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SNAILS AS BIOLOGICAL MONITOR (BIOINDICATOR)

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AUTHORS' CONTRIBUTION

This work was carried out in collaboration between both authors. Author AKS designed the study and wrote the first draft of the manuscript. Authors AKS and VKS managed the analyses of the study and managed the literature searches. Both authors read and approved the final manuscript.

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Review Article

ABSTRACT

A biological monitor reveals the qualitative status of the environment that are present in many water bodies can be monitored for biochemical or behavioural changes that may indicate a problem within their ecosystem. Bioindicators can tell us about the cumulative effects of different pollutants in the ecosystem. Due to their ubiquitous distribution and enormous species number, molluscs play important ecological roles in the different aquatic and terrestrial ecosystems of the world. They provide key species for ecosystem functioning because they contribute to huge amounts of the biomass on the different trophic levels in ecosystems. Gastropods represent the only molluscan class in terrestrial ecosystems and consequently, snails are the only molluscs which can be used for bioindication and biomonitoring purposes in these environments. Most species of the snails play a dominant role in the fresh waters by providing food for other organisms like fish and improve water quality by consuming large quantities of detritus and algae. The heavy metal accumulates in the body of the soft parts of the animal, as well as in the shell Gastropoda. Bioaccumulation of heavy metals by gastropods are influenced by environmental factors such as water flow, water availability, pH, sediment, salinity, and other.

Keywords: Biomonitor; pollutant; ecosystem; heavy metals; gastropoda; accumulation; contamination.

1. INTRODUCTION

A biological monitor or bioindicator is any species or group of species whose function, population, or status can reveals the qualitative status of the environment that are present in many water bodies can be monitored for biochemical, physiological or behavioural changes that may indicate a problem within their ecosystem [1]. Manickavasagam et al [2] described that bioindicators can tell us about the combined effects of different pollutants in the ecosystem and about how long a problem may have been present. Parmar et al. [1] explained that a biological monitor or biomonitor is an organism that provides assessable information on the status of the environment around it. Therefore, a good biomonitor will indicate the presence of the pollutant and can also be used in an attempt to provide supplementary information about the amount and intensity of the exposure [3]. Gall et al. [4] reported that land snails are mainly plant consumers and, as a result, they could be important indicators of transfer of the pollutants to higher trophic levels and they also play a major role in food chain transfer of the metals from

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plants to carnivores. Vaufleury and Pihan [5] reported that especially Helicidae have the magnitude to accumulate different classes of chemicals and, there-fore, they can serve as relivent species for monitoring of trace metals, agrochemicals, urban pollution, and industrial electromagnetic fields. Singh et al. [6] reported that environmental concentration of heavy metal on the local fauna, biomarkers of the environmental stress are explore mainly in the midgut gland of mollusks and these gland was chosen as a target organ for the biochemical assessment because it accumulates pollutants of a diverse nature and actively participates in the detoxification processes. Nica et al. [7] have shown that three species of snails: *Helix aspersa*, *Helix pomatia* and *Arion rufus* accumulate zinc, cadmium and lead in their hepatopancreas, an organ that also plays a significant role in the animals' nutritional physiology. Moreover, *Helix aspersa* snails have been extensively used under laboratory conditions to assess the accumulation and/or deleterious effects of Cd. Benbow et al. [8] reported that due to their global distribution and enormous species number, molluscs play important ecological roles in the different aquatic and terrestrial ecosystems of the world and they provide key species for ecosystem functioning. Many other groups feed on molluscs, like echinoderms, fish, birds and mammals. Molluscs act as vectors for a number of human-relevant parasites and diseases, e.g. as middleman hosts of trematodes, and a number of mollusc species live as endoparasites themselves [9]. Parker et al. [10] reported in his literature that molluscs are for a number of reasons well suited as bioindicators or biomonitors and only Gastropods constitute the only molluscan class in terrestrial ecosystems and consequently, snails are the only molluscs which can be used for bioindication and biomonitoring purposes in these environments. Oehlmann and Oehlmann [11] reported that most terrestrial gastropods belong to the class pulmonates (order Stylommatophora), but also the members of the two prosobranch subtropical and tropical families Hydrocenidae and Helicinidae and the highly endangered European littorinid snail *Pomatias elegans* are living in terrestrial environments. Manickavasagam et al [2] also reported that biomonitoring aim with snails have found an increasing interest during the last decade and a number of favourable projects have already been conducted. Most of them made use of the snails' bioaccumulation potential for metals and organic contaminants, but there are also examples for surveys which assessed the biological effects of soil contaminants on different levels of biological corporation [12]. The value of the environment is a matter of significant anxiety, due to the outcome of human intervention are already obvious. Although environment is extremely important for people and other living organisms, it is also endangered due to human activities that are continuously devastate it [13]. East Hammar marsh is one of the important water bodies in the province of Basra that expose to continuous of many serious pollutants like trace metals, which is one of the natural element in the earth's crust and may enter water bodies through nonpoint source pollution. Gburi et al [14] reported that contamination by this type of pollutants may increases the risk of these contaminants when they reach the aquatic environment in large quantities. Rai [15] reported that Wetlands (marshes) are of the most important ecosystems used to get rid of trace metals in the water due to the presence of aquatic plants that accumulate of these metals in its biomass. Trail metals are found in water both in soluble and particulate also found in residue and are accumulated in the bodies of living organisms, including invertebrate [15]. The present study shall discuss the impact of various bioindicators in environmental pollution.

2. GASTROPODS STRUCTURE

Samsi et al. [16] described in his review that the shell of gastropods is twisted, uneven, usually with a circular scroll shell and their soft body is divided into four main parts: the head, which is usually notable in the anterior of the shell; legs, stomach muscular organ with the essentially flat part that is used to crawl or burrowing; visceral mass, that fills the back of the spire shell, and contains important organ systems; coat, a tegumen such as lines and produce shells, and formed the mantle cavity which is usually where the gills. Most gastropods have a single circular shell, and the gill cover operculum. Strong et al. [17] reported that Prosobranchia as the majority type gastropods and shells of gastropods Prosobranchia usually consists of a circular and spiral tube increases with diameter growth, and opening only at the end of the growing ventral, called aperture. The axis may be vacant shells or columella, organize the opening of the shell, umbilicus. Basic shell formed by the largest spiral or body whorl, while the other whorls, which closer to the top or apex, is spire [18]. The continuous line where two adjoinig helices and joined known as suture or joint. The aperture may be simple, rounded lines eggs, or can be re-shaped anteriorly by siphonal canal. Margins are close to columella forming an inner lip, while the opposite margin of the outer lip; Last margins occasionally show posterior canal. Shell surface is usually smooth, but usually also look chiseled, sculptured. A chisel element in the form of a spiral else (follow the arc of a helix), or axial (transverse to the whorls and approximately parallel to the axis of the circular or axis) [16].

3. WHY SNAILS AS BIOINDICATOR

Elder and Collins [19] reported that freshwater mollusks snails and bivalves have been used commonly as bioindicator of both organic and inorganic contaminants. Salánki et al. [20] reported that the two important ascendancy of snails and bivalves over most other freshwater organisms for biomonitoring research are their large size and restricted mobility and in addition, they are plentiful in many types of fresh water environments and are somewhat easy to collect and identify. At metal concentrations that are within ranges common to natural waters, they are generally potent bioaccumulators of metals [21]. Sowa et al. [22] reported that biomonitoring studies with freshwater molluscs have covered a wide multiplicity of species, metals, and environments and even within one species, individual characteristics such as size, life stage, sex, and genotype can have remarkable effects on responses to contaminants. The bioavailability of the metal is highly variable and depends on pH, presence of organic ligands, water hardness, and numerous other controlling factors [23]. Stankovic et al. [24] reported that the snails can be used as superior ecological indicators due to their small body size, narrow mobility and position in the food chain. Most species of the snails play a presiding role in the fresh waters by providing food for other organisms like fish and enhance water quality by consuming large quantities of detritus and algae [25]. Pabian and Brittingham [26] reported that in the forest ecosystem a decline in the reproduction in the passerine birds due to decrease in the snail abundance on acidic soils. Amadi et al. [27] reported that the snails are sensitive to the bulk of pollutants dispersed in their environment, such as pesticides and heavy metals, field studies on the cross section collected from polluted sites can provide information on the effects of chronic exposure to the contami-nants on snails' health. Therefore, the investigaton of the cellular biochemical parameters in snails under field conditions gives a chance to evaluate their sensitivity to the environmental stress [27]. Authman et al. [28] reported that bioaccumulation of metals in biota is a function of both uptake and absolution. Uptake in molluscs may be through either of two vectors- ingestion of food and other metal-containing substances or through direct adsorption of dissolved ingredient [28].

4. GASTROPODS MOLLUSC AS IDEAL BIOINDICATOR

Some of the unique combination of different features which specify molluscs as ideal bioindicators are described by several authors in his literature. These are as follows-Vinarski et al. [29] described in his review that the gastropods molluscs are universal and plentiful in all marine and freshwater ecosystems worldwide and they are also be found in almost all terrestrial environments. Walters [30] reported that due to the lack of an exoskeleton, as it is present in arthropods, molluscs are in direct relation with the ambient medium i.e. water or soil. Therefore, chemicals can be taken up not only from the diet but also additionally from ambient water or soil via the integument, including the respiratory organs in aquatic species, resulting in a prominant accumulation potency for contaminants. Parker et al. [10] reported that many molluscs are key species for the functioning of marine, freshwater and terrestrial ecosystems so that it is likely that a pollutant that affects such a mollusk population will also display a negative impact for the whole ecosystem. Strong et al [17] reported that some terrestrial gastropods are endemic with a rather restricted distribution, principally those living in the aquatic environment, exhibit a broad distribution within and even between continents, facilitating their use in geographical large scale surveys. Furthermore, a number of species and genera are even cosmopolitans e.g. mussels of the genus *Mytilus* with the two species *M. edulis* and *M. galloprovincialis* being the most widespread. Oehlmann and Oehlmann [11] reported that the majority of gastropod and bivalve species exhibit an especially limited mobility or are completely sessile as adults. Therefore, these molluscs represent the contamination of their habitat ideally. The only deviations are pelagic snails from the prosobranch genus *Janthina*, the Heteropoda (*Atlanta*, *Carinaria*, *Pterotrachea*) and Pteropoda (*Hyalela*, *Creseis*, *Styliola*). Most of the aquatic mollusc species, especially in the temperate, subtropical and tropical region, have a planktonic larval stage which promise a high dispersal potential and allows a recruitment of populations even in those habitats where sexually mature adults might have become extinct due to the high level of contamination. Zierold et al. [31] reported that Molluscs represent a broad variety of reproductive modes, like simultaneous and successive hermaphroditism, gonochory and parthenogenesis, each of them combined with semelparity or iteroparity so that effects of contaminants affecting specifically these types of reproduction can be monitored. Furthermore, mollusks exhibit an marvellous variation of life-cycle-strategies, especially with respect to their longevity. While the majority of the cephalopods, the marine opisthobranch snails and most of the freshwater and terrestrial gastropods are short living species with a maximum life span of one year, the marine prosobranch snails and many bivalves are long-living so that they can intermix contaminations of their environment over long time periods. Abdallah

[32] compared with other invertebrate groups like arthropods and especially vertebrates, molluscs demonstrate only a limited ability to excrete pollutants directly via their kidneys or other excretory organs and tissues, to metabolise organic chemicals, and to physiologically inactivate toxic heavy metals, e.g. by the formation of and binding to metallothioneins. As a result, molluscs attain higher bioaccumulation or bioconcentration factors for many toxicants than other systematic groups. Therefore, pollutants might exhibit negative impacts on molluscs at lower environmental concentrations than on other invertebrates or vertebrates, facilitating their use as a kind of ecological early warning system. Oehlmann and Oehlmann [11] reported that molluscs are non-controversial as organisms for ecotoxicological research, especially as test animals and for environmental monitoring.

5. IMPACT OF HEAVY METALS ON SNAILS

Gundacker [33] reported that bioaccumulation of heavy metals by gastropods are govern by environmental factors such as water flow, water availability, pH, sediment, salinity, and in addition, body size, weight, and gender have an important role in the accumulation of heavy metals. Jaishankar et al. [34] reported that bioaccumulation and acute and chronic toxicity are highly dependent on metal speciation because of this influence of metal speciation, toxicity and bioaccumulation do not have a accordant relation to each other. Sensitivity to toxic effects of a metal is likely to be significantly greater in juvenile or larval stages than in adults. Nho et al. [35] noted that Gastropods also are used as an indicator of metal contaminants in sediments of mangrove Dumai, Sumatra, Indonesia. Amin et al. [36] reported that if the concentration of Cd, Cu, Pb, Zn, Ni and Fe increased the abundance of gastropods and species diversity will decline and the link between the concentrations of heavy metals in sediment with a number of species of gastropods are found to be negative. Wolf and Rashid [37] in his experiment found that the *Littoraria scabra* density is higher in areas that are not polluted than the polluted area. Hodkinson and Jackson, [38] reported that biomonitor or bioindicator using indicator taxa that explore the impact of environmental changes such as change of habitat, fragmentation, and climate change in the spatial and temporal scales and also noted that indicator species may act as a representative of a group of organisms or the larger community. Ansari et al [39] reported that marine gastropods bountiful along the coast in the world, easily be identified, and seize all the time every year, and can tolerate a wide range of concentrations of contaminants and physicochemical variables such as salinity. Marine gastropods most ideal as biomonitor [40]. Jackson et al. [41] reported that bioavailability is found the Cd in the form of nanoparticles and they are also used large-scale as bioavailability. Wolf and Rashid, [37] also reported that Aluminium, copper, manganese, tin, and zink is found in the soft tissues *Littoraria scabra* which living in polluted mangrove area. Tchounwou et al. [42] reported that *L. scabra* may accumulate heavy metals derived from the water or the food. Atobatele and Olutona [43] reported that the heavy metal accumulates in the body of the soft parts of the animal, as well as in the shell of Gastropoda. They also noted that large heavy metal content in each of the soft tissues and shells of gastropods will be different and distribution of heavy metals in body tissues gastropods are influenced by physiological tissue and metal bonding, storage and detoxification strategies. Sorogya et al. [44] reported that the shell of *Nerita albicilla* can accumulate Cu, Pb, Zn, Ag, Th, Ba, Ti, S, Sc, Se and *Canarium (Gibberulus) gibbosus* can accumulate Mo, U, Au, and K and in addition, changes in the size of *Littoraria scabra* were found in the area of non-polluting has a total weight, shell length and shell width greater than those found in the polluted area.

6. EXAMPLES OF SNAILS AS BIOINDICATOR

There are various kinds of gastropods that can be used to dictate the presence of pollutants in the environment [45]. Wolf et al. [46] reported that *Littoraria scabra*, gastropods used in the study of heavy metal accumulation in mangrove ecosystems. Samsi et al. [16] using *Terebralia palustris* to determine the direct and indirect effects of contaminant waste to it. Ruiz, et al. [47] reported that *Nucella lapillus* and *Nassarius reticulatus* used to determine the figure of bioaccumulation butyltin. In addition, shells *Nerita albicilla* and *Canarium (Gibberulus) gibbosus* used as an indicator of pollution in the Red Sea, Egypt [44]. Gastropods types *Telescopium telescopium* also used in biomonitor Cd, Cu, Pb, Fe, Ni and Zn in Sungai Sepang Besar, Malaysia. Metal contamination found in tissue and soft tissue gastropod shells. Body parts such whorl shell, the shell middle, and part of apex. The soft tissue covering the legs, tentacles, gills, muscles, coat, digestive tract and other tissues [48].

7. CONCLUSIONS

Molluscs have been successfully used as bioindicators in monitoring programmes in the past. Terrestrial ecosystems were much less considered than the aquatic environment but even for the latter it can be stated that bivalves, gastropods and especially the other molluscan classes have not yet received the attention they probably deserve, speaking in terms of their ecological importance. Gastropods can be used as bio-indicators and biomonitor heavy metal pollution. Gastropod response to pollutant indicated by the decrease in the abundance, size changes and can affects the community structure. Environmental factors, body size, weight, and gender influence in the accumulation of heavy metals. Heavy metals can affect hardness, thickness, volume, and color of the shell.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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