vibrios in pond sediment increased during grow-out as temperature and input of feed increased. A maximum *V. parahaemolyticus* count of 3.7 $x10^3$ cfu ml^{-1} in water, 5.5 $x10^3$ cfu g^{-1} in sediment and 1.9 $x10^2$ cfu g^{-1} in shrimp was noted on the 150^{th} day of culture from shrimp culture environments by Dalmin et al. [35]. A maximum *V. parahaemolyticus* count in sediment at 150^{th} day of culture ($5.5x10^7$ cfu g^{-1}) and the minimum at 25^{th} day of culture ($1.3 x10^7$ cfu g^{-1}) was noted in an aquaculture pond by Anand Ganesh et al. [36]. These are in conformity with the present observations.Decomposition of excess feed and algal die-off result in proliferation of vibrios [37]. High organic load in modified extensive culture system is also known to increase *Vibrio* count [38]. In the present study, in both systems distribution of *V. parahaemolyticus* showed an increasing trend with increase in salinity. Influence of salinity on the survival of *V. parahaemolyticus* is well documented [39] [40]. *V. parahaemolyticus* from Tuticorin coastal environments, was isolated more frequently during summer; its density declined during monsoon season [41]. While studying the microbial quality and physicochemical parameters of a brackishwater shrimp culture pond, Sanjeev [11] observed that salinity varied from 1.83 to 24.58‰ and that *V. parahaemolyticus* count of water was the maximum during February to April when salinity was high and it was absent from July to November, when the salinity of water was minimum. Vibrios are autochthonous to saline water and hence the recovery of *Vibrio* spp. in both water and sediment from brackishwater ponds is quite natural [42]. In Cochin backwaters [43] and in Abu Dhabi coastal waters [44], the maximum bacterial count was noted during warmer months. So also did in extensive aquaculture ponds adjacent to Cochin backwaters [42], in Cochin backwaters [45], in old port, Bhavnagar coast [46] and in El-Qanatar fish farm, Cairo [33]. It is noteworthy here that, living conditions remaining favourable, microorganisms will quickly multiply during summer. The present results are in agreement with the foregoing.

4. Conclusion

V. parahaemolyticus is a human pathogen of marine origin and can be found in water, sediments, plankton, finfish and shellfish of coastal and estuarine environments and it is known to cause diarrhoea, gastroenteritis, wound infection, ear infection and secondary septicaemia in humans. Presence of this pathogen in substantial quantities in all three compartments (water, sediment and shrimp) of both extensive and modified extensive shrimp culture ponds, must be reckoned as a warning signal on the environmental deterioration of such ponds and on the high likelihood of precipitation of shrimp and human health hazards. Measures should be taken by the aquaculturists to maintain good microbial quality of ponds as their product being handled and consumed by mankind.

Table 1: Mean microbial load (given as bacterial count) in the three compartments, water (cfu ml-1), sediment (cfu g-1) and shrimp (cfu g-1) and shrimp (cfu g-1) and percentage distribution of various microbial loads in three compartments of extensive and modified extensive shrimp culture systems during three seasons of shrimp culture operation.

Bacterial Counts	Compartments	Extensive System				Modified Extensive System			
		Pre-monsoon	Monsoon	Post- monsoon	Mean	Pre- monsoon	Monsoon	Post- monsoon	Mean
V. parahaemolyticus	Water (cfu ml^{-1})	197	171	228	196	896	181	922	618
	Sediment (cfu g^{-1})	3217	2038	2725	2598	46463	3103	5788	16916
	Shrimp (cfu g^{-1})	136	46	95	88	163	85	117	118
		Extensive System				Modified Extensive System			
V. parahaemolyticus (%)	Water	5.5	7.6	7.5	6.7	1.9	5.4	13.5	3.5
	Sediment	90.6	90.4	89.4	90.1	97.8	92.1	84.8	95.9
	Shrimp	3.8	2.1	3.1	3.1	0.3	2.5	1.7	0.6

Table 2: Results of correlation analysis showing *r* values comparing various *V. parahaemolyticus* loads in water with hydrographical parameters of extensive (N = 20) and modified extensive (N = 40) shrimp culture system.

Exensive culture system			Modified extensive system		
Water	Sediment	Shrimp	Water	Sediment	Shrimp
0.107	0.071	0.08	-0.163	-0.057	-0.024
-0.138	-0.277	-0.348	-0.133	-0.071	-0.131
0.591#	0.540*	0.653#	0.246	0.019	0.144
-0.323	-0.382	-0.361	-0.159	-0.255	0.038
0.328	0.369	0.529*	0.189	0.341*	0.062
0.325	0.3	0.477*	0.223	0.139	0.159
0.355	0.362	0.296	0.448#	0.255	0.323*
0.151	0.104	0.218	-0.087	-0.072	0.024
0.395	0.428	0.634#	0.362*	0.11	0.216
0.426	0.479*	0.719#	0.375*	0.15	0.254
0.466*	0.395	0.559*	0.232	-0.055	0.065
0.127	0.276	0.472*	0.196	0.141	0.285
-0.137	0.239	0.193	0.034	0.081	0.148
0.18	0.225	0.454*	0.237	0.146	0.3
0.583#	0.557*	0.41	0.061	0.084	-0.173
-0.249	-0.212	-0.197	0.306	0.066	0.266
-0.312	-0.429	-0.342	-0.118	-0.202	-0.162
-0.04	-0.064	0.126	0.176	-0.009	0.082
0.467	0.41	0.605#	0.031	-0.076	0.17
***P* < 0.05; #*P* < 0.01**					

Table 3: Results of correlation analysis showing r values comparing V. parahaemolyticus loads with sedimentological parameters of extensive (N = 20) and modified extensive (N=40) shrimp culture system

	Extensive System			Modified Extensive System		
Compartments	Water	Sediment	Shrimp	Water	Sediment	Shrimp
Temp.	0.227	0.272	0.336	-0.027	0.029	0.16
pH	-0.393	-0.322	-0.246	-0.134	-0.025	-0.404*
OC	-0.129	0.152	0.091	-0.148	-0.055	-0.013
Sand	-0.302	-0.263	-0.525*	-0.394*	-0.267	-0.351*
Clay	0.537*	0.351	0.590#	0.136	-0.062	0.061
Silt	0.244	0.232	0.481*	0.397*	0.297	0.364*

* *P* < 0.05; # *P* < 0.01

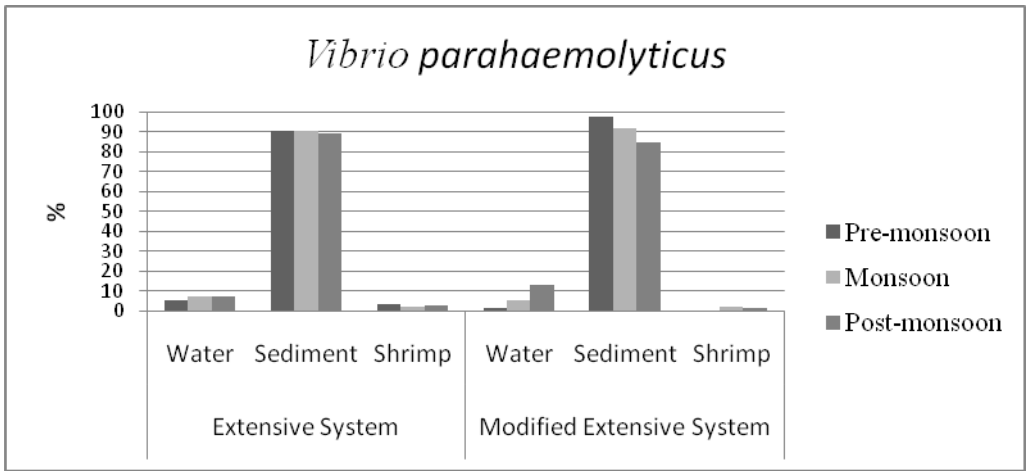

Figure 1: Seasonal variation in *V. parahaemolyticus* distribution in extensive and modified extensive *Penaeus monodon* culture systems

5. Acknowledgements

We are thankful to the Department of Aquatic Biology and Fisheries, University of Kerala, Kariavattom, for providing necessary laboratory facilities. The first author acknowledges with thanks the financial support for this study from the University of Kerala, India.

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