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REVIEW ARTICLE

Environmental opportunities of aquatic insects in nanotechnology

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HIGHLIGHTS

> Aquatic Insects in Nanotechnology.

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ABSTRACT

Nanotechnology plays an important role opportunity in several industries, biotechnology, medicine, and environments by creating new opportunities. These roles may be developed for recyclability, to prevent environmental pollution and performance of countless products. For example, in terms of environmental protection, nanotechnology has every possible method. The most influential members of the environment are insects in terms of species numbers-varieties. For this reason, in terms of the sustainability of these areas, it is important to analyze insects in more detail, especially in freshwater. If these details are obtained, it can only be feasible with nano-scale research that current and evolving technology. The purpose of this review is to investigate to take lead in the formation of ideas that will enable the discovery of new features about correlations between aquatic insects and nanotechnology. It is expected that this review will enable us to explore the latest ecological data and will lead us to new methodological approaches on nano-scale for aquatic insects.

1. Introduction

Over the long history of human evolution, various insects (hexapods) have adapted to the unique habitats and conditions created by humans in and around the household. This group of organisms has also successfully adapted to their natural habitats. The adaptation was accomplished through the ability of hexapods associated to utilize food resources and harborages with humans [1]. In all ecosystems, biotic concussion is expected gradually to increase worldwide due to human activities [2]. These adaptations have taken place in an ecosystem balance. However, human activities negatively affect all terrestrial and aquatic ecosystems [3].

Freshwater is an essential resource for life [4] in aquatic ecosystems. These areas support approximately 10% of all species in the World [5]. Especially macroinvertebrates constitute an important part of the biotic parts in freshwaters. Hexapods cover the majority of macroinvertebrate communities [6]. Hexapods, without its means to collapse food production [7], have some exemplary living beings in analyzing the structure and function of the freshwater ecosystem due to their high abundance, huge biomass, and rapid colonization of freshwater habitats [8]. In addition, they are responsible for much of the transfer of organic matter [9] in freshwaters.

Some insects are commonly used as indicators of ecological conditions to describe recent habitat transformation [10]. Therefore, freshwater ecosystems have been studied to better understand their current and future importance [11] through new methodological and technological studies. The first of these new technologies is nanotechnology. Nanotechnology includes running manipulation of materials at atomic/molecular level in the range of 1-100 nm. Objects in this level display

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incomparable and distinct physical, chemical, or biological characters over their mass form. The 21st era may be concerned as a new centenary of nanotechnology [12].

In this study, information is given about widely use of aquatic insects in nanotechnology. Our results are believed as an important gain in ecological and nano-scale dimensions. In terms of all these, evaluating using, purposing, and opportunities of aquatic hexapods in nanotechnology are the subject of this review. The review examines aquatic insects in wetlands, which have not yet been totally discovered in nanotechnology. It is expected that important data will form basis for some scientific studies. It is believed that anatomical structure, physiological properties and adaptive abilities of these insects will shed light on some unexplored new discoveries in nanobiotechnology.

2. Main body and discussion

Our current era can be easily regarded as a new era of nanotechnology in research and development with its potential applications ranging from electronics to material science. This field enables to development of novel nanoscale-based manufacturing processes (Figure 1), nanostructured materials, and nanoelectronics. Nanomaterials have definite physical, chemical, or biological properties over their massive form (Figure 2). Nano-scale opportunities open a fresh corridor in the area of innovative product development and are considered to the uplift the economy and development of the country significantly in near future [13,14].

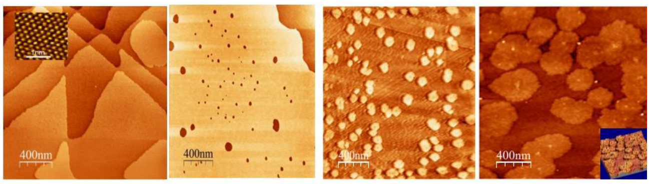

Figure 1. Images on nano-scale under SEM [15].

Enzyme-imitation catalytic nanoparticles, more commonly known as NanoZymes [16], so using enzyme mimicking on aquatic hexapods is possible to preventing invasive organisms and pollution in terms of bio-indicator. Nanotechnology intervenes in these circumstances by all means. In visual research, a new hybrid apposition/superposition lens system borrows much of its design inspiration from the compound lens structure found in hexapods such as the dragonfly [17]. Nanoscale fibrillary building on hexapod pods and geckos are the principal components, which endow them with such extraordinary adhesive wall walking properties. Fibrillary structures take on a hairy appearance that varies in size and surface density between species. The weight of animals has ordered the evolutionary path of adhesive design, supplying smaller hexapods with large adhesive structures, and geckos with fine nanometer-scale hairs [18].

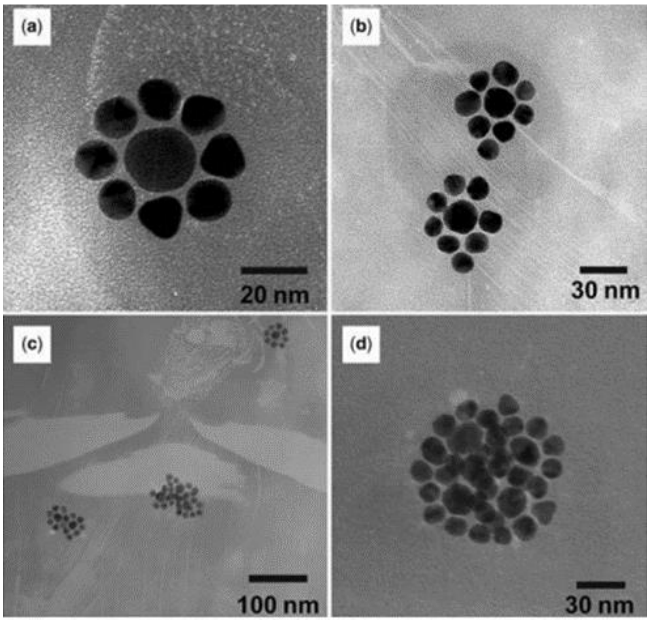

Figure 2. Various nano sizes [19].

Examples of particles levels, nanoparticles have been used for a very long time. For example, carbon black is the most well-known example of a nanoparticulate material that has been produced in quantity for decades. In old Indian medical practice, the therapeutic effects of gold and silver were known and put to use [20]. Nanoparticles have captivated big attention for biomedical applications including disease diagnosis and treatment [21]. These particles own prominent physical, biological and chemical properties associated with their atomic strength [22]. Goswami et al. experiment was purposed at pedigree and testing of lipophilic entomotoxic silica nanoparticle (SNP) in tropical climates and value addition for urban and intensive agriculture and poultry industries [20]. In summary, the experiment is not a hexapod infestation, which is found in the SNP treated stored rice even after 2 months, so SNP can also be used as an excellent seed-protecting agent. Hexapod control and nanoparticles should be accelerated toward the introduction of faster and eco-friendly pesticides in next near days [23]. Nano-scale (biological) control applications in environments will change public awareness and increase its implements in the future.

Ecosystems differ in their dynamics [24] and animal influence on the ecosystem dynamics remains widespread, especially hexapod herbivory has a substantial impact on some environment dynamics [25]. Aquatic macroinvertebrates act important roles in many ecological processes in their living area [26]. For example, aquatic hexapods (Figure 3) can build up inland waters [27]. Coleoptera order comprises some 250,000-known species, many of which are able to exploit human-made, are now important pests. Pest species are known from a wide range of commodities, including dried fish, skins, woolen articles, museum specimens, and cereal grains [28]. It is very important to conduct nano-scale research on this family, which is important especially in aquatic areas with its prevalence and known annoyances.

Figure 3. An aquatic hexapod [29].

Coleoptera, which is expressed as "hexapods" or "hard-winged", is the hexapod group represented by the most species on earth. Percentages 40 of existing hexapods are in this order [30]. Some of these living creatures undergo holometabolic metamorphosis and their life phases are egg-larva-pupa and adult [31,32]. Studies on the biology of Dytiscidae family hexapods have been researched. These hexapods provide necessary oxygen by creating air spaces as hunting [33–37]. This is important for nanoscale studies. Helophoridae, which has a wide distribution area, are represented with 200 species (approx.) in the world [38–53]. Hexapods of the Hydrophilidae family; these members have nutritional value for fish and waterfowl, found in lakes, small puddles, and shallow parts of fast-flowing water [45,54–57]. Elmidae family has 1497 species in 147 genera worldwide. They have also been reported that there are five fossil records belonging to two genera [58]. They prefer to live on rapid-flow Rivers and are sensitive to the various pollutants [59,60]. Adults and larvae feed on diatoms, rotten algae detritus, and plant residues [61]. Therefore, it is known that they were clean-water [60,62]. Doubtlessly, it is nanotechnologically inevitable that this expansion will bring many scientific and technological opportunities. Heteroceridae family live in the muddy or sandy parts of the aquatic habitats where galleries they have opened in soil [63–66]. If these galleries are examined at the nanoscale, it is likely that there will be unexpected discoveries.

In aquatic ecosystems, some mycelium contains a hydrophilic segment. These micelles have low resolution, low-level features. Therefore, Micelles pharmaceutical products. It is inexpensive to manufacture and can be used widely. More allows small sizes to roam alongside [19]. This is a risk to the environment. The mechanisms of the aquatic hexapods feeding on these micelles to dissolve the toxic substances in the micelles can be explored on a non-scale. Otherwise, there are several communities were associated with these aquatic areas. Firstly, extremophiles organisms are described that are accommodated to grow selectively at or near the extreme ranges of environmental variables [67]. Nanoscale characters in the life of extremophiles are the subject of research. Else, another aquatic area, microbial communities may be given a second example from other communities. Microbial communities play pivotal roles in biogeochemical processes [68]. Precursory research included modeling enthusiastic behavior of using prokaryotic channel proteins and to date, the first ion channels purified have been sodium and potassium channel [69,70] from *Escherichia coli*.

Once more, heavy metal deposition is a pervasive environmental problem because heavy metals are non-biodegradable and have the potential to accumulate in macro-organisms. Most of these metals are drastically toxic even at low concentrations depending on the solubility of heavy metal compounds in the aquatic areas [71]. Some heavy metals such as Cadmium, Copper, Lead, and Zinc are essential for the growth and survival of the organisms [72]. Many studies have been carried out due to the problems caused by heavy metals, the environment, and human health. There are bacteria that bind heavy metals in the gut microbiota of some aquatic hexapods [73], in particular, it has great value in the nano-scale prevention of environmental pollution. As it is thought that heavy metals are effortlessly aggregated in edible parts of leafy vegetables, as compared to grain or fruit crops [74], as *Exiguobacterium*. *Exiguobacterium* bacteria are below growth, Gram-positive, facultative anaerobes. Matching of expansion of *Exiguobacterium* strains isolated from cold and hot environments indicated that all could grow within a temperature range of 20–37 °C. Nevertheless, the least possible temperature permissive of growth appeared to vary noticeably [75]. Three *Exiguobacterium* sp. defined, it has attracted the attention of researchers as an important resource for developing environmentally friendly biological alternatives, because of its ability to survive in changing environmental conditions and to tolerate heavy metal stress including arsenic. Nano-scale manipulation is understood how important of agricultural and environmental.

If we talk about pesticide use by utilizing the technology of nano-scale, accession for leading of hexapod pest has become the need of our current. As to be envisioned in the implementation of nanotechnology in agriculture, it can be suggested that the use of nanomaterials will result in the development of efficient and potential approaches toward the management of hexapod pests [76].

Divergently, since 1950 annually plastic demand has risen at defensible rates [77], with growing trouble of waste disposal and high cost of pure substrates in polyhydroxyalkanoates (PHA) production. It has caused to future need of upgrading waste streams from different industries into the role of feedstock for the production of PHA [78]. In previous studies, bacterial species were discovered; these bacteria effectively degrade plastic from hexapod guts [79]. Also, *Exiguobacterium* spp. has the potential to degrade synthetic products such as plastics. [77,80].

Magnetic research has indicated that hexapods have ferromagnetic resonance, which is temperature-dependent. Magnetic material is present in the head, thorax, and abdomen of some hexapods. Magnetic nanoparticles in the social hexapods act as geomagnetic sensors [81]. It is aware of the behavior of a great variety of higher animals is influenced by changes in the local magnetic field within their environment. If we give more interesting examples, it has been displayed that honeybees (*Apis mellifera* Linnaeus) use geomagnetic field information for orientation, homing, and foraging [82].

Intercalary, in forestry industries, nanotechnology is in its fresh stage. For this reason, it has countless studies opportunities for innovations like the development of intelligent paper/wood-based products along with in-built sensors, manufacturing pulp, paper, and wood/fiber-based products, building functional lignocellulosic surfaces, nano dimensional building blocks of higher strength and lighter weight [83]. The cardboard sector has been evolved with use of microfibers and clay fillers that substantially improves their performances. These features make lignocellulose an outstanding material for forest-based research. Nanotechnology has the potential to produce valuable wood-based materials such as engineered wood and fiber-based materials that can effectively replace non-renewable materials used in the manufacturing of plastic, metallic or ceramic products. Thereby, fulfilling social demands and improving forest health as well [12].

Nonetheless, chitosan is not toxic, a bio-harmonious polymer that has found a number of applications in drug delivery [84], use of chitosan in nanotechnology is prevalent [85]. Chitosan is an amino polysaccharide and exoskeleton of some animals as hexapods. This organic object is not toxic. The biocompatible polymer has found a number of applications in drug delivery [86]. Chitosan can bind to DNA and take part in gene transfer (Figure 4).

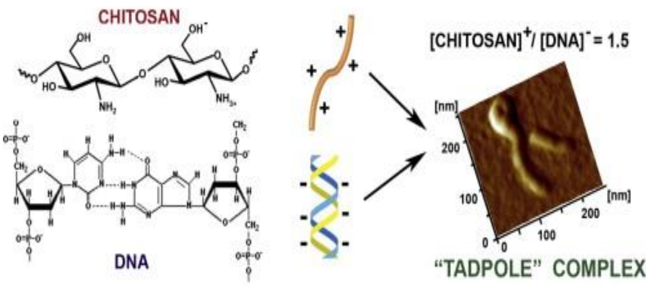

Figure 4. Chitosan–DNA complexes [87].

Additionally, chitin-like substances are obtained from aquatic hexapods [88].

Finally, these data in industry and technology, which have been published, constitute the main idea of our review.

3. Conclusions

Hexapods, the most populated group in the living world, has been attracted attention with their various characteristics by researchers. When we regard many more unexplored nanoscale characters of aquatic hexapods in their life forms, it is believed that many features of nanotechnological significance are still unsolved. Many undetermined hidden nanoscale properties of these creatures are likely to be used in agriculture, industry, medicine, defense, medicine, and even astronomy (on the extremophile aspect). In the next few years, we expect that it will be realized with more research to be done by nanotechnology.

Compliance with Ethical Standards

There is no conflict of interest to disclose.

Conflict of Interest

The author(s) declares no known competing financial interests or personal relationships.

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