AN INVESTIGATIVE STUDY ON INFECTIOUS DISEASES CAUSED BY PEST AND INSECTS: BIOMEDICAL AND ZOOLOGICAL EVALUATION

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ABSTRACT

Disease-carrying insects and rodents are not limited to the likes of fleas, cockroaches, mosquitoes, and rats. Lyme disease, strep throat, Rocky Mountain spotted fever, salmonella, malaria, dengue fever, and many more are all transmitted by insects. Mosquitoes and other insects may spread diseases like West Nile virus and Zika virus. The potential for bats to spread illness is substantial, making them a considerable health danger in the same way that other rodents are. Included in this group are viruses like the plague and hantavirus. The potential for the spread of zoonotic diseases in India is high. The potential for laboratory manipulation to increase the virulence, transmissibility, or resistance to therapy regimens of naturally occurring zoonotic infections is a source of concern. If any of these bugs are present, you may assume the product is contaminated and shouldn't use it. Insect and mite infestations pose a threat of ingestion (though this is usually only a worry at very high pest densities), and certain humans and animals may be allergic to the organism, its components, or its waste products if they have been exposed to it in the past. It's possible that insects are like this. Since their allergens are similar to those found in common house dust mites, mites offer a particularly dangerous hazard despite their little size and extensive dispersion. The dangers that storage mites pose to human health are often overlooked. It is suggested that further research be done to understand the exact nature of the engagement of both insects and dust mites in the development of allergic responses. Pests may have harmful effects on people even if they are designed to kill insects.

Key Words: *Health, Diseases, pathogen, insects, pest, dangerous hazard*

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INTRODUCTION

The most obvious connection between health and happiness is avoidance of hazards that might endanger one's health or safety, such as pathogens, chemicals, or dangerous environments. Keeping one's dwelling clean and limiting one's exposure to insects might save lives. Some insects and other pests may transmit a broad variety of diseases. Infectious illnesses are those that may be spread from one living creature to another (Gwenzi et al., 2021). As an added concern, many infectious illnesses may be acquired from ingesting contaminated water or food. Numerous insects act as primary or secondary hosts for or as vectors for diseases that affect humans. It is possible that insects may spread protozoa, bacteria, viruses, and helminths like tapeworms, flukes, and roundworms. This research is a credible resource since it evaluates the literature on infectious illnesses carried by insects and other pests. Insect- and pest-borne illness treatments are assessed differently in veterinary and medical disciplines (Stejskal, Hubert, & Li, 2018).

1.1 BACKGROUND

Infectious diseases

Diseases that may be transmitted to humans by insects are called "insect-borne diseases (Davide Gibellini, et al., 2021)." Contrast the bubonic plague with the more frequent yet harmless head lice (pediculosis). The symptoms of an insect bite illness are often limited to the skin. Examples include scabies, pediculosis capitis (more commonly known as head lice), and public lice (pediculosis pubis). Even while the insects involved do not spread disease, their bites nonetheless hurt like hell.

However, opportunistic bacteria may infect a stressed or unwell insect host and cause disease (Furuse Y. et al., 2018) Saprophytic bacteria are prevented from becoming pathogenic by a combination of factors, including the insect's immune system, nutritional shortage, and the existence of competing bacteria. If bacteria are able to establish an infection despite the host's immune defences, illness might ensue. When bacteria enter an insect, there are three potential outcomes, each of which is affected by the insect's immune system and the virulence of the bacterium.

Infectious diseases caused by pest and insects

Rare yet deadly bug-borne illnesses. Infected insects may bite a human and transfer fatal germs and viruses (Peter et al., 2018). Yellow fever, dengue fever, and trench fever are transmitted by mosquitoes; bubonic plague is spread by fleas, ticks, and lice. These diseases tend to be localised or caused by the environment. Tropical locations have more mosquito-borne illnesses. Overcrowding and inadequate sanitation cause trench fever. In temperate, forested locations, ticks spread Lyme disease. Areas with a high rat population likely to have a high plague population as well. Mosquitoes, fleas, lice, and ticks carry several illnesses. Vectors are carriers. Mosquitoes spread West Nile virus and malaria. Deer ticks may spread Lyme disease (Elena Tricarico, Giuseppe Mazza, 2018).

Biomedical evaluation

Infectiousness, pathogenicity, and virulence of the agent and host features determine infection and sickness susceptibility. Physical and social environmental elements affect host susceptibility to exposure.

Mechanical and chemical surface barriers including skin, tears, and mucus are the host's first line of defence against infection (Jianying Gu, et al., 2021). Burns may weaken the skin's natural layer, causing secondary sepsis and wound infection. Vaginal acid kills several STI agents. Lysozyme destroys bacteria in saliva, tears, milk, sweat, and mucus. Resident microbiome bacteria may protect the host by starving pathogenic bacteria and monopolising resources.

Infected people may transmit various infectious diseases (Schowalter, 2019). Certain pathogens, such as those that cause STIs, may be transferred without a third person, whereas vectors are needed for others, such as vector-borne illnesses (VBDs).

Zoological evaluation

A locust outbreak like the one that plagued Madagascar in 1997 may harm crops and grazing pastures. Developed countries gave fipronil (insecticide) to help control the locust outbreak, but an evaluation of the chemical's impact revealed unintended consequences, such as genotoxicity, cytotoxicity, impaired immune function, and decreased growth and reproductive success in vertebrates, even at concentrations below those associated with mortality (Sherman, 2018).

Vector-borne illnesses threaten human health in Africa. Female anopheles mosquitoes that carry Plasmodium falciparum are a public health danger. Culex mosquitoes disseminate elephantiasis-causing Wuchereria bancrofti. Rat fleas transmit plague-causing Yersinia pestis, whereas tsetse flies carry sleeping sickness parasites Trypanosoma brucei rhodesiense and gambiense. Schistosomiasis is carried by parasites in fresh water snails. Each spreads illnesses and fatalities that cost money and lives. There are several insects that may harm animals (Angela Williams, 2022).

DISCUSSION

Infectious diseases overview

The infectiousness of a disease is its potential for spreading to new hosts, whereas the infectivity of a pathogen is its ability to invade, survive, and multiply inside a host. Microscopic organisms, such as bacteria, viruses, fungi, and parasites, may cause and spread illness by infecting surfaces they come into contact with or by dispersing through the air (Moore, Hatcher, 2019). Humans are susceptible to pathogenic microorganisms if they come into contact with an infected animal. Diseases might be spread by lizards, mosquitoes, mice, ticks, beetles, and flies. Pathogens and the immune systems of their hosts interact, leading to infectious illnesses. The virulence of the infection and the host's immunity both have a role in the development and severity of disease. Doctors categorise infectious bacteria or germs as primary pathogens or opportunistic pathogens depending on how well they are able to evade the host immune system (Davies, et al., 2019).

Infectious diseases caused by pest and insects

Vector-Borne Diseases: The Zika virus, Lyme disease, and rabies are just a few of the infectious diseases that may be transmitted by vectors. Animals such as mosquitoes, ticks, and rats may potentially transmit diseases to people. The Environmental Protection Agency (EPA) has licenced many pesticide treatments, including repellents, for use against certain vectors or pests (Julie et al., 2020):

- Bugs and pesticides
- Mosquitoes
- rodenticides

Asthma and Allergies - Cockroaches and other insects often found inside may exacerbate asthma and allergy symptoms in some people. Any pesticide that has been approved for use by the Environmental Protection Agency (EPA) will do the trick (DiPrete Brown, 2018). The EPA also distributes materials teaching people how to use these items safely in institutional settings like schools and households. Learn more about.

- Cockroaches
- Pest management at home
- Managing Pests in the Classroom

Numerous microorganisms and acellular particles, including bacteria, viruses, prions, and protozoans, may cause sickness and infection in humans. Antimicrobial pesticides that have received EPA approval are used in many public and private facilities to stop the spread of disease (Nicoletti, 2020).

- Microbial pests that pose a threat to public health
- Antimicrobials Approved for Intended Indications

Sources and contamination process

The body contains several infection entrance points. Some diseases can only be transferred by direct physical contact, such as ingesting infected water or food or touching contaminated bodily fluids or animal products. Pathogens may transmit infections via the air.

When measuring the spread of an infectious disease in a community, the vector must be considered. Being able to spread over the air increases an agent's ability to infect many people compared to direct contact (Anna Nicholson, et al., 2020).

Insect- and pest-transmitted diseases may spread vertically and horizontally. Countertops, doorknobs, and sink handles may harbour bacteria. You can get someone's cold or flu by touching anything they've touched, such a doorknob. If you haven't cleaned your hands, don't touch your face.

Similarly, polluted food or drink raises the risk of illness. This pathway may transmit infectious diseases quickly. Raw hamburger and unpasteurized juice may contain E. coli (Daiana et al., 2020).

Many insect species are major or secondary vectors for human illnesses. Insects may spread protozoa, bacteria, viruses, and helminths like tapeworms and flukes. Insects transmit illness mechanically and biologically.

Biological discipline

Studying insect illness transmission is unique (Claire et al., 2018). Pathology is the study of human sickness and damage. Insect pathology studies several insects. India is highly vulnerable to pest- and insect-borne infectious diseases due to its location, population, healthcare spending, research expenditures, lack of coordination with central and state health departments, constrained participation of private actors, low biosecurity knowledge, and poor public health infrastructure. India confronts three biological threats:

(1) naturally occurring infections in humans, animals, or agricultural infestations;

(2) infections caused by the inadvertent release of pathogens into the environment (Goddard, 2018); and

(3) possible spread of diseases caused by the wilful weaponization of dangerous pathogens that affect humans, animals, or crops. India should practise recognising and responding to these dangers individually or in combination.

Medical evaluations

The symptoms of many infectious illnesses are quite similar to one another. The specific bacterium responsible for a disease may occasionally be identified by analysing samples of bodily fluids. The doctor may then personalise their care to your specific needs.

- Blood testing. A blood sample is taken by placing a needle into a vein, most often in the arm, and drawing the blood out (Rahman, et al., 2020).
- Diagnostics based on urine samples. To do this simple test, you'll need to pee into a cup. It is common practise to teach patients to use an antiseptic pad to wipe off their genitalia before to collecting urine and to wait until the pee is in the middle of the stream before removing the sample.
- Swabs of the throat. A sterile swab may be used to collect samples from the throat or other wet parts of the body.
- To take a stool sample. In some cases, a lab examination of a stool sample for parasites and other organisms will necessitate your collection of the sample (Nicoletti, M. (2020).
- Tap on the spine (lumbar puncture). A little amount of cerebrospinal fluid is extracted through needle insertion between the vertebrae of the lumbar spine. Usually, you will be asked to lie on your side with your knees pulled up to your chest (Miller, 2018).

Zoological evaluation of the rise of pests are the cause of health issue

The FAO estimates that every year plant pests and diseases cause a loss of up to 40 percent of the world's food crops. Pests and illnesses are on the rise due to a number of factors, including climate change and increased international commerce. Pest population sizes, survival rates, and geographic distributions may all be influenced by climate change, as can the severity, progression, and geographic dispersion of illnesses. Experts agree that changes in temperature and rainfall have a crucial role in the dispersal of pests and illnesses (Andre Barretto Bruno et al., 2022).

Health hazards and cures to the diseases

Hazards

As a result of the country's weather, India is susceptible to vector-borne illnesses including malaria and dengue fever (Artsob, 2019).

India is prone to zoonotic viruses including bird flu, swine flu, Nipah virus disease, and coronavirus diseases like COVID-19 because to its dense livestock population and inadequately protected animal-human interface.

Antibiotic resistance is a growing public health concern because of nontherapeutic antibiotic usage to boost farm animal development, noncompliant patients, self-medication, and illegal over-the-counter access to antibiotics..

Safety concerns

Pathogens that may cause illness can be found almost wherever in nature. More and more tools to alter them are becoming accessible (Montag, 2021). These technological advancements and natural disorders might be weaponized on purpose by evildoers.

India is very vulnerable to the spread of zoonotic diseases. Manipulating naturally occurring zoonotic illnesses in the lab may enhance their virulence, transmissibility, and/or resistance to therapeutic regimens (Okoth, 2021).

India's porous borders with several of its neighbours make it vulnerable to the spread of illness over national boundaries.

Natural invasive diseases and artificially generated viruses or pests are both tools that threat actors may employ to disrupt agricultural supply chains and to manipulate illnesses that have an impact on human health.

Imaging procedures such as X-rays, CT scans, and MRIs may help physicians make a more accurate diagnosis or rule out less likely explanations for symptoms (Nitesh et al., 2020).

3. RELATED STUDIES

- **Malaria**. caused by the Plasmodium protozoan and spread mostly by mosquitoes of the genus Anopheles, is the most devastating illness spread by insects. About 250 million individuals worldwide are susceptible to contracting malaria, making it the deadliest Arthropod-borne illness. There are annual instances of malaria in the United States, but they are limited to those who have been to malarial regions abroad (Ortega-et al., 2018).
- **Arboviruses**. mosquito bites spread the viruses that cause these illnesses. Mosquitoes may spread over 28 different viruses that are very dangerous to human health. Mosquitoes of

the genus Aedes spread both Dengue and Yellow Fever. Mosquitoes of the genera Aedes and Culex are the primary vectors of numerous different types of encephalitis (Möhlmann, et al., 2020).

- **Plague**. The flea is the carrier of the plague, which may infect both humans and animals. Humans may get bubonic plague, pneumonic plague, and septicemic plague. The bubonic strain, caused by the bacteria Yersina pestis, is carried by fleas. Plague bacilli are transmitted when fleas bite, when flea faeces are scraped into the skin, or when a host swallows an infected flea. Millions of individuals were wiped off by the plague between the 14th and 17th centuries. Twenty-five million people died as a consequence of the great epidemic that swept over Europe in the 14th century. There are still a significant number of plague cases each year—roughly 5,000 (Ansari, Iet al., 2020).
- **Enteric diseases**. Direct or indirect faecal contamination of food or water is a common route of transmission for many bacterial infections. The common house fly is a key agent in the mechanical transmission of many illnesses. Typhoid Fever, caused by the bacteria Salmonella typhi, is a common gastrointestinal illness that affects people all over the globe. Cholera is yet another major intestinal illness. Enteric illnesses are common and include Shigella, which causes diarrhoea and dysentery, and Escherichia coli, which causes urogenital and intestinal infections (Uzal, et al., 2018).
- **Lyme disease**. Borrelia bugdorferi, the microorganism that causes Lyme disease, is transmitted by the deer tick. When the germs are transferred into the bloodstream of a person or other warm-blooded animal by a bite, Lyme disease may develop. New England and the mid-Atlantic states were the first to report the sickness, but now it has spread over the whole Northern Hemisphere (Cardenas-de la Garza, et al., 2019).
- **Sleeping Sickness**. Its basically Nausea in the Morning after Being Unwell the Night Before. There are a few different names for this condition. The disease is transmitted by tsetse flies, which are members of the genus Glossina. Africa's trypanosomiasis is caused by a parasite called Trypanosoma brucei (two forms). Due to the high mortality rate caused by the illness, which affected both people and cattle, many areas of Africa were unavailable for colonisation. The destruction of large areas of land and the elimination of reservoir hosts have slowed the disease's progress (Dewar, et al., 2022).
- **American Trypanosomiasis**. This condition goes under many different labels. Trypanosoma cruzi, the protozoan that causes Chagas disease, often affects skeletal muscle but may also infect the heart and intestines. Protozoa flourish under such conditions. Adult trypanosomes may be detected circulating in the blood, but they do not penetrate blood cells as malaria parasites do. The protozoa are disseminated mostly by the faeces of Conenose Bugs, often known as Kissing Bugs, who are the actual vectors of infection. Humans are easy targets for conenose bugs because they often attack when people are sleeping (Echeverria, & Morillo, 2019).
- **Prebaiting**: Since rodents like rats and mice are so suspicious of unfamiliar objects and food sources, prebaiting is recommended by the Military Pest Management Handbook (MPMH). This quality is what allows rats to stay alive in dangerous environments. This avoidance reaction has led to the use of prebaiting (baiting without poison) in control efforts. Mice and rats, for example, eat very little food at first. When an animal becomes ill from a sublethal dose of poison, its avoidance reaction becomes more pronounced, making it very difficult to complete a poisoning programme. A rodent's avoidance reaction may be muted or nonexistent if it is hungry or if it is in a place where it often encounters unfamiliar items and food, such as a garbage dump (Prakash, 2018).

4. SUGGESTION

- ➢ India might benefit from a government agency whose only responsibility is to identify, control, and eradicate infectious disease threats due to the ongoing and ever-evolving nature of this threat.
- ➢ If there is ever a biological emergency, India should finance an organisation that can coordinate policy responses.
- ➢ One solution is to have the National Disaster Management Authority set up a full-time Office of Biological Threats Preparedness and Response (BTPR).
- ➢ The collaborative effort of public health experts, academics, industry researchers, epidemiologists, and data scientists to create a model for the spread of illness.

- Developing uniform methods for reporting illnesses in order to collect data on disease outbreaks from a consistent set of sources.

FINDINGS

If you don't keep rats and other pests from urinating, defecating, and shedding their skin and hair all over the place, your property might become polluted. Insects and other creepy-crawlies may cause just as much havoc as rats. It's inconvenient to have them around, and they spread germs in the kitchen and pantry, increasing the risk that we'll eat something we shouldn't. For example, mouse urine may be found pretty much wherever in your house since mice pee so often. Salmonella, meningitis, Weil's illness (leptospirosis), and Lyme disease are just a few of the 35 diseases that rats and mice are responsible for spreading. Simply being in the same room as a pest might trigger an allergic reaction in some. But most allergic responses begin with a bite or sting from an insect. Bed bugs, for instance, don't spread illness, yet they still bite people for food. Itchy red bumps may appear on the skin following an insect bite if the victim has an allergy to insects. An infection may develop from a bite if it is scratched or not treated properly. Of course, bees and wasps can provide a stinging hazard. An anaphylactic reaction may occur if a person is stung by an insect like a bee or a wasp.

Insects and rodents are common pests, and they may exacerbate preexisting conditions. For example, cockroaches may wreak havoc on the health of persons with asthma and other respiratory diseases. Infestation is inevitable if even a few cockroaches find their way into your house. Airborne particles may originate from the constant shedding and release of cockroach skin and faeces. The large number of tiny particles in the air might make breathing difficult for anybody with respiratory issues. Children who have a hereditary predisposition to asthma may get an asthma attack if they are exposed to cockroaches for an extended period of time.

FUTURE SCOPE

The topics of research requirements and knowledge gaps were also discussed.

- quantitative evaluation of the potential for microbiological contamination,
- Common Household Pests, Rodents, and Pets in Third World Countries and Their Antimicrobial Resistance
- Insect, rodent, and pest populations are showing signs of increasing antibiotic resistance, making it important to investigate the influence of both natural and anthropogenic factors.
- Examining the involvement of common home pests and rodents in the transmission and health concerns associated with AMR using cutting-edge research methodologies (including in-silico approaches, genomics, network analysis, and big data analytics or machine learning).
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CONCLUSION

This essay argues that pest control is so important because of the detrimental effects that pests may have on human health. The spread of disease-carrying rodents and lagomorphs into new areas increases as human population grows and urban sprawl spreads across both continents. Effective rodent- and vector-control strategies, proper monitoring, public education, and sustainable environmental management practises are all essential for preventing the development of diseases that may be transferred by rats. These precautions should aim to minimise human contact. Such procedures are likely economically feasible despite their possible costly nature due to the costs associated with treating human cases of rodent-related diseases and repairs to property destroyed by some of these animals.

REFERENCE

1. Andre Barretto Bruno Wilke, Cleber Galvão, Jader Oliveira, Kaio Cesar Chaboli Alevi, Mauro Marrelli, Wanzhi Cai, (2022). Biology, Systematics, Taxonomy, and Evolution of Insect Vectors. (n.p.): Frontiers Media SA.
2. Anna Nicholson, Cecilia Mundaca Shah, V. Ayano Ogawa, Yamrot Negussie, (2020). The Convergence of Infectious Diseases and Noncommunicable Diseases: Proceedings of a Workshop. United States: National Academies Press.
3. Ansari, I., Grier, G., & Byers, M. (2020). Deliberate release: Plague–A review. Journal of Biosafety and Biosecurity, 2(1), 10-22.

4. Artsob, H. (2019). Powassan encephalitis. In The arboviruses: epidemiology and ecology (pp. 29-50). CRC Press.
5. Cardenas-de la Garza, J. A., la Cruz-Valadez, D., Ocampo-Candiani, J., & Welsh, O. (2019). Clinical spectrum of Lyme disease. European Journal of Clinical Microbiology & Infectious Diseases, 38(2), 201-208.
6. Claire Garros, Jérémy Bouyer, Renate C. Smallegange, Willem Takken, (2018). Pests and vector-borne diseases in the livestock industry. Netherlands: Wageningen Academic Publishers.
7. Daiana Ávila, Halley Caixeta Oliveira, Leonardo F. Fraceto, Renata Lima, Renato Grillo, Vera Lucia S.S. de Castro (2020). Nanopesticides: From Research and Development to Mechanisms of Action and Sustainable Use in Agriculture. Germany: Springer International Publishing.
8. Davide Gibellini, Giulia De Falco, Paul Gerard Murray, Pier Paolo Piccaluga, Sam Mbulaiteye (2021). Molecular Mechanisms of Pathogen-Driven Infectious and Neoplastic Diseases. (n.p.): Frontiers Media SA.
9. Davies, B., Chrisler, C., Escota, G. V., Spec, A. (2019). Comprehensive Review of Infectious Diseases. Netherlands: Elsevier Health Sciences.
10. Dewar, C. E., Casas-Sanchez, A., Dieme, C., Crouzols, A., Haines, L. R., Acosta-Serrano, Á., ... & Schnaufer, A. (2022). Oxidative phosphorylation is required for powering motility and development of the sleeping sickness parasite Trypanosoma brucei in the tsetse fly vector. Mbio, 13(1), e02357-21.
11. DiPrete Brown, L. (2018). Foundations for Global Health Practice. Germany: Wiley.
12. Diseases and Illnesses Transmitted to Humans by Animals, Insects, and Contaminated Food and Water. (2020). United States: Omnigraphics.
13. Echeverria, L. E., & Morillo, C. A. (2019). American trypanosomiasis (Chagas disease). Infectious Disease Clinics, 33(1), 119-134
14. Elena Tricarico, Giuseppe Mazza, (2018). Invasive Species and Human Health. United Kingdom: CABI.
15. Furuse Y. Analysis of research intensity on infectious disease by disease burden reveals which infectious diseases are neglected by researchers. Proc Natl Acad Sci U S A. 2019 Jan 8;116(2):478-483. doi: 10.1073/pnas.1814484116. Epub 2018 Dec 31. PMID: 30598444; PMCID: PMC6329976.
16. Goddard, J. (2018). Infectious Diseases and Arthropods. Germany: Springer International Publishing.
17. Gwenzi W, Chaukura N, Muisa-Zikali N, Teta C, Musvuugwa T, Rzymski P, Abia ALK. Insects, Rodents, and Pets as Reservoirs, Vectors, and Sentinels of Antimicrobial Resistance. Antibiotics (Basel). 2021 Jan 12;10(1):68. doi: 10.3390/antibiotics10010068. PMID: 33445633; PMCID: PMC7826649
18. Jianying Gu, Yufeng Wang, Zhan Zhou. (2021). Evolutionary Mechanisms of Infectious Diseases. (n.p.): Frontiers Media SA.
19. Julie S.. Pasche, Lyndon Porter, Mary Burrows, Robert Martin Harveson, Weidong Chen, (2020).Compendium of Pea Diseases and Pests. United States: American Phytopathological Society.
20. Miller, M. E. (2018). Diseases Spread by Insects Or Ticks. Momentum Press.
21. Möhlmann, T. W., Vogels, C. B., Göertz, G. P., Pijlman, G. P., Ter Braak, C. J., Te Beest, D. E., ... & Koenraadt, C. J. (2020). Impact of gut bacteria on the infection and transmission of pathogenic arboviruses by biting midges and mosquitoes. Microbial ecology, 80(3), 703-717.
22. Montag, A. (2021). Diseases Caused by Arthropods. In Braun-Falco´ s Dermatology (pp. 1-45). Berlin, Heidelberg: Springer Berlin Heidelberg.
23. Moore, L. S. P., Hatcher, J. C. (2019). Infectious Diseases, Microbiology and Virology: A Q&A Approach for Specialist Medical Trainees. United Kingdom: Cambridge University Press.
24. Nicoletti, M. (2020). Insect-Borne Diseases in the 21st Century. Netherlands: Elsevier Science.
25. Nicoletti, M. (2020). Insect-Borne Diseases in the 21st Century. Netherlands: Elsevier Science.
26. Nitesh K. Maru, Ashwani Kumar, Sunil Zachariah, (2020). Insect Pathology Text Book and Practical Manual. (n.p.): Scientific Publishers.
27. Okoth, E. Y. (2021). Laboratory Assessment of Vector Competence of Phlebotomus

Duboscqi to a Novel Sandfly-associated Phlebovirus (Doctoral dissertation, UON).
28. Ortega-Pajares, A., & Rogerson, S. J. (2018). The rough guide to monocytes in malaria infection. Frontiers in immunology, 9, 2888.
29. Peter H. Adler, Robert G. Foottit. (2018). Insect Biodiversity: Science and Society, Volume 2. United Kingdom: Wiley.
30. Prakash, I. (2018). Bait shyness and poison aversion. In Rodent pest management (pp. 321-329). CRC Press.
31. Rahman, M., Sobur, M., Islam, M., Ievy, S., Hossain, M., El Zowalaty, M. E., ... & Ashour, H. M. (2020). Zoonotic diseases: etiology, impact, and control. Microorganisms, 8(9), 1405.
32. Schowalter, T. D. (2019). Insects and Society. United States: CRC Press.
33. Sherman, A. (2018). Medical Parasitology. United Kingdom: EDTECH.
34. Stejskal, V., Hubert, J., & Li, Z. (2018). Human health problems and accidents associated with occurrence and control of storage arthropods and rodents. In Recent advances in stored product protection (pp. 19-43). Springer, Berlin, Heidelberg.
35. Uzal, F. A., Navarro, M. A., Li, J., Freedman, J. C., Shrestha, A., & McClane, B. A. (2018). Comparative pathogenesis of enteric clostridial infections in humans and animals. Anaerobe, 53, 11-20.