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Fasciolosis: Causes, Challenges and Controls

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We dedicate this book to our research mentor and pathfinder of our academic journey Lt. Prof. R. A. Agarwal, Ex-Head, Department of Zoology; Ex-Dean, Faculty of Science; Ex-Pro Vice-Chancellor, D.D.U. Gorakhpur University, Gorakhpur, U.P., India.

Preface

Fasciolosis is a waterborne disease caused by *Fasciola hepatica* and *F. gigantica*. Both species are important helminthiases and have a great impact on human development. The importance of fasciolosis infection and control measures against them is emphasized by the World Health Organization (WHO). The definitive host range of *Fasciola* is broad and includes many mammals and humans. The presence of *Fasciola* infection in cattle or human population basically depends upon the presence of substantial reservoir, intermediate host, opportunity for water resource contamination by human/nonhuman hosts, and dietary practices that include consumption of raw aquatic vegetation. The ability of *Fasciola* species to spread is related to the large capacities of fasciolids to colonize and their ability to adopt new environments. Various lymnaeid snails are intermediate hosts of *Fasciola*, which helps in spreading the disease. The present book is focused toward the current status of fasciolosis, their economic impact, evolutionary origin and genetic diversity, distribution of disease, and vector snails. Effective fasciolosis control requires proper diagnosis, vaccination, and treatment at various stages of infection. Snail control is one of the effective methods to reduce *Fasciola* infection. It is recommended in all the epidemic areas as the snail represents the weakest link in the life cycle of *Fasciola*. The population of snail can be maintained below a threshold level by various molluscicides. With the advancement of technology, various snail control methods such as use of plants products, cow urine, drug combinations, use of spectral color of the sunlight, and phytotherapy of snails/their larvae inside/outside the body are now explored to control fasciolosis.

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About the Book

Fasciolosis is a waterborne disease which causes a huge impact on human health and economy. There is no consolidated literature on the causes, challenges, and controls of fasciolosis. This book attempts to provide a comprehensive overview of fasciolosis constrain and their control. The first chapter of the book provides a brief history, status, economy, life cycle, evolutionary origin, and genetic diversity of *Fasciola*. The second chapter contains the constrain of fasciolosis status in different states of India, whereas the chapter third focuses on the distribution and ecology of vector snail belonging to the Lymnaeidae/Planorbidae family in India. The fourth chapter is on fasciolosis control, which deals with the diagnosis, vaccination, and treatment of *Fasciola*. The fifth chapter deals with vector snail control and its future probability in controlling fasciolosis. Control methods are focused on the toxicity of synthetic as well as natural products against vector snails. The use of cow urine and cow dung as molluscicide for the effective control of vector snails is discussed in this book. The use of different visible monochromatic lights of seven colors with chemoattraction in trapping the snails for killing them by various combinations of molluscicides is described. Snail control by bait formulations as well as synergistic treatments of various combinations is also discussed. Phytotherapy of snails without killing the vector snail is one of the new approaches to control fasciolosis. One of the promising methods to control fasciolosis with the help of the photosensitive plant product chlorophyllin against host as well as parasite larvae is also discussed. A new biological tool, i.e., phytotherapy of snail by chlorophyllin, can efficiently manage fasciolosis infection, without killing the vector snail. The authors are confident that this book is a step toward a new approach in the field of fasciolosis control in India as well as other parts of the world.

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Dinesh Kumar Singh is the former Head of the Department of Zoology at DDU Gorakhpur University, India, and has been actively engaged in the study of molluscan physiology, biochemistry, and snail control since four decades. He has successfully isolated and identified pure molluscicidal compounds from more than three dozen medicinal plants and observed their mode of action on snails at the cellular level. He is an internationally recognized expert on the formulation and use of synthetic and bio-pesticides for integrated vector management. Prof. D. K. Singh serves as a referee for the Third World Academy Award sponsored by TWA, Italy. His expertise in snail control has been sought by scientific bodies in the Philippines and Africa. He has published 213 research papers (17 review articles) in over 108 reputed international journals as well as two reference books and three book chapters. He is a fellow of the Zoological Society of India and Academy of Environmental Biology, a life member of various national and international academic societies, and an editor and reviewer of various international journals.

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Fasciolosis

1

Abstract

First chapter of the present book deals with the introduction of fasciolosis disease, their history, overall status, economic impact on livestocks and milk production. Life cycle of *Fasciola* is briefly discussed to understand their mode of parasitism in cattle as well as human beings. Evolutionary origin and genetic characterization of *Fasciola hepatica*/*Fasciola gigantica* in different parts of world with respect to their distribution is also described to understand their global prevalence.

Fasciolosis is considered to be waterborne disease of historic period. Several prehistoric human coprolite studies indicate the presence of *Fasciola* eggs in that time (Bouchet 1994, 1995, 2003; Aspock et al. 1999; Dittmar and Teegen 2003). According to Bouchet et al. (2003), *Fasciola* has been found in prehistoric human population 5000–5100 years ago at the end of Mesolithic period and Neolithic period of animal domestication and the development of agriculture. *Fasciola hepatica* has been reported in Bronze Age as well as middle age (Bouchet et al. 2003). Carvalho et al. (2002) have opinion that eggs of liver fluke found in European coprolites but never in the new world, suggesting that *fasciolosis* in America is a relatively recent introduction.

One of the best cattle breeders in France, Jean de Brie for the first time written a treatise in the year 1379 and gave an accurate description of *Fasciola hepatica* and its damage in the liver of sheep. Later, an English Judge, Anthony Fitzherbert (1523) emphasized the importance of the ecology of *Fasciola hepatica*. In 1684, Francesco Redi had published monumental tome, which is one of the earliest and best work on parasitology. He describes the *Fasciola hepatica* in rabbit. In 1881, F.R. Leuckart published a series of articles on the life cycle of *F. hepatica*. Algemon P.W.T. in 1881 described the life cycle of *F. hepatica* independently. Perhaps, this was the first

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complete description of the life cycle of digenetic trematode. Further in 1882, Algemon P.W.T. in his second report of experiment on the development of liver fluke found that this fluke is transmitted by the intermediate host molluscs, particularly the snails *Linaeus pereger* and *L. truncaltulus*. In spite of the extensive studies of Algemon and Leuckart, many gaps in the complete description of the life cycle of *F. hepatica* remained. Later, in 1892, Adolf Lutz has done the detailed study on its life cycle and explained that those animals acquire *F. hepatica* by swallowing the encysted stage. Dimitry F. Ssinitzin (1914) reported the new details of the life history of *Fasciola*. He demonstrated that young flukes migrate through the intestinal wall into the abdominal cavity and then penetrate the liver of rabbit.

Fasciolosis is an important helminth disease caused by two trematodes *Fasciola hepatica* and *Fasciola gigantica* of subfamily Fasciolinae (Mas-Coma et al. 2005; Tolan 2011). The subfamily fasciolinae includes three genera: *Fascioloides*, *Tenuifasciola*, and *Fasciola*. *Fascioloides* are represented by *F. magna*, the large American liver fluke, reported in the liver of North American and European bovids. Genus *Tenuifasciola* is represented by *F. tragelaphi* found in the bile duct of *Tragelaphus spekei* (Pike and Condy 1966) and also in cattle in Zimbabwe (Mukaratirwa and Brand 1999). Third genus *Fasciola* includes four species (Yamaguti 1971). *F. hepatica* is found in the liver of domestic ruminants viz. sheep, goat, cattle, equines, camelids, pigs and many wild animals deer, rabbits, hares. *F. hepatica* is distributed in temperate and subtropical areas of the Americas, Europe, Asia, and Africa (Mas-Coma and Bargues 1997). Tropical liver fluke *F. gigantica* is a common parasite of liver of domestic animals sheep, goats, cattle, buffaloes, camels, pigs, horses and donkeys and wild animals—large antelopes, deer, giraffes, and zebras. *F. gigantica* is distributed in tropical and subtropical areas of Asia and Africa. *F. nyanzae* and *F. jacksoni* are found in liver of *Hippopotamus amphibious* and Asian elephants, respectively.

Many species of freshwater snail belonging to the family Lymnaeidae and Planorbidae are intermediate host of highly infective fluke larva of the genus *Fasciola*. These snails act as intermediate hosts found in natural ponds, lakes, canals, and paddy fields there by more chances of natural infection. Buffaloes are more exposed to the *Fasciola* larvae as they dwell in these water bodies infested with snails, while other cattle come in contact of infection by grazing near water submerge area and drinking water in the snail infested water bodies. Fasciolosis is reported in all the five continents of the world. Now, fasciolosis is recognized as an emerging-reemerging human disease (Mas-Coma et al. 2005). The World Health Organization has estimated that 2.4 million people are infected with *Fasciola*, and a further 180 million are at risk of infection (WHO 2007).

1.1 Fasciolosis Status

Fasciolosis is an important disease among the entire zoonotic helminthes worldwide (Haridy and Ibrahim 1999). The two liver fluke species infect a wide range of mammals especially cattle and sheep, while humans are regarded as accidental