

Brief Report on Top-10 Human Associated Protozoans in Pakistan

Fazal Akbar¹, Jan Khan¹, Tauqeer Rahman¹, Akhtar Rasool¹,
Muhammad Israr², Naseer Ullah³, Muzafar Shah^{3*}

¹Center for Biotechnology and Microbiology, University of Swat, Pakistan.

²Department of Forensic Sciences, University of Swat, Pakistan

³Center for Animal Sciences and Fisheries, University of Swat, Pakistan

*Corresponding Author: Muzafar Shah, Center for Animal Sciences and Fisheries, University of Swat, Pakistan.

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et al.

Abstract

This study was carried out as a scientific survey to evaluate the "Top-10" most important protozoa in the context of their relationship with general population in Pakistan. Pathologists were contacted and asked them to nominate which human associated protozoa they would like to place in "Top-10" based on their scientific importance. This generated 207 votes from the relevant researchers in Pakistan for "Top-10" human associated protozoa. The "Top-10" list in rank order included: (1) *Entamoeba histolytica* (25.44%) (2), *Plasmodium vivax* (19.80%), (3) *Giardia lamblia* (21.33%), (4) *Plasmodium falciparum* (10.62%), (5) *Leishmania* (8.53%), (6) *Trichomonas vaginalis* (6.44%), (7) *Toxoplasma gondii* (5.31%), (8) *Naegleria fowleri* (4.02%), (9) *Cryptosporidium parvum* (2.74%), and (10) *Balantidium coli* (1.44%). This investigation would present an insight for the future research work on the currently reported important protozoa and provides basis for biological scientists to design strategies for prevention and control of pathogenic protozoa and enhancement of beneficial ones in controlled environment.

Keywords: Protozoa; Scientific Survey; Pakistan; Top-10

Introduction

The term protozoa (singular protozoan), was first coined by Georg August Goldfuss in 1818 which means "first animals". Protozoa are eukaryotic organisms and most of them are composed of a single cell surrounded by plasma membrane. There are more than 200,000 species of protozoa of which about 10,000 are parasites of invertebrates and vertebrates [1]. Major agents of disease in human are species of *Trypanosomes* (causing sleeping sickness or Chagas' disease) and *Leishmania* (causing Kala azar, oriental sore) of the class Kinetoplastida, *Giardia* and *Trichomonas* of the class Metamonadea and Parabasalia respectively. *Plasmodium* (causing malaria), *Toxoplasma* and *Cryptosporidium* of the class Sporozoa are the potential disease causing agents. *Entamoeba* (causing amoebiasis), *Naegleria* (causing amoebic meningoencephalitis) and *Acanthamoeba* (causing amoebic encephalitis, keratitis of the cornea) of the class Rhizopoda are also pathogenic to human [2]. Protozoan diseases cause economic losses to both common people and governments. The economic burden for individual and government includes missing and loss of working days, buying of medicines and drugs for treatment, absence from the school due to illness, expenditures on preventive measures such as spraying against vector and distribution of net, and a setback to the tour-

ism industry. Protozoan diseases such as amebiasis, giardiasis and malaria can add further to the miseries of the government and people in case of natural disasters such as flood. The present research study is designed to investigate the scientifically and economically important Top 10 human protozoa in Pakistan. The study aims to initiate discussion and debate amongst the protozoology community, as well as laying down a bench mark, as it will be interesting to see in future years how perceptions change and which protozoan leave and enter the Top 10. This would be the first attempt to highlight the economically and scientifically important protozoa in Pakistan which will help the national and international community to enhance the research work in the field of protozoology and will also help to combat diseases caused by protozoa in future.

Materials and Methods

Collection of data and polling for Top 10 human associated protozoa

A scientific survey was conducted among the pathology community in Pakistan and a simple form was filled from each participant of the study to nominate which human associated protozoa they would like to place in a list of "Top-10" based on their scientific and economic importance. The data were collected from the relevant

authors, researchers, scientists, professors, reviewers, editors and other professionals' experts of pathology who were from recognized institution of Pakistan. They were contacted either through personal emails, letters, on a phone call or through a personal visit, and a simple question was presented to them in order to nominate three human associated protozoa that they would expect to see in a list of "Top-10" most scientifically/economically important human associated protozoa in Pakistan [3-5]. Overall, 207 votes were collected from the above mentioned contributors of the study.

Analysis of data and ranking of Top 10 protozoa

The frequency (number of votes) and percentage (%) of votes were calculated for each protozoan. Based on polling result, the protozoan with maximum votes was kept at the top of the list (ranked as first) followed by the rest of protozoa in a ranking manner. The first ten protozoa with maximum voting were selected and included in the list of Top 10 protozoa and in this manner an inclusive list of top 10 protozoa was prepared.

Results and Discussion

Top 10 human associated protozoans in Pakistan

Most of the pathologists feel that their particular microorganism of interest should appear in the list of most important pathogens. Globally, the surveys have been done for such kind of studies and lists are generated for most of the microbes such as bacteria, viruses and fungi [3-5]. To our knowledge, no such lists exist for any of the microbe in Pakistan. The aim of this study was to survey all protozoology's/microbiologists and asked them to nominate which human associated protozoa they would like to place in list of "Top 10" most important protozoa based on their economics/scientific importance.

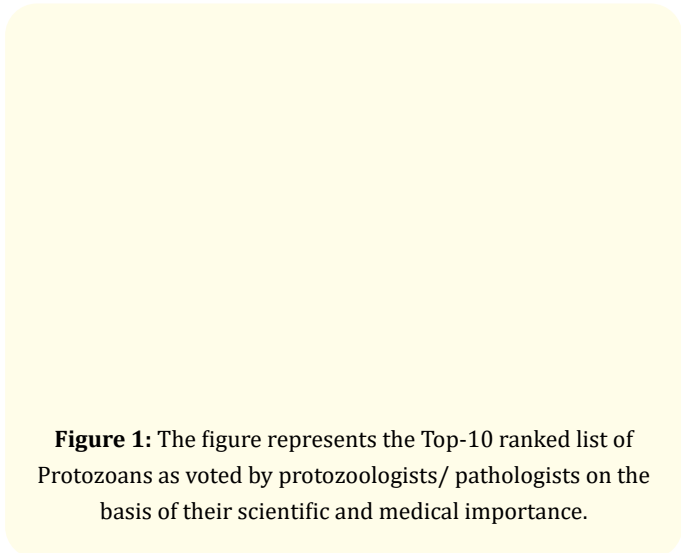
As a novel report, this study was carried out as a scientific survey to evaluate the most important protozoa in the context of their relationship with general population in Pakistan, which is ultimately linked to the economical perspectives. The survey was done across Pakistan during the study period of July 2015 to September 2015. This generated 207 votes from the relevant researchers/experts and thus, a list of "Top 10" most important human associated protozoa in Pakistan was generated (Table 1).

The list of Top 10 human associated protozoa in Pakistan includes, in ranked order: (1) *Entamoeba histolytica* (25.44%) (2), *Plasmodium vivax* (19.80%), (3) *Giardia lamblia* (214.33%), (4) *Plasmodium falciparum* (10.62%), (5) *Leishmania* (8.53%), (6) *Trichomonas vaginalis* (6.44%), (7) *Toxoplasma gondii* (5.31%), (8) *Naegleria fowleri* (4.02%), (9) *Cryptosporidium parvum* (2.74%), and (10) *Balantidium coli* (1.44%) (Table 1, Figure 1). The proto-

zoa just missing out on the Top-10 list include *Trypanosoma*, *Paramecium*, and *Euglena* species.

| Rank | Protozoa | Frequency/ No. of votes | Percentage (%) | Disease caused |
|--------|-------------------------------|-------------------------|----------------|-----------------------------|
| 1 | <i>Entamoeba histolytica</i> | 158 | 25.44% | Amoebiasis |
| 2 | <i>Plasmodium vivax</i> | 123 | 19.80% | Malaria |
| 3 | <i>Giardia lamblia</i> | 89 | 14.33% | Giardiasis |
| 4 | <i>Plasmodium falciparum</i> | 66 | 10.62% | Malaria |
| 5 | <i>Leishmania species</i> | 53 | 8.53% | Leishmaniasis |
| 6 | <i>Trichomonas vaginalis</i> | 40 | 6.44% | Trichomoniasis |
| 7 | <i>Toxoplasma gondii</i> | 33 | 5.31% | Toxoplasmosis |
| 8 | <i>Naegleria fowleri</i> | 25 | 4.02% | Amoebic Meningoencephalitis |
| 9 | <i>Cryptosporidium parvum</i> | 17 | 2.74% | Cryptosporidiosis |
| 10 | <i>Balantidium coli</i> | 9 | 1.44% | Balantidiasis |
| 11 | Others | 8 | 1.28% | ----- |
| TO-TAL | | 621 | 100% | |

Table 1: Top 10 human associated protozoa. The table represents the ranked list of protozoa as voted by protozoologists/ microbiologists on the basis of their scientific and economic importance.



This survey was carried out as many research/review papers and grant applications claim that a particular protozoon of their interest is of huge importance, and this is probably right so. Though the aim of this study was to identify the Top 10 most important human associated protozoa in Pakistan, we are also aware of the fact that priorities and importance can vary locally across the country and disciplines. We are also very much aware that due to several numerical reasons all the protozoa could not be included in the list of Top 10. Thus, we feel it highly suitable to mention all those protozoa that just missed out the Top 10, and still they could be regarded as highly important. The current study is very much similar in its nature, format and layout to the previous review on Top 10 plant associated bacteria, viruses and fungi, in the world. However, the current study is focusing on the human associated protozoa in Pakistan in contrast to the previous studies, that were mainly focusing on plant pathogenic bacteria, viruses and fungi around the globe [3-6]. This intends to initiate discussion and debate amongst the protozoology/microbiology community in Pakistan and will also lay down a benchmark. It would of interest in coming years to see how perceptions change and which protozoa leave and enters the Top-10.

This study, the first prospective, multicenter study to find out and compare top ten economically and scientifically important protozoa across Pakistan, provides important contemporary information. This study would present an insight for the future research work on the currently reported important protozoa and will provide basis for biological scientists to design strategies for prevention/control of pathogenic protozoa and enhancement of beneficial ones in contained environment.

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