for 5 sampling periods with the results shown in Table 4. It was found that the mean value calculated from each station ranged from 1.108 to 1.334 with the standard deviation varying from 0.11 to 0.34. The maximum deviation variation was found at station no.5 which has a large open water surface.

TABLE 1. Presence (1) and Absence (0) of protozoa species found at 8 stations..

Species	Stations							
	1	2	3	4	5	6	7	8
1. *Acanthocystis chaetophora*	1	1	0	0	0	0	0	1
2. *Acineta sp.*	0	0	0	0	0	0	1	0
3. *Actinobolina radians*	1	1	1	0	1	0	1	1
4. *Actinobolina sp.*	0	0	0	1	0	0	0	0
5. *Actinophrys sol.*	1	1	0	0	1	0	0	0
6. *Actinophrys sp.*	1	1	1	1	1	0	1	1
7. *Actinosphaerium eichlornii*	0	0	1	0	1	1	0	0
8. *Actinosphaerium sp.*	1	1	0	1	0	0	0	0
9. *Amoeba dubia*	0	0	1	0	0	0	0	0
10. *Amoeba gorgonia*	0	1	1	1	1	0	1	0
11. *Amoeba proteus*	1	0	1	1	0	1	1	0
12. *Amoeba sp.*	1	1	1	1	1	0	1	1
13. *Amphileptus claparedei*	0	1	1	1	1	1	0	1
14. *Amphileptus sp.*	0	0	1	0	0	1	0	0
15. *Anisonema ovale*	1	0	1	1	1	0	1	1
16. *Arcella sp.*	0	0	1	0	0	0	0	0
17. *Arcella vulgaris*	1	1	1	1	1	0	1	1
18. *Aspidisca costata*	1	1	1	1	0	1	1	1
19. *Aspidisca lynceus*	1	0	0	1	0	1	0	0
20. *Aspidisca sp.*	0	0	1	1	0	1	1	0
21. *Astasia klebsii*	0	1	1	1	1	1	0	1
22. *Balanbidium coli*	0	0	0	0	0	0	1	0
23. *Bodo caudatus*	1	0	0	1	1	0	1	1
24. *Campanella umbellaria*	0	0	1	1	0	1	1	1
25. *Carteria globosa*	0	0	1	0	0	0	0	0
26. *Centropyxis sp.*	0	1	1	0	0	0	0	0
27. *Chilodonella cucullulus*	1	0	1	1	1	1	1	1
28. *Chilodonella sp.*	0	0	0	1	0	1	1	1
29. *Chilodonella uncinata*	0	0	1	0	0	1	0	1
30. *Chilophrya sp.*	1	0	0	0	0	0	0	0
31. *Chilorhyrya utahenisis*	1	0	0	0	0	0	0	0
32. *Chitomonas peramecium*	0	0	0	0	0	0	1	0
33. *Chlamydomonas angulosa*	1	1	0	1	1	1	1	1
34. *Chlamydomonas cingulata*	0	0	1	1	0	0	0	0
35. *Chlamydomonas sp.*	0	1	1	0	1	0	1	1
36. *Chlorogonium euchlorum*	0	1	0	0	0	0	0	0
37. *Chromulina globusa*	0	0	1	0	0	0	0	0
38. *Cinetochilum margaritaceum*	1	1	0	1	0	1	1	1
39. *Clathrulina elegans*	1	0	0	0	0	0	0	0
40. *Coleps hirtus*	1	1	0	0	0	0	0	0
41. *Coleps octaspinus*	0	1	0	0	0	0	0	0
42. *Coleps sp.*	1	1	1	1	1	1	1	1

Table 1. (Continued)

Species	Stations							
	1	2	3	4	5	6	7	8
43. Colipidium clopoda	0	0	0	0	1	1	0	0
44. Colpoda cucullus	1	0	0	0	1	1	1	0
45. Conchophthirus anoclontae	0	0	0	0	0	1	0	0
46. Cothurnia variabilis	1	0	0	0	0	C	0	0
47. Cryptomonus ovata	0	1	0	0	1	0	0	0
48. Cryptomonus sp.	0	0	0	0	0	0	1	0
49. Cyclidium glaucona	1	0	1	0	0	1	0	0
50. Cyclidium sp.	1	1	1	1	0	1	1	1
51. Didinium baldianii	0	1	0	0	0	0	0	0
52. Didinium nasutum	1	1	1	0	0	0	1	0
53. Didinium sp.	0	1	1	1	1	1	1	1
54. Difflugia acumenata	0	0	0	1	0	0	0	0
55. Difflugia oblonga	0	0	0	0	0	0	1	0
56. Difflugia sp.	1	0	1	0	0	0	0	0
57. Difflugia tobostoma	1	1	1	1	1	1	0	1
58. Dileptus anser	0	0	1	0	0	0	1	1
59. Enchelydium sp.	0	0	1	0	0	0	0	0
60. Endosphaera engelmanni	0	1	1	0	0	0	1	0
61. Entameba histolytica	1	0	0	0	0	0	0	0
62. Entosiphon sulcatum	1	0	0	0	0	1	1	1
63. Epalxella mirabilis	0	0	1	0	0	0	0	0
64. Epistylis chrysemedis	1	0	0	0	0	0	0	0
65. Epitylis cambari	0	0	0	1	0	0	1	0
66. Epitylis chrysemedis	1	0	0	0	0	0	0	0
67. Epitylis niagarae	0	0	1	0	0	0	0	0
68. Epitylis plicatilis	0	0	0	0	0	1	0	0
69. Euglena acuminata	0	0	0	0	0	1	0	0
70. Euglena acus	1	1	1	1	1	0	1	1
71. Euglena chrenbergii	1	1	1	1	1	1	1	1
72. Euglena cyclopicola	1	1	1	1	1	0	0	1
73. Euglena deses	0	0	1	0	0	1	0	1
74. Euglena gracilis	0	0	0	0	0	0	0	1
75. Euglena polymorpha	1	1	1	1	1	1	1	1
76. Euglena rostrifera	1	1	1	1	1	1	1	1
77. Euglena rubra	1	1	1	1	1	1	1	1
78. Euglena sp.	0	1	1	1	0	1	1	1
79. Euglena spirogyra	0	1	1	0	1	0	1	1
80. Euglena tripteris	1	1	1	1	1	1	1	1
81. Euplotes acdiculatus	0	1	0	0	0	0	0	0
82. Euplotes patella	1	1	0	0	1	1	1	0
83. Euplotes sp.	1	0	1	1	0	1	1	1
84. Frontonia leucas	0	1	1	0	0	0	0	0

Table 1. (Continued)

Species	Stations							
	1	2	3	4	5	6	7	8
85. *Frontonia sp.*	1	0	0	0	0	0	0	0
86. *Glaucona scintillans*	1	0	1	0	1	0	0	1
87. *Gonium pectorale*	1	1	1	0	0	0	0	0
88. *Halteria grandinella*	0	0	0	1	0	0	0	0
89. *Holophrya simplex*	1	0	1	1	0	0	1	1
90. *Kahlia acrobates*	0	0	0	0	0	1	0	1
91. *Karona polyporum*	0	0	1	0	0	0	0	0
92. *Lacrymaria magnus*	0	0	0	0	0	0	1	0
93. *Lacrymaria olar*	0	0	1	1	1	0	1	0
94. *Lacrymaria vior*	1	0	0	0	0	0	0	0
95. *Leucophrys patula*	0	0	0	0	1	1	1	1
96. *Litonotus fasciola*	1	0	1	1	1	1	1	1
97. *Litonotus lamella*	0	0	1	1	0	1	1	1
98. *Litonotus sp.*	1	0	1	0	0	0	0	0
99. *Loxocephalus plagius*	0	0	0	0	0	1	0	0
100. *Loxodes magnus*	0	0	1	0	0	0	0	0
101. *Loxodes vorax*	1	0	1	0	0	0	0	1
102. *Metopus es*	0	1	1	1	0	0	0	0
103. *Metopus sp.*	1	0	0	0	0	0	0	1
104. *Nassula aurea*	1	1	0	0	0	0	0	0
105. *Nassula ornata*	0	0	1	0	0	1	1	0
106. *Nyctotherus cordeformis*	0	0	0	0	0	0	0	0
107. *Onychodromus grandis*	1	0	0	0	0	0	0	1
108. *Oxytricha befaria*	0	0	0	0	0	1	0	0
109. *Oxytricha fallax*	0	0	1	1	1	0	0	1
110. *Oxytricha sp.*	1	1	1	1	1	1	1	1
111. *Paramecium aurelia*	0	0	1	1	0	1	0	0
112. *Paramecium caudatum*	1	0	0	0	0	1	0	0
113. *Paramecium multimicronucleatum*	1	1	1	0	0	1	1	0
114. *Paramecium sp.*	1	1	1	1	0	0	1	0
115. *Paramecium trichium*	1	1	1	1	0	1	1	1
116. *Pardorina morum*	0	0	0	0	1	0	0	0
117. *Pelomyxa paulstris*	0	0	0	1	0	0	0	0
118. *Peranema sp.*	1	1	1	1	1	1	1	1
119. *Peranema trichophorum*	0	0	0	0	1	1	0	0
120. *Phacus acuminata*	0	1	1	0	0	1	1	1
121. *Phacus longicauda*	0	1	0	0	1	1	1	1
122. *Phacus pleuronectes*	1	1	1	1	1	1	1	1
123. *Phacus pyrum*	0	0	0	0	1	0	0	0
124. *Phacus quirquemargimatus*	0	1	0	0	1	1	1	1
125. *Phacus sp.*	0	0	0	0	0	1	1	0
126. *Phacus torta*	0	0	0	0	0	1	0	0

Table 1. (Continued)

Species	Stations							
	1	2	3	4	5	6	7	8
127. *Phacus warszenrizii*	1	1	1	1	1	1	1	1
128. *Pleodorina illinoisemsis*	0	0	0	0	0	0	1	0
129. *Pleuronema coronatum*	0	0	1	0	0	0	0	0
130. *Podophrya fira*	1	0	0	0	0	0	0	0
131. *Podophrya sp.*	1	0	0	0	0	0	0	0
132. *Spanaotoma sp.*	0	0	0	0	1	0	0	0
133. *Spathidium spathula*	1	1	0	0	0	0	0	1
134. *Spirostomum intermedium*	1	0	0	1	0	0	0	0
135. *Spirostomum minus*	1	0	0	0	0	0	0	0
136. *Spirostomum teres*	0	0	1	0	0	0	0	0
137. *Stentor coerucleus*	0	1	0	0	0	0	1	1
138. *Stentor igneus*	0	0	0	0	0	1	0	0
139. *Stentor mulleri*	0	0	0	0	0	1	0	0
140. *Stentor rveseli*	0	0	0	0	0	1	0	0
141. *Stentor sp.*	1	1	1	0	0	1	0	1
142. *Sticotrica aculeata*	0	1	0	0	0	0	0	0
143. *Stylonychia complenata*	0	1	0	0	0	0	0	0
144. *Stylonychia mytilus*	0	1	1	1	1	1	1	1
145. *Stylonychia pustulata*	0	0	0	0	0	0	0	1
146. *Synura uvella*	0	1	0	0	0	0	0	0
147. *Tetrahymena geleii*	1	0	0	1	1	1	1	0
148. *Tetrahymena pyrifomis*	1	0	0	0	0	0	0	1
149. *Tillina magna*	1	0	0	0	0	1	1	1
150. *Trachelomonus armata*	0	0	0	0	0	0	0	1
151. *Trachelomonus conifer*	0	0	0	0	0	0	0	1
152. *Trachelomonus hispida*	1	1	1	0	1	1	1	0
153. *Trachelomonus honida*	1	0	0	0	1	0	0	1
154. *Trachelomonus sp.*	1	0	0	0	1	0	1	1
155. *Trachelomonus urceolata*	1	1	1	1	1	1	1	0
156. *Trachelomonus volvocima*	1	1	1	0	1	0	0	0
157. *Urceolaria mitra*	0	1	0	0	0	0	0	0
158. *Urocentrum turbo*	0	0	0	1	0	0	0	0
159. *Uroleptus piscis*	0	0	0	0	1	0	0	0
160. *Uroleptus sp.*	0	0	0	0	0	1	0	0
161. *Uronema griseolum*	0	0	1	0	0	1	0	0
162. *Urosoma sp.*	0	1	0	0	1	0	0	0
163. *Volvox sp.*	1	1	0	1	0	0	1	1
164. *Vorticella carpanula*	0	0	0	0	0	1	1	1
165. *Vorticella sp.*	1	1	1	1	1	1	1	1

TABLE 2. Presence (1) and Absence (0) of protozoa species over 5 periods..

Species	Periods				
	1	2	3	4	5
1. *Acanthocystis chaetophora*	0	0	0	1	1
2. *Acineta sp.*	0	0	0	1	0
3. *Actinobolina radians*	0	1	1	1	0
4. *Actinobolina sp.*	0	0	0	1	0
5. *Actinophrys sol.*	0	0	1	1	1
6. *Actinophrys sp.*	1	1	1	1	1
7. *Actinosphaerium eichlornii*	0	0	1	0	1
8. *Actinosphaerium sp.*	0	1	1	1	0
9. *Amoeba dubia*	0	0	1	0	0
10. *Amoeba gorgonia*	0	1	1	1	0
11. *Amoeba proteus*	0	1	1	0	0
12. *Amoeba sp.*	1	1	1	1	1
13. *Amphileptus claparedei*	1	1	1	1	1
14. *Amphileptus sp.*	0	1	0	0	0
15. *Anisonema ovale*	0	0	1	1	1
16. *Arcella sp.*	0	0	1	0	0
17. *Arcella vulgaris*	1	1	1	1	1
18. *Aspidisca costata*	0	0	1	1	1
19. *Aspidisca lynceus*	0	0	1	1	0
20. *Aspidisca sp.*	0	1	0	1	0
21. *Astasia klebsii*	0	1	1	1	1
22. *Balanbidium coli*	1	0	0	0	0
23. *Bodo caudatus*	0	0	0	1	0
24. *Campanella umbellaria*	1	0	1	1	1
25. *Carteria globosa*	0	0	0	0	1
26. *Centropyxis sp.*	1	0	0	0	0
27. *Chilodonella cucullulus*	0	1	1	1	1
28. *Chilodonella sp.*	1	1	1	0	1
29. *Chilodonella uncinata*	1	0	0	1	1
30. *Chilophrya sp.*	0	0	1	0	0
31. *Chilorhyrya utahenisis*	0	0	1	0	0
32. *Chitomonas peramecium*	0	0	0	1	0
33. *Chlamydomonas angulosa*	1	1	1	1	0
34. *Chlamydomonas cingulata*	0	0	0	0	1
35. *Chlamydomonas sp.*	0	1	0	0	1
36. *Chlorogonium euchlorum*	0	0	0	1	0
37. *Chromulina globusa*	0	0	0	0	1
38. *Cinetochilum margaritaceum*	0	0	1	1	1
39. *Clathrulina elegans*	0	0	0	0	1
40. *Coleps hirtus*	0	0	0	1	0
41. *Coleps octaspinus*	0	0	1	0	1
42. *Coleps sp.*	1	1	1	1	1

Table 2 (Continued)

Species	Periods				
	1	2	3	4	5
43. Colipidium clopoda	0	0	1	0	1
44. Colpoda cucullus	1	1	1	1	0
45. Conchophthirus anoclontae	0	0	0	1	0
46. Cothurnia variabilis	0	0	0	1	0
47. Cryptomonus ovata	0	1	0	1	0
48. Cryptomonus sp.	0	1	0	1	0
49. Cyclidium glaucona	0	0	1	1	1
50. Cyclidium sp.	1	1	1	1	1
51. Didinium baldianii	0	0	0	1	0
52. Didinium nasutum	1	1	1	0	0
53. Didinium sp.	1	0	1	1	1
54. Difflugia acumenata	1	0	0	0	0
55. Difflugia oblonga	1	0	0	0	0
56. Difflugia sp.	0	0	0	0	1
57. Difflugia tobostoma	1	0	1	1	1
58. Dileptus anser	1	0	1	0	0
59. Enchelydium sp.	0	0	0	0	1
60. Endosphaera engelmanni	0	0	1	1	0
61. Entameba histolytica	1	0	0	0	0
62. Entosiphon sulcatum	1	1	1	1	1
63. Epalxella mirabilis	0	0	0	1	0
64. Epistylis chrysemedis	0	0	1	0	0
65. Epitylis cambari	0	0	1	1	0
66. Epitylis chrysemedis	0	0	1	0	0
67. Epitylis niagarae	0	0	0	1	0
68. Epitylis plicatilis	0	0	0	0	1
69. Euglena acuminata	0	1	0	0	0
70. Euglena acus	0	1	1	1	1
71. Euglena chrenbergii	1	1	1	1	1
72. Euglena cyclopicola	0	1	1	1	1
73. Euglena deses	0	0	1	1	1
74. Euglena gracilis	0	0	0	0	1
75. Euglena polymorpha	0	1	1	1	1
76. Euglena rostrifera	0	1	1	1	1
77. Euglena rubra	0	1	1	1	1
78. Euglena sp.	1	0	1	1	1
79. Euglena spirogyra	0	0	1	1	0
80. Euglena tripteris	1	1	1	1	1
81. Euplotes acdiculatus	0	1	0	0	0
82. Euplotes patella	1	1	1	1	0
83. Euplotes sp.	0	1	1	1	0
84. Frontonia leucas	0	1	0	0	0

Table 2. (Continued)

Species	Periods				
	1	2	3	4	5
85. Frontonia sp.	0	0	1	0	0
86. Glaucona scintillans	0	1	1	1	0
87. Gonium pectorale	1	1	0	0	0
88. Halteria grandinella	0	1	0	0	0
89. Holophrya simplex	1	1	1	1	1
90. Kahlia acrobates	0	0	0	1	0
91. Karona polyporum	0	0	1	0	0
92. Lacrymaria magnus	1	0	0	0	0
93. Lacrymaria olar	1	0	0	1	1
94. Lacrymaria vior	1	0	0	0	0
95. Leucophrys patula	0	1	1	1	0
96. Litonotus fasciola	1	1	1	1	1
97. Litonotus lamella	1	1	1	1	0
98. Litonotus sp.	0	0	1	0	1
99. Loxocephalus plagius	0	0	0	0	1
100. Loxodes magnus	1	0	0	0	0
101. Loxodes vorax	1	0	1	1	0
102. Metopus es	0	0	1	1	1
103. Metopus sp.	0	0	1	1	0
104. Nassula aurea	1	1	1	1	1
105. Nassula ornata	0	1	1	0	1
106. Nyctotherus cordeformis	0	0	0	1	0
107. Onychodromus grandis	0	0	0	0	1
108. Oxytricha befaria	0	0	1	0	0
109. Oxytricha fallax	0	0	1	1	0
110. Oxytricha sp.	0	1	1	1	1
111. Paramecium aurelia	0	1	0	1	1
112. Paramecium caudatum	0	0	1	0	0
113. Paramecium multimicronucleatum	1	0	1	0	0
114. Paramecium sp.	1	0	1	0	1
115. Paramecium trichium	1	1	1	1	1
116. Pardorina morum	0	1	0	1	1
117. Pelomyxa paulstris	0	0	1	0	0
118. Peranema sp.	0	0	1	0	1
119. Peranema trichophorum	0	1	1	1	0
120. Phacus acuminata	1	1	1	1	0
121. Phacus longicauda	1	1	1	1	1
122. Phacus pleuronectes	1	0	1	1	1
123. Phacus pyrum	0	0	0	1	0
124. Phacus quirquemargimatus	0	0	0	1	1
125. Phacus sp.	0	1	1	1	0
126. Phacus torta	0	0	0	1	0

Table 2 (Continued)

Species	Periods				
	1	2	3	4	5
127. Phacus warszenrizii	1	0	1	1	1
128. Pleodorina illinoisemsis	0	0	0	1	0
129. Pleuronema coronatum	0	1	0	0	0
130. Podophrya fira	1	0	0	0	1
131. Podophrya sp.	0	1	0	0	0
132. Spanaotoma sp.	0	0	1	0	0
133. Spathidium spathula	1	0	0	1	0
134. Spirostomum intermedium	1	0	0	0	0
135. Spirostomum minus	0	1	0	0	0
136. Spirostomum teres	0	0	0	1	0
137. Stentor coerucleus	0	0	1	1	1
138. Stentor igneus	0	1	0	0	0
139. Stentor mulleri	0	0	0	1	0
140. Stentor rveseli	0	0	1	0	0
141. Stentor sp.	0	1	1	1	1
142. Sticotrica aculeata	0	0	0	1	1
143. Stylonychia complenata	0	1	0	0	0
144. Stylonychia mytilus	0	1	1	1	0
145. Stylonychia pustulata	0	0	1	0	0
146. Synura uvella	0	0	0	1	1
147. Tetrahymena geleii	1	0	1	0	0
148. Tetrahymena pyrifomis	0	0	1	0	0
149. Tillina magna	0	1	0	0	0
150. Trachelomonus armata	0	0	0	1	0
151. Trachelomonus conifer	0	0	0	1	0
152. Trachelomonus hispida	1	1	1	1	1
153. Trachelomonus honida	0	0	0	1	1
154. Trachelomonus sp.	0	1	1	1	0
155. Trachelomonus urceolata	1	1	1	1	1
156. Trachelomonus volvocima	0	1	1	0	1
157. Urceolaria mitra	0	0	0	1	0
158. Urocentrum turbo	1	0	0	0	0
159. Uroleptus piscis	0	0	0	1	0
160. Uroleptus sp.	1	0	0	1	0
161. Uronema griseolum	0	0	0	1	1
162. Urosoma sp.	0	1	0	0	0
163. Volvox sp.	1	0	0	0	0
164. Vorticella carpanula	0	0	0	1	0
165. Vorticella sp.	1	1	1	1	1

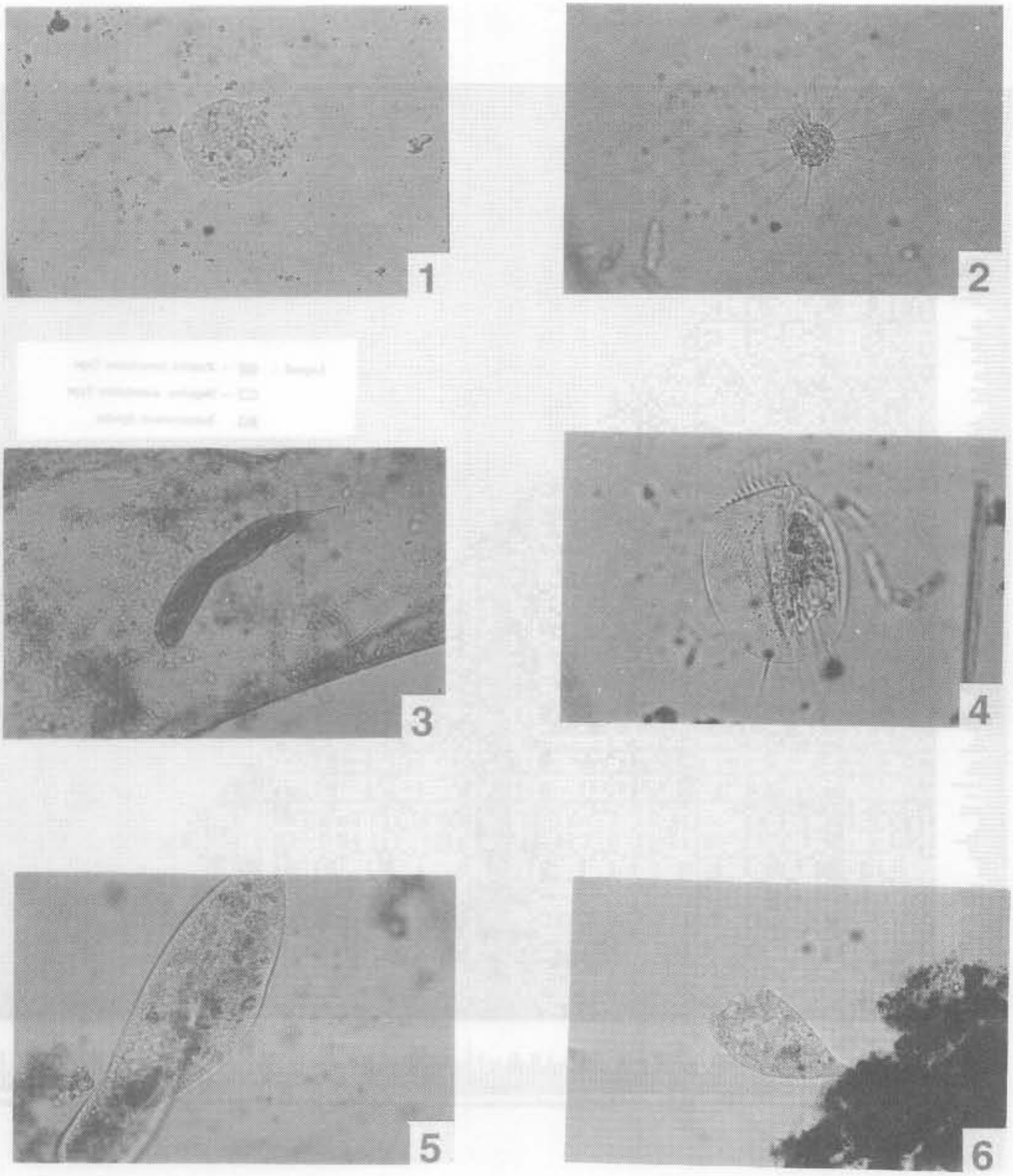

Fig. 2. Typical species of protozoa in Thammasat University, Rangsit campus.

1. *Amoeba* sp. 2. *Actinophrys* sp.
3. *Euglena* sp. 4. *Euplotes* sp.
5. *Paramecium* sp. 6. *Vorticella* sp.

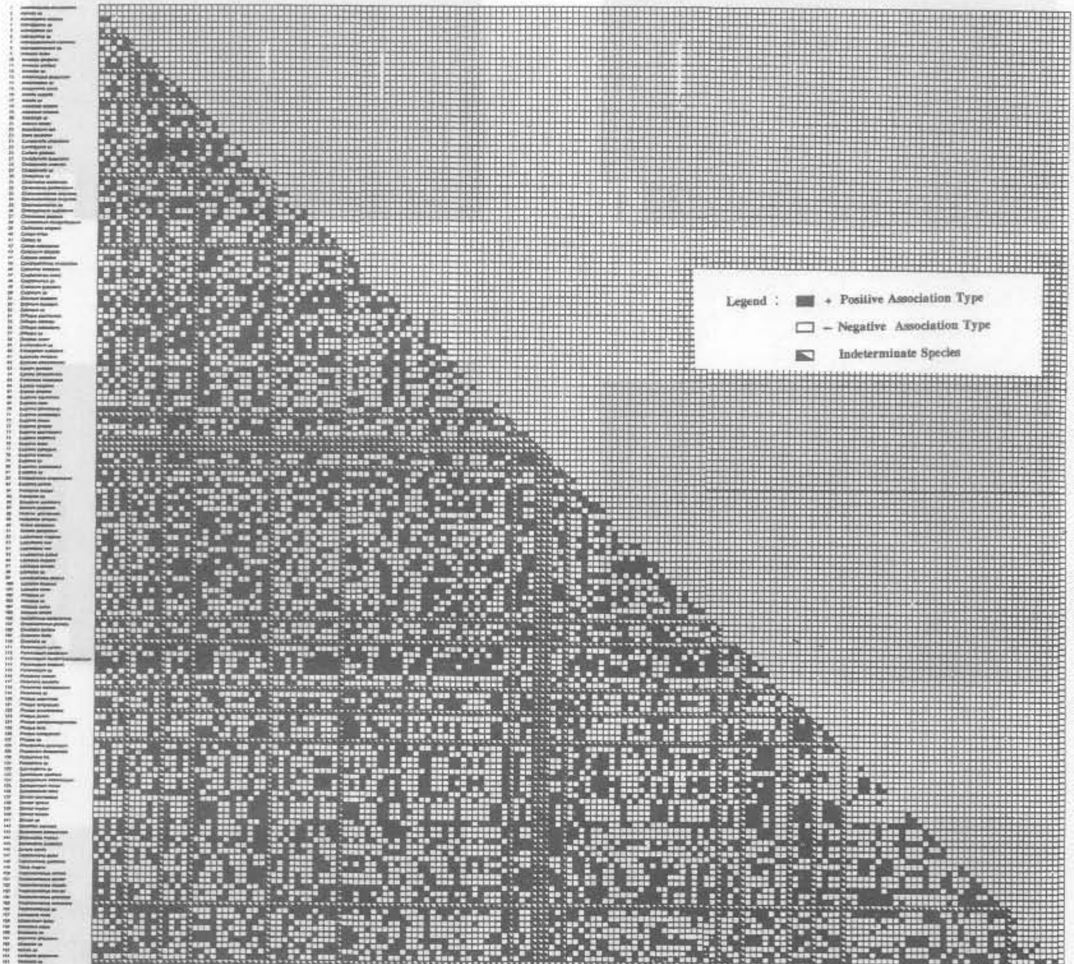

Fig. 3. Interspecific association species type at eight (8) stations sampling units.

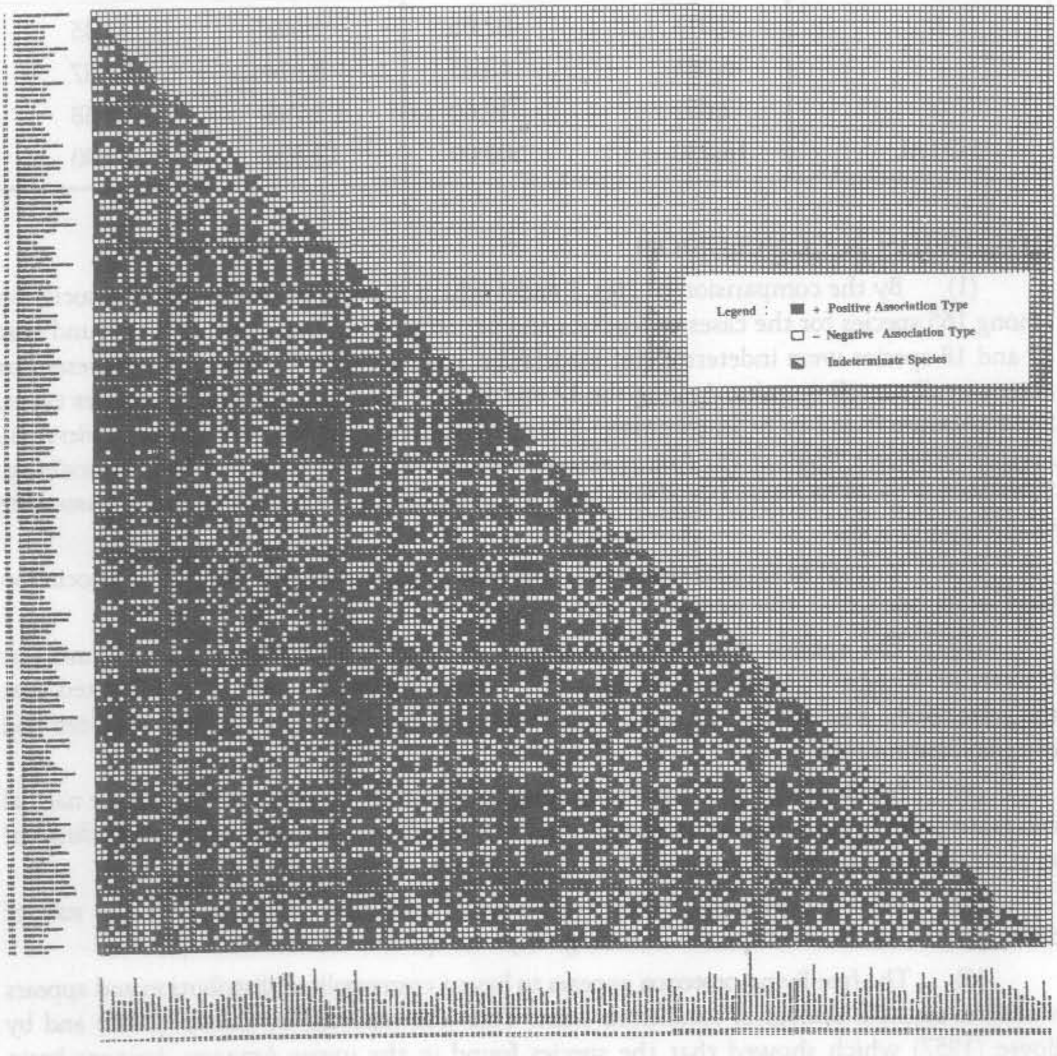

Fig. 4. Interspecific association species type over five (5) periods sampling units.

TABLE 3. Number of pairs and precentage of Interspecific Association type for the cases of stations and periods sampling units.

Interspecific Association type	Stations		Periods	
	No. Pairs	%	No. Pairs	%
+	5,013	37.05	5,608	41.45
-	5,865	43.35	5,124	37.87
0	2,652	19.60	2,798	20.68
TOTAL	13,530	100.00	13,530	100.00

DISCUSSION & CONCLUSION

(1) By the comparision of Figs. 3 and 4 which showed the interspecific association among 165 species for the cases of stations and period (s) sampling units, it was found that 17 and 18 species were indeterminant association species types (0) ,which were present or absent in all sampling units. Among the 17 and 18 indeterminant association species types, 8 species were found to be in common. These were *Actinophrys* sp. , *Amoeba* sp., *Coleps* sp., *Euglena cyclopicola*, *Euglena* sp., *Phacus pleuronectes*, *Trachelomonas volvocina*, and *Vorticella* sp. Such species could be present or absent in any station at any period which did not associate with other species.

(2) It could be noticed that many species of *Euglena* appeared positive in association with other species at any period of time.

(3) The species diversity as indicated by protozoa community in Thammasat University, Rungsit campus was found to be relatively high in value. This indicated that the water body was rich in nutrients. Also, this water body was in a state of stabilized and complex community.

(4) Polyurethane foam used as an artificial substrate was effective to replace natural substrate since it could be controlled in a natural condition with the resulted findings of as many as 165 species of protozoa.

(5) Most of protozoa found were ciliated protozoa which played the role of decomposer and detritus species including *Euplotes* sp. and *Paramecium* sp. .

(6) The free-living protozoa appears to have a cosmopolitan distribution and appears wherever suitable ecological conditions exist. This was reported by Cairns (1966) and by Bovee (1957) which showed that the species found in the upper Amazon drainage basin were similar to those found in the Savannah River basin in the United States which were under similar ecological environment.

In this connection, protozoa species commonly found in Mesosaprobic and water bodies as reported by Farmer (1980) in the United States was also found in this study. These protozoa species were *Euplotes* sp., *Colopoda* sp., *Cyclidium* sp., *Paramecium* sp., *Coleps* sp. and *Vorticella* sp. This could be concluded that the water body in Thammasat University, Rungsit campus was mesosaprobic to polysaprobic.

TABLE 4. Shannon-Weiner Diversity Index.

Stations	Shannon-Weiner Diversity Index : H'					Max	Min	Mean	Standard Deviation (SD)
	Periods								
	1	2	3	4	5				
1. Oxidation treatment pond	0.90	1.25	1.43	1.43	1.42	1.43	0.90	1.288	0.20
2. Female Student Dormitory	1.22	1.13	1.29	1.59	1.44	1.49	1.13	1.334	0.11
3. Canteen	1.06	1.20	1.51	1.51	1.37	1.51	1.06	1.330	0.18
4. Institute of East Asean Studies	0.68	1.25	1.36	1.39	1.29	1.39	0.68	1.194	0.26
5. University Administrative Building	0.44	1.27	1.22	1.40	1.21	1.40	0.44	1.108	0.04
6. Lecture Building 1	0.76	1.28	1.33	1.62	1.39	1.62	0.76	1.276	0.28
7. Research and Academic Service Building	1.38	1.39	1.33	1.51	0.93	1.51	0.93	1.308	0.20
8. Central Library	0.70	1.22	1.31	1.60	1.26	1.60	0.70	1.218	0.29

(7) Other study on protozoa species in Thailand was reported by Jarupun B. and Jarupun N. (1989). Their study area is in the Bung Makasan swamp in the cosmopolitan area of Bangkok, Thailand. A total of 74 protozoa genera were found mostly to be bacteria feeder and detritivore. These protozoans played an active role in self-purification of water. However, there was no report on species diversity.

(8) It could therefore be concluded from this study that protozoa communities in different areas of Thammasat University, Rungsit campus were not made up of different aggregation of protozoa species. In further study it is proposed to extend the study area outside Thammasat University, Rungsit campus in order to see the impact of different habitat on structure of protozoa communities.

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บทคัดย่อ

การศึกษานี้พยายามที่จะเน้นถึงการศึกษาโครงสร้างของชุมชนโปรตัวซัวและการจัดรูปแบบโครงสร้างของชุมชน การเก็บตัวอย่างได้ใช้ที่ยึดเกาะเทียมธรรมชาติผูกไว้ในคูน้ำ บ่อน้ำ และบ่อบำบัดภายในมหาวิทยาลัยธรรมศาสตร์ ศูนย์รังสิต ซึ่งจัดว่าเป็นพื้นที่ชานเมืองในภาคกลางของประเทศไทย เพื่อให้โปรโตซัวยึดเกาะที่ยึดเกาะเทียมธรรมชาติที่ว่าเป็นโพลียูริเทนโฟม ซึ่งพบว่ามีโปรโตซัวถึง 165 ชนิดพันธุ์ 87 สกุล แล้วนำมาวิเคราะห์ค่าความสัมพันธ์ระหว่างชนิดพันธุ์ โดยใช้ 2 x 2 ค่า chi-square ทั้งสิ้น 13,530 คู่ พบว่าหากพิจารณาตัวแปรจากสถานีที่เก็บตัวอย่าง มี 37.05 %, 43.35 % และ 19.60 % เป็นความสัมพันธ์แบบ (+), (-) และ (0) ตามลำดับ ทำนองเดียวกันกับเมื่อแปรตามเวลาที่เก็บตัวอย่าง มี 41.45 %, 37.87 % และ 20.68% ตามลำดับเช่นกัน ซึ่งพวกที่มีความสัมพันธ์แบบ (0) จะเป็นชนิดพันธุ์ที่พบว่า อาจจะพบหรือไม่พบเลยในทุกสถานีที่เก็บตัวอย่าง ส่วนการวิเคราะห์ค่าการแพร่กระจายหรือความหลากหลายนั้น จากค่าดัชนีความหลากหลายของ Shonnon-Weiner ในทุกสถานีตลอดการศึกษา พบว่ามีค่าเฉลี่ยอยู่ในช่วงระหว่าง 1.108 ถึง 1.334 และมีค่าความเบี่ยงเบนมาตรฐานอยู่ระหว่าง 0.11 ถึง 0.34 และพบที่มีค่าความเบี่ยงเบนมาตรฐานมากที่สุดในแหล่งน้ำที่เป็นบ่อใหญ่ ท้ายสุดสามารถสรุปได้ว่า จากการศึกษานี้พบว่า การแพร่กระจายและการจัดรูปแบบของชุมชนโปรโตซัวนี้ไม่มีความแตกต่างกันในสถานที่อยู่ที่แตกต่างกัน อย่างไรก็ดีควรที่จะมีการศึกษาเพิ่มเติมในอนาคตเพื่อดูผลกระทบต่อการแพร่กระจายในสถานีที่ห่างออกไปนอกมหาวิทยาลัยธรรมศาสตร์