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## ENVIRONMENTAL WELLNESS WITH SPECIAL REFERENCE TO HAEMATOZOAN INFECTION IN REPTILIAN HOSTS

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**ABSTRACT:** Environment provides a solid platform for good health. An unhealthy environment makes place unsafe for wild animals. One of the effects is a parasitic load on these animals, as a high degree of parasitization may cause harm to the health of these animals. In the present research work, blood parasitic infestation in two species of lizards, *Hemidactylus flaviviridis* and *Calotes versicolor* were investigated and it was observed that lizards from the highly polluted area were infested with high parasite load that ultimately caused harm to these animals which biologically constitute an important part of the food chain. The intensity of blood parasites (*Hepatozoon* and *Plasmodium*) in lizards from different habitats was studied and it was observed that highly polluted areas (Mirzapur) had a high incidence of the parasites. It is known that Mirzapur is more polluted than Bareilly and Chandausi, the other sites selected for investigation. Parasites are regarded as indicators of pollution. To make the environment healthy and peaceful, positive energy and healthy habitats can contribute to a better environment.

**INTRODUCTION:** There are many risk factors of environment such as air, water and soil pollution, chemical exposure, climate change and ultraviolet radiation which are sources of many diseases. Environmental wellbeing includes well-known aspects of a viable and nonviable diverse ecosystem. This maintains a way of life that maximizes harmony with the earth and minimizes harm to the environment. The environment plays a very important role in maintaining the life of organisms living on earth. Good interaction with the environment makes life easy and long.

The benefit of environmental health includes a very good biological, physical, chemical, social and cultural interaction with nature, which provides a clean, safe, healthy, hygienic and peaceful surroundings. One of the benefits of environmental wellness is to prevent disease which is common due to unhealthy environmental conditions like malaria, dengue, typhoid, diarrhoea.

Good and pollution-free environment helps to save the life of wildlife animals too. In the case of pollution and habitat loss, wildlife affects the biodiversity of wild animals. The concept of wellness was developed to define the overall sense of wellbeing which is dependent on the environment and encompasses health <sup>1</sup>. This reinforces us to live in harmony with the earth by taking action to protect it. Environmental wellness includes the safety of food and water supply, prevention from infectious diseases, violence in

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society, ultraviolet radiation, air and water pollution. This encourages us to live a lifestyle that is respectful of our surroundings. The core foundation of environmental wellness is respect for nature and all species living in our environment. WHO's assessment gives an idea about many risk factors such as air, water and soil pollution, chemical exposure, climate change and ultraviolet radiation, which commit more diseases and injuries.

In an unhealthy environment, humans and other creatures cannot thrive well. The healthy and clean environment provides safety for wildlife also. Parasites make the environment unhealthy and are even more important as they affect their immediate environment (micro-environment) as well as the environment of the host (macro-environment). This necessitates awareness about parasitic infectivity and environmental factors<sup>2</sup>. Environmental wellness makes an important impact on one's surroundings<sup>3</sup>. Wellness has been characterized as research and practice-oriented which can identify the causes of wellness rather than causes of illness<sup>4</sup>. The individual's relationship is described with nature and community resources<sup>5</sup>. Pollution can cause sub-lethal physiological stress for the host and hence reduce their capacity to withstand parasite proliferation potentially increasing the infection level indirectly. Environmental conditions make an important impact on the host's survival and wellbeing, but these effects can be different for different parasitic life cycles. An intimate interaction was reported between environmental conditions and parasitism which is highly vulnerable<sup>6,7</sup>.

Light pollution can impact the structure and function of the ecosystem via cascading effects and natural light controls both, relevant parasite life-history traits and intermediate host behaviors, which is seen in a higher incidence of Leishmaniasis and Malaria in some regions<sup>8,9</sup>. In India, around 12.4 lakh deaths in 2017 are attributable to air pollution. The country faces different forms of pollution at its major environmental issue and is more vulnerable to the effect of climate change being a developing nation. India has a law protecting the environment and is one of the countries that signed the convention on Biological Diversity Treaty. Sustainable lifestyle

protects natural resources, eliminating pollutants and excessive waste thereby including the respect and awareness of surroundings. Environmental wellness not only includes places where we live and work but it also relates to relationships we have with nature, physical possessions and buildings.

**MATERIALS AND METHODS:** The present studies were undertaken to observe the correlation of environmental wellness and haematozoan (*Plasmodium indica*<sup>10</sup> and *Hepatozoan lacertilis*<sup>11</sup>) infection in two species of lizards. The reptilian hosts, *Hemidactylus flaviviridis* (Family: Gekkoidea n = 359) and *Calotes versicolor* (Family: Agamidae n = 54) were collected from various localities of Bareilly and also from nearby areas of Chandausi and Mirzapur. The hosts were collected and maintained in cages in the laboratory. Blood parasites were observed by hanging drop preparations and their infectivity was recorded. Blood films were used for studies on diagnostic, taxonomical, morphometric, intensity and incidence of haemoparasites. Blood films were prepared, allowed to air dry, fixed in 10% buffered formalin or methanol and then air-dried again prior to staining with Giemsa, Leishman or Giemsa-eosin-methylene blue and buffer of pH 7.2 in the ratio of 1:7, for 1 h. The slides were mounted in DPX and observed under oil immersion objective. The entire work was conducted in the Department of Animal Science, M.J.P. Rohilkhand University, Bareilly, India.

**Why Contemplate Parasites:** Parasites are likely the most abundant life forms on earth and major ecosystem components<sup>12, 13</sup>. Host and their parasites are strongly influenced by the environment. Parasites are considered to be important bio-indicators having an influential environmental impact. Bio-indicators are organisms which manifest changes in physiology or chemical composition occurring due to habitat alterations. Exposure to pollutants at different levels of organization from the sub-cellular to the ecosystem level can be measured by these bio-indicators. Parasites are very important as indicators because their life cycles are adapted to repetitive seasonal patterns and co-evolved predator-prey relationships<sup>14</sup>. Parasites are important components of the ecosystem which play an important role in population dynamics and

community structure. They provide important information on environmental stress, food web structure and function and are involved in environmental degrading. Parasites may affect hosts in multifarious ways such as behaviorally, physiologically, morphologically or reproductively<sup>15</sup>. These are also the cause of host mortality and regulate host population<sup>16</sup>. They play an important role in structuring the ecological communities<sup>17, 18</sup>. Ecosystem stability is regulated by parasites<sup>19</sup>. Half of all biodiversity might comprise of parasitic species<sup>20</sup>. Parasites shape the community, ecosystem and ecology. As parasitic species diversity increases, ecosystem functioning improves<sup>21</sup>. Parasites can affect biodiversity and alter the taxonomic and functional structure of communities by affecting host phenotype, reducing host abundance and altering species richness and evenness<sup>22</sup>. Parasites are considered to be the food resource for non-host species<sup>23</sup>.

Many host-specific parasites maintain a community rich in host species which ultimately increases the parasite abundance<sup>21</sup>. This diversity and abundance of parasites reflect the diversity and abundance of a community of hosts. Climate change influences the structure and species composition of the entire ecosystem. Ecological disturbances result in host distribution, water levels, eutrophication, stratification, ice cover, acidification, oceanic currents, ultraviolet radiation, extreme weather and human interference<sup>24</sup>. Two important factors, pollution and stress, govern the species richness of parasites. Considering environmental wellness, it affects the balance of parasite and host.

Parasites are always neglected in studies on population and communities of organisms although they can have a noticeable effect on hosts affecting their behavior, growth, fecundity and mortality. Due to the unhealthy environment parasites increase in that area, causing a decline in the host population.

**RESULTS AND DISCUSSION:** In our studies, it was observed that habitat of the hosts may act as an important factor for assessing the prevalence and intensity of blood parasites in reptilian hosts, the variance in infectivity may be due to different factors as each habitat is typified by its own fauna and environmental conditions. Parasites influence the community structure as a whole. During the present investigation, it was observed that the malarial parasites *Plasmodium indica*<sup>10</sup> and Apicomplexan *Hepatozoon lacertilis*<sup>11</sup> infected the lizards of Mirzapur more frequently as compared to Bareilly and Chandausi, the other sites of investigation, indicating the effect of pollution on the species richness of that region. *Plasmodium indica* occurred at a prevalence of 2.70% at Mirzapur and the intensity was 1 par/500RBC's in *Hemidactylus flaviviridis*. In other sampling sites, Plasmodium was not recovered from the lizards *H. flaviviridis* and *C. versicolor*. *Hepatozoon lacertilis* was recorded at 16.21% in *Hemidactylus flaviviridis* whereas the prevalence was also higher (19.04%) in *C. versicolor* from Mirzapur.

The intensity was 1-2 par/500RBC's whereas prevalence was only 5.29% in Bareilly. Chandausi was depauperate in blood parasites.

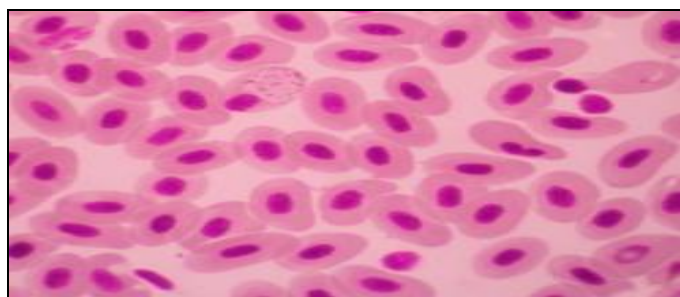


FIG. 1: PHOTOMICROGRAPH OF *PLASMODIUM INDICA*

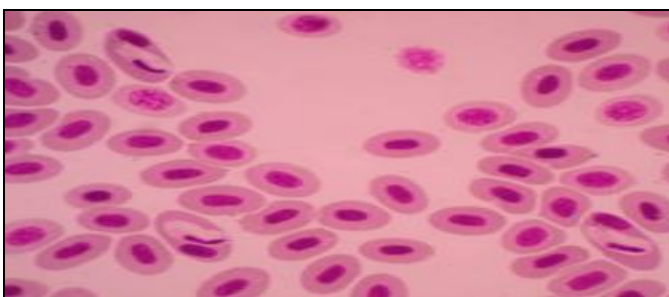


FIG. 2: PHOTOMICROGRAPH OF *HEPATOZOON LACERTILIS*

Being ectothermic, the physiological processes of reptiles are superintended by ambient temperature. Heavily infested lizards are unable to sustain in the environment easily. These parasites affect the

health of lizards, which interrupts biodiversity. Parasites play a fundamental role in natural communities by controlling population numbers as they are the causative agents of many diseases. But

parasites make a balance in the ecosystem and indulge in activities that maintain biodiversity. Environmental factors have controlling system on the availability of parasites. It could be concluded that the Mirzapur site has a higher load of blood parasites and it was considered to be more polluted at the time of the investigation. There are numerous reports on the effects of anthropogenic induced environmental perturbations on parasitic organisms at both the populations and community level<sup>25, 26, 27</sup>. Environmental stressors, domestic and industrial sewage, eutrophication, acidification, pulp mill effluents, pesticides, thermal stress, hydrological changes, urban development and ultraviolet light are the main causes of disturbing biodiversity.

The effect of environmental stress on a single species of the parasite was also examined by numerous investigators<sup>25, 28, 29, 30</sup>. The population of individual parasite species may increase or decrease when exposed to environmental stress. Parasites accumulate when the host's resistance is compromised under stressful conditions. Environmental stress can increase the parasite number if it promotes host susceptibility or increases host density and thereby also affects transmission potential<sup>29</sup>. The host's immune system has been supervised by changing environmental conditions. Parasites are considered to be more sensitive indicators of environmental degradation as compared to their hosts.

Parasites reflect environmental impact because they respond to habitat alterations with changes in physiology and chemical composition. It is widely known that habitat procreates a large impact on parasites. It was documented that prevalence and infection load of blood parasites were higher in high elevation deteriorated habitat whereas prevalence and infection load of ticks showed a reverse pattern<sup>31</sup>. In the role of bioindicators, they measure the pollutants at different levels of organizations and are useful pollution indicators. They are influential in maintaining host diversity. These can affect population viability by causing death or increasing susceptibility to predators or other stressors<sup>32</sup>.

It was inscribed that parasitism should be investigated and correlated with environmental conditions<sup>27, 32</sup> as they are necessary for host

survival but these are also exceptionally important for parasites. Interaction of environmental conditions with parasitism was emphasized and underlined that this association is eminently susceptible<sup>7</sup>. It was concluded that they are sensitive to free-living species diversity and some can be useful as bio-indicators of ecosystem degradation and recovery<sup>33</sup>. A healthy functioning and resilient ecosystem are always rich in parasitic species<sup>21, 24</sup>. Many parasites regulate the host population, which is evidenced through an effect on coexistence, competition, predation and herbivory that help in maintaining diversity in the system<sup>34</sup>. Habitat plays an important role in tolerating diseases. The acquaintance of global decline in biodiversity, particularly reptiles and amphibians, advocated that research can be focused to resolve a mechanism that transmits the idea to figure out the role of parasite in ecology<sup>35</sup>.

The present study investigated the consequences of pollutants and concurrently occurring parasites. This gives importance to parasites in indicating environmental pollution. They respond to ecosystem disturbances and can provide valuable information about a system's quality, integrity and health in response to pollutants and other stressors.

The present investigation draws attention to the integration of different trophic levels present in the environment, which makes them an important indicator of environmental pollution.

**CONCLUSION:** From the present investigation, it was concluded that the parasitic species composition is affected by environmental stress. The species richness increases under stressful conditions as pollution increases, which increases the community of parasites. Disturbances in ecosystem makes parasites authoritative organisms which are employed as bio-indicators for any polluted site.

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