JSIANE : Vol. 1, Issue 2, 2021 Page 21–25 ISSN (Online): 2583-2093

Journal of Science Innovations and Nature of Earth

Journal homepage : www.jsiane.com

Honey Bees as Bio-monitors of Environmental Contaminants and Climate Changes

Surbhi Mittal, Archna and Bhupesh Gupta*

Department of Zoology, Kisan P.G. College, Simbhoali, Hapur, U.P.

IIMT University, Meerut *

Corresponding author's email: surbhikpg@gmail.com

Abstract

Insect diversity and abundance are currently on the decline throughout the world. It's a combination of many factors that's causing this decline. Aside from natural causes, habitat loss, and climate change, pollution is a major factor. It is critical to keep an eye out for pollutants, pesticides, and pathogens in the environment if we are to protect the health of our people, agriculture, and the ecosystem as a whole. To keep an eye on the environment, scientists have employed a variety of methods, ranging from simple physical sensors to complex networks of sentinels. So far, attention has been focused on the effects of pesticide exposure on social insects rather than heavy metals or fine particulate matter. Non-target effects of pesticides and insecticides on honeybees and wild bees have been studied as a means of conserving these important pollinators. Pesticides in beeswax and honey have also garnered a lot of attention in recent years. These bee products can be used for environmental bio monitoring because they can carry pollutants to human consumers. There are a number of important characteristics of the bee that make it an excellent biological indicator. Beekeeping provides an unlimited supply of these characteristics. If the bee dies in large numbers, it's a sign of toxic molecules in the environment, but it can also be a sign of non-toxic chemicals like heavy metals and fungicide residues in honey and pollen or larvae. *A. mellifera* is an ideal bio monitoring species because of these characteristics, in addition to its worldwide distribution and widespread human management.

Keywords: Environmental bio monitoring, honeybee, pesticides, bio indicator, environmental pollution.

Received 26.04.2021 Revised 15.05.2021 Accepted 20.05.2021

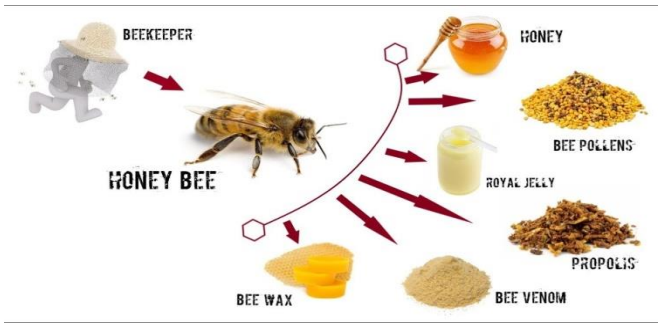
Introduction

Concerns about the quality of the environment on a global scale require concerted action on the part of all nations that are impacted by a given environmental problem. In order to find solutions to these problems, we will need to collaborate. The ability to provide data on pollutant concentrations and the effects those concentrations have on biota should be a requirement for every region, regardless of the environmental, infrastructure, social, or economic conditions of that region. In order to accomplish this, bio monitoring makes use of living things and various natural resources. In particular, the honeybee is an organism that is widespread, has an easy breeding process, and is very mobile. Its hairy body is able to pick up materials and particles from the environment when it comes into contact with those substances and particles. Because of this, bees are extremely efficient accumulators of materials taken from the ground, vegetation, the air, and the water. Because of its dual function as a bio indicator and a passive bio accumulator, the honeybee is an excellent option for monitoring large areas at a low cost, even in regions with limited infrastructure. Honeybees are found in almost every ecosystem on Earth. Monitoring the environment can be accomplished through the utilization of both biotic and abiotic systems, in addition to a a mix of physical, chemical, and genetic research (Cordier et al., 2020, Kienzl et al., 2003). A bioteleophyte is a species that may also reveal quantitative features of the environment. An environmental journalist is a species that responds to environmental change and reflects environmental quality in general. On the other hand, a bioteleophyte can also indicate environmental quality (Markert and Wunschmann, 2011). The European honey bee possesses some distinct qualities that could prove useful in the field of insect bio monitoring (*Apis mellifera*) To put it another way, because it is the most important pollinator in agricultural systems, the *A. mellifera* is like a pet that is a microscopic insect and can be found all over the world. Since 1962, this species of bee has been utilized more frequently for a variety of environmental monitoring purposes, including the detection of heavy metal pollution in territorial and urban surveys, the presence of pesticides on farms, and the presence of radionuclides throughout the environment. To address the wide variety of problems with the quality of the global environment that we are all currently dealing with, we absolutely need to collaborate with one another. The ability to provide data on pollutant levels and the effects those levels have on biota should be a requirement for every region, regardless of the ecological, infrastructural, social, or economic conditions of that region. In order to accomplish this, bio monitoring makes use of living things and other components of the natural environment. In particular, the honey bee is a widespread species of bee that is simple to breed and possesses a high rate of mobility. Its body, which is covered in hair, is constantly absorbing whatever it comes into contact with as it moves through the environment. As a consequence of this, bees are highly efficient collectors of materials from the ground, the vegetation, the atmosphere, as well as bodies of water and liquid. Because of these qualities, honey bees are an ideal agent for simple and cost-effective surveillance of large areas. This is true even in regions with limited infrastructure, such as the Amazon rainforest, where there is a dearth of such facilities. Methods of bio monitoring that are either passive or active can be classified separately as being part of this field of study. Active bio monitoring requires the introduction of organisms into the area that is being monitored, whereas passive bio monitoring only requires the observation and analysis of organisms that are already present in the ecosystem being monitored. Bio

monitoring is a low-cost alternative that offers a high level of detail and reliability, in comparison to the expense of maintaining electronic surveillance stations. To put it another way, a bio monitoring data set is not comparable to that of a single sampling instrument because it reveals how various living organisms react to pollutants in a given area. This makes the bio monitoring data set incomparable to that of a single sampling instrument. Instruments and methods of measurement from the field of analytical chemistry are utilized in the process of collecting data for bio monitoring. Bio monitoring is a useful tool for monitoring pollution because it has a number of benefits that make it stand out from other monitoring methods. In the process of bio monitoring, both biological indicators and bio accumulators may be utilized (Wolterbeek 2002). Because they satisfy such a wide variety of requirements, bees make for an excellent biological indicator. The production of honey through beekeeping creates an endless supply. In spite of the fact that bees prefer to gather pollen from nearby fields, They can fly large distances, even 10 kilometres under specific conditions: a hive may keep a seven-square-kilometer region "under its authority" (Crane, 1984). In addition, there is a great deal of bees present in the region. The concept of utilizing bees as a means of environmental observation is not a novel one. Researchers found an increase of the radionuclide strontium-90 in nearby areas using bee monitoring. They attributed this increase to recent atmospheric nuclear testing because it occurred in the atmosphere. J. Svoboda's belief in 1935 (Crane, 1984) that this insect could provide us with useful information about the environmental impact of specific industries in specific locations was the impetus for this research (Svoboda, 1962). Pollution caused by heavy metals. Heavy metals were discovered in regional and urban surveys (Cavalchi and Fornaciari, 1983; Crane, 1984; Accorti and Persano Oddo, 1986; Accorti *et al*, 1987; Stein and Umland, 1987; Celli et al, 1988b), and pesticides in rural regions (Atkins and Lunden, 1986; Celli *et al*, 1987; Mayer *et al*, 1987). (For a review on the state of the research on these topics in Italy see Porrini *et al*., 2002).

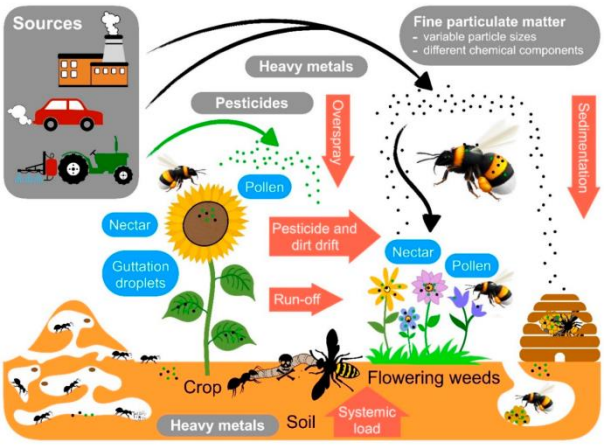
Honey bees and hive products

Social insects like honey bees live in groups of tens or even hundreds of thousands of individuals. The queen is the only reproductive female in a colony of 10,000 to 80,000 individuals, and the males appear in the spring and summer. Bees are generally sterile worker bees with a lifespan of six weeks, except in winter colonies where they can live for several months. To gather nectar and pollen, bees leave their hive to forage on a wide variety of flowering plants, including those found in urban areas (Baldock, 2020). Pollination by bees and other pollinating insects is essential to the survival of a wide variety of animals and plants, including humans. Bee products, which are a natural food source, are also available from them. In today's fast-paced world, they are an ideal source of nourishment because they have been used for millennia. Pollen, propolis, royal jelly, and wax are all made by bees, in addition to honey, which is by far the most common bee product. Bee venom is another product from which people can gain benefit. '



Environmental contaminants

A synthetic compound is considered to be a pollutant in the environment if it is released into the atmosphere in an unauthorized or intentional manner. Heavy metals, persistent synthetic compounds, airborne particulate matter, and agrochemical pesticides are examples of the naturally occurring impurities that can be found in honey bee-related materials. Microorganisms, plants, and animals can be harmed by impurities in the environment that are brought about by farming, cities, and other modern activities. Additionally, newly emerging microorganisms and fluctuations in the environment can also be harmful. Heavy metals, earth-industrious synthetic compounds, and agrochemical pesticides are some of the most interesting and potentially hazardous substances. They can store and travel by soil, water, and air, gathering in bodily tissues and creating disappointment in the regeneration process, as well as neurotoxic harm and moving through the bloodstream. They have the potential to significantly alter the climate (Simpleton *et al.*, 2014, Williams *et al*., 2015). The natural environment is not the only place that is impacted negatively by these activities. Toxins found in people have been linked to a variety of illnesses, including infections and diseases of the respiratory system (Briffa *et al*., 2020, Woodworker, 2006, Dockery *et al*., 1993, Lambert *et al*., 2012a). It is becoming increasingly important to conduct consistent monitoring of the natural quality in order to maintain the existing levels of biodiversity, food security, and human well-being.



Climate Change and Bees

On a cellular level, honey bees can be affected by climate change, as well. People's behaviour and physiology can be affected directly by this medication. It can also influence the development cycle by influencing the level of the floral surroundings and rising or falling colony harvesting capacity and growth. Honey bees mature at distinct rates depends on their race. This is a well-known fact. As a result, any change in the climate or the migration of honey bees from one region

to another is bound to have measurable effects. As the temperature rises, insects' thermal tolerance and ability to adapt to changes in temperature are affected by climate change. A bio monitoring programme could evaluate queen fertility or quantify genetic material like HSPs, which are indicators of temperature changes and climate change, to research the incidence of heat-induced loss of fertility in diverse environments (McAfeeetal., 2020).

Conclusion

Due to the fact that environmental pollution is a global problem, the methods used to monitor the quality of the environment must be adaptable enough to be used in regions with vastly different environmental, infrastructure, social, and economic conditions. This is one of the most urgent issues that contemporary society must address. Bio monitoring employs organisms that are sensitive, widespread, and stable within the territory of interest for the purpose of obtaining accurate information on the pollutants present in the territory and the effects of these pollutants on biological systems. Honeybees have been demonstrated to be capable of meeting all of these requirements. Honey bees are regarded as reliable biological indicators because they emit two signals indicating the presence of chemical contamination in their environment. These indicators include a high mortality rate in the presence of pesticides, as well as the presence of pesticide residues in their bodies or in the products of their hives, which can be identified using the appropriate laboratory techniques. Honeybees can detect and monitor environmental pollution because their foraging behaviour encompasses such a broad spectrum (Rezvan Davodpour et al., 2019). For environmental bio monitoring to be effective, programmes that establish direct links between changing environmental conditions and the state of the ecosystem must be developed. Honey bees are a useful tool for bio monitoring, which can be conducted with varying degrees of difficulty, sensitivity, and health. A rise in any of these variables will increase the quantity of high-quality data. Nonetheless, an increase in any of these factors will also result in an increase in the financial cost and expertise required to conduct such bio monitoring. In contrast, an increase in the application of these factors reduces the capacity for bio monitoring. Consequently, there is a level that is suitable for everyone, but it depends on the circumstances and objectives of the bio monitoring being conducted. As a result of the studies conducted, it is possible to conclude that the bee organism reacts swiftly to a wide range of external factors. This allows honey bees to be used as an accumulation and reactive indicator for environmental quality bio monitoring. (Crane, 1984; Bilalov *et al*., 1992; Jeliazkova *et al*., 2001; Jeliazkova *et al*., 2002; Porrini *et al.*, 2003; Zhelyazkova *et al*., 2004; Fakhimzadeh *et al*., 2005; Stanimirovic *et al*., 2005; Bianu and Nica, 2006; Gallina *et al*., 2005; Spodniewska and Romaniuk, 2006). For the purposes of biomonitoring, the following can be monitored: the growth of bee colonies, alterations in bee behaviour, and periodic reporting of the death rate. Alternately, one could apply comparative analysis by indicator characteristic of bees (content of heavy metals, pesticides, radio nucleotides, and other contaminating agents in the bee organism) reared in areas with differing degrees of anthropogenic impact. The matrices of honeybees reflect the spatial variations that occur in ecological agrochemicals, heavy metals, airborne particulate matter, and persistent synthetics. Honey bee lattices can be utilized to screen for toxins, which has numerous applications. The outcomes of this screening method can direct changes in agricultural management practises and direct remediation efforts to improve ecological quality and reduce human exposure to toxic or carcinogenic compounds. In an effort to protect crop yields, food security, and beneficial species, honey bee settlement frameworks for bio surveillance of plant and pollinator microorganisms and invasive species can be examined.

References

Accorti M., Persano Oddo. L., 1986. - Un servizio di monitoraggio ambientale urbano: "Apincittà". InformatoreAgrario, 42:39-41.

Atkins E. L., Kellum D., Atkins K. W., 1981. - Reducing pesticides hazard to honey bees: mortality prediction techniques and integrated management strategies. - Division of Agricultural Sciences, University of California, Leaf. 2883, 22 pp . (With: Supplemental list to leaflet 2883 (1981) compiled by E. A tkins, Nov.1990).

Bianu, E. and D. Nica, 2006. Honeybees – bio indicators in a heavy metals polluted area. In: Proceedings of the Second European Conference of Apidology EurBee,Praque, Czech Republic, 10-16.IX. 2006, www.eurbee.org/topics.html

Cavalchi B., Fornaciari S., 1983.- Api, miele, polline epropoli come possibili indicatori di un inquinamento dapiombo e fluoro - Una esperienza di monitoraggio biologiconel comprensorio ceramico di Sassuolo-Scandiano.- In: Attidel seminario di studi "i biologi e l'ambiente" Nuove esperienzeper la sorveglianza ecologica. Reggio Emilia, Italy (Manzini, P., Spaggiari, R., Eds) 17-18 febbraio 1983, 275-300.

Celli G., 1983.- L'ape come insetto test della salute di un territorio.-In: Atti XIII Congresso Nazionale Italiano Ento139mologia, Sestriere – Torino, Italy (Arzone, A., Conti, M., Currado, I., Marletto, F., Pagiano, G., Ugolini, A., Vidano, C., Eds) 637-644.

Celli G., Porrini C., 1987.- Apicidi E Residui Di Pesticidinelle Api E Nell'alveare In Italia (1983-1986).- Bollettinodell'istituto Di Entomologia "Guido Grandi" Dell'universitàdegli Studi Di Bologna, 42: 75-86.

Celli G., Porrini C., Baldi M., Ghigli E., 1991.- Pesticides in Ferrara Province: two years' monitoring with honey bees(1987-1988).- Ethology, Ecology and Evolution, Special Issue,1: 111-115.

Celli G., Porrini C., Siligardi G., Mazzali P., 1988b.- Lecalibrage de l'instrument abeille par rapport au plomb.In: Proceedings XVIII International Congress of Entomology,Vancouver, August, 3-9, 1988, 467.

Celli G., Porrini C., Tiraferri S., 1988c.- Il problema degliapicidi in rapporto ai principi attivi responsabili (1983-1986).- In: Atti Giornate Fitopatologiche, Lecce, Italy, (Brunelli A., Foschi S., Eds) 2: 257-268.

Cordier et al. 2020 T. Cordier, L. Alonso- Saez, L. Apotheloz- Perret Gentil, E. Aylagas , D.A Bohan, A. Bouchez, A. Chariton, S. Creer, L. Fruhe, F. Keck, N. Keeley, O. Laroche, F, Leese, X.pichon, T. Stoeck, J. Pawloswski, A. Lanzen Ecosystems monitoring powered by environmental genomics: A review of current strategies with an implementation roadmap mol. Ecol., 46(2020), pp.235-248,10.1111/mec.15472

Crane, E., 1984. Bees,honey and pollen as indicators of metals in the environment. Bee World, 65 (1): 47 – 49.

Fakhimzadeh, K., M. Lodenius, J. Kujala, H. Kahiolotoand E. Tulisalo, 2005. Using bees and hive products to assess metal pollution in Finland. In: Proceeding of XXXIX-th Apimondia International Apicultural congress, 21-26 August 2005, Dublin, Ireland, 52 pp.

Gallina, A., A. Baggio and F. Mutinelli, 2005. Heavy metal contamination of honey in Veneto region (Northheastern Italy): an overview of the situation 2003 – 2004. In:Proceeding of XXXIX-th Apimondia International Apicultural congress, 21-26 August 2005, Dublin, Ireland, pp. 145 – 146.

Gattavecchia E., Ghini S., Tonelli D., Porrini C., 1987.- Ilmiele italiano dopo Chernobyl.- L'ape nostra Amica, 9 (5):27.indicators of environmental radioactive pollution.- Journal Radioanalytical and Nuclear Chemistry, Articles, 141(2):427-436

Jeliazkova, I., M. Marinova and. Peneva, 2001. Honey bee and their products as bioindicators for environmental pollution.I. Study on mineral content of body of bee-workers received different doses of microelements with their food. Journal of Animal Science, 38 (6): 37-40 (Bg).

Jeliazkova, I., M. Marinova and K. Gurgulova, 2002. Honey bee and their products as bio indicators for environmental pollution. II. Influence of sub-feeding of bee families with microelements contaminated sugar solution on content of those elements in bee organism. Journal of Animal Science, 39 (4-5): 154-157 (Bg).442

Kienzl *et al.*, 2003 Kienzl, K., Riss, A., Vogel, W., Hackl, J., Götz, B., 2003. Chapter 3 Bio indicators and biomonitors for policy, legislation and administration, in: Markert, B.A.,Breure, A.M., Zechmeister, H.G.(Eds.), Trace Metals and other Contaminants in the Environment. Elsevier, pp. 85-122. doi.org/10.1016/S0927-5215(03)80133-9.

Le Conte,Y. and Navajas, M. 2008. Climate change: impact on honey bee populations and diseases. Rev. Sci. Tech. of. Int. Epiz., 27 (2):499-510.

Markert and Wünschmann, 2011 B. Markert, S. Wünschmann bioindicators and biomonitors: Use of organisms to observe the influence of chemicals on the environment P. Schröder, C.D. Collins (Eds.), Organic Xenobiotics and Plants. Plant Ecophysiology, Vol 8, Springer, Dordrecht (2011), pp. 217-236, 10.1007/978-90-481-9852-8_10

Mayer D. F., Lunden J. D., 1986.- Toxicity of fungicides and an acaricide to honey bees (Hymenoptera: Apidae) and their effects on bee foraging behavior and pollen viability on blooming apples and pears.- Environmental Entomology, 15:1047-1049.

Mayer D. F., Johansen C. A., Lunden J. D., Rathbone L.,1987.- Bee hazard of insecticides combined with chemical stickers.- American Bee Journal, 127 (7): 493-495.

McAfee *et al.* , 2020 A. Mcfee, A. Chapman, H. Higo, R. Underwood,J. Milone,L.J. Foster,M.M Guarna, D.R Tarpy, J.S PettisVulnerability of honey bee queens to heat-induced loss of Fertility Nat. Sustainability, 3(2020),pp.367-376, 10.1038/S41893-020-0493-x

Mcgeogh, 1998 M.A. McgeoghThe selection, testing and application of terrestrial insects as bioindicators Biol. Rev., 73 (1998), pp. 181-201, 10.1017/S000632319700515X

Porrini C., Colombo V., Celli G., 1996.- The honey bee (Apis mellifera L.) as pesticide bioindicator. Evaluation of the degree of pollution by means of environmental hazard indexes.- In: Proceedings XX International Congress ofEntomology, Firenze, Italy, August 25-31, 1996, 444.

Porrini C., Ghini S., Girotti S., Sabatini A. G., Gattavecchia E., Celli G., 2002.- Use of honey bees as bioindicators of environmental pollution in Italy.- In: Honey Bees: Estimating the Environmental Impact of Chemicals,(Devillers J., Pham-Delègue M., Eds), Taylor & Francis, London and New York, 186-247.

Porrini, C., P. Medrzycki, L. Bortolotti, A.G. Sabatini, S. Girotti, S. Ghini, F. Grillenzoni, E. Gattavecchia and G. Celli, 2003. Honey bees as bio indicators of the environmental pollution. In: Proceeding of XXXVIIIth Apimondia International Apicultural Congress, 24-29 August 2003, Ljubljana, Slovenia, Final Programme and Book of Abstracts, 424 pp.

Rezvan Davodpour, Soheil Sobhanardakani, Mehrdad Cheraghi, Nourollah Abdi & Bahareh Lorestani, 2019. "Honeybees (Apis mellifera L.) as a Potential Bioindicator for Detection of Toxic and Essential Elements in the Environment (Case Study: Markazi Province, Iran)", Archives of Environmental Contamination and Toxicology volume 77, pages344–358 (2019)

Spodniewska, A. and K. Romaniuk, 2006. Concentration of lead and cadmium in bees and bee bread. In: Proceedings of the Second European Conference of Apidology EurBee, Praque, Czech Republic, 10-16.IX. 2006, www.eurbee.org/topics.html

Stanimirovic, Z., J. Stevanovic, K. Fakhimzadeh and M. Baltic, 2005. Investigations of differences of heavy metalsamount in honeybee bodies and their honey-indication ofhoneybee biofilter abilities. In Proceeding of XXXIX-thApimondia International Apicultural Congress, 21-26 August2005, Dublin, Ireland, 95 pp.

Stein K., Umland F., 1987.- Mobile und immobile Probensammlungmit Hilfe von Bienen und Birken.- FreseniusZeitschrift für Analytische Chemie, 327: 132- 141.

Svoboda J., 1962.- Teneur en strontium 90 dans les abeilles etdans leurs produits.- Bulletin Apicole, 5: 101-103.

Tonelli D., Gattavecchia E., Ghini S., Porrini C., Celli G., Mercuri A. M., 1990.- Honey bees and their products as indicatores of environmental radioactive pollution. Journal of Radioanalytical and Nuclear Chemistry volume 141, pages427–436 (1990

Wallowork-Barber A. K., Ferenbaugh R. W., Gladney E. S., 1982.- The use of honey bees as monitors of environmental- Honey bees and their products as indicators of environmental radioactive pollution.- Journal Radio analytical and Nuclear Chemistry, Articles, 141(2):427-436.pollution.- American Bee Journal, 122 (11): 770-772.

Wolterbeek B., (2002) Bio monitoring of trace element air pollution: principles, possibilities and perspectives. Environ Pollut 120:11–21

Zhelyazkova, I., M. Marinova and K. Gurgulova, 2004.Changes in the quantity of heavy metals in the haemolymph of worker bees fed micro-element contaminated sugar solution. Aricilik, 4 (2): 77 – 80.