Scholar Publishing Group
Academic Journal of Environmental Biology
https://doi.org/10.38007/AJEB.2022.030104
ISSN 2789-8407 Vol. 3, Issue 1: 38-47

Biological Monitoring Index of Fluorine Polluted Animal Husbandry Ecological Environment Based on Machine Learning Algorithm

Dazhi Xu[1, a*], Yu Yuan[1, b] and Xiaoyong Xiao[1, c]

[1]*College of Economics and Management, Hunan University of Arts and Science, Changde 415000, Hunan, China*

[a]*xudazhi@huas.edu.cn*, [b]*yy8646@huas.edu.cn*, [c]*zxxy2001@huas.edu.cn*

[*]*corresponding author*

Keywords: Machine Learning Algorithm, Fluorine Pollution, Animal Husbandry Ecological Environment, Biological Monitoring Indicators

Abstract: Fluorine widely exists in nature, and its element is one of the most oxidizing substances among all elements. It can even react with some inert gases to form corresponding fluorides. Due to this special chemical property, fluorine has a wide range of applications in many fields including medicine, chemical industry, aerospace and atomic energy. Therefore, the development of water defluorination technology is related to human health and happy life, as well as environmental health and water quality safety. The research purpose of this paper is the biological monitoring index of fluorine pollution animal husbandry ecological environment based on machine learning algorithm. Using machine learning algorithm and diversity index in the experiment, from the alarm value and grading standard of poultry manure load, the environmental impact of fluorine-contaminated livestock and poultry manure and other pollutants, and the biological monitoring of fluorine-contaminated livestock and poultry ecological environment three aspects of the indicators were analyzed experimentally.

1. Introduction

With the widespread use of fluorine, many people around the world have been affected by fluorosis. A small amount of intake can help prevent dental caries and prevent osteoporosis [1]. Excessive intake can be harmful, causing dental fluorosis and bone fluorosis. Fluoride is an essential element for the mineralization of human tissues and plays an important role in bone health and the formation of tooth enamel. However, excessive intake of fluoride can cause serious health

problems such as dental fluorosis and calcium and phosphorus metabolism disorders. The adsorption method is widely used in fluorine pollution control due to its low cost and reproducibility. The cost of adsorbents is the focus of the current development and promotion of adsorption technology. As a ubiquitous substance in nature, iron oxides have many types and complex structures, and have good adsorption properties for fluorine.

Machine learning algorithms are widely used in all walks of life, and it is becoming easier and easier to develop an application of machine learning algorithms to solve real-world problems. However, in the process of using machine learning, the optimization of machine learning algorithms is still a difficult task to solve.Tarasenko V F investigated laser measurements of diffuse emission from a mixture of helium and fluorine in a strong inhomogeneous light field. The laser light is trapped in the visible and vacuum ultraviolet spectral regions emitted by fluorine atoms and molecules. The results showed that in the mixture, the duration of the laser was several times longer than the current approximation. Due to the uniformity of diffuse emission, the maximum lasing efficiency of a fluorine laser is comparable to that of a laser pumped by a pre-ionized external volume discharge [2]. Kallinen We investigated cannabinoid-like receptors that are upregulated on activated microglia as markers for PET imaging of neuroinflammation. Typically, ligands show low nanomolar titers, selected ligands show high CB2 binding affinity, radiolabeled with fluorine from chloropyridyl and alkyl tosylate precursors, with good to highly resolved radioactive yields . Specific binding of radioligand candidates was assessed on rat spleen maps using in vitro autoradiography [3].The research on the fluorine-polluted animal husbandry ecological environment based on machine learning algorithm still needs to be improved.

This paper studies the overview of fluorine, including the existing forms of fluorine and the source of fluorine pollution; in the fluorine pollution control technology, the ion exchange method and membrane treatment method are described, and the membrane treatment method includes electrodialysis and nanofiltration. It expounds the research on animal husbandry, the research on the countermeasures of animal husbandry development. In the experiment, the species diversity index can be divided into diversity indices, which all depend on the number of species in the community and the number of individuals in each group, and are several measurable indicators that reflect the diversity of the community. Using machine learning algorithms and a diversity index, the Shannon-Wiener index, referred to as the Shannon index, is currently the most widely accepted and widely used diversity index by ecologists. The experimental analysis was carried out from three aspects: alarm value and classification standard of poultry manure load, environmental impact of fluorine-contaminated livestock and poultry manure and urine and other pollutants, and biological monitoring indicators of various livestock and poultry ecological environment in fluorine-contaminated animal husbandry.

2. Study on Biological Monitoring Index of Fluorine Polluted Animal Husbandry Ecological Environment

2.1. Overview of Fluorine

(1) Existence form of fluorine

Fluorine is the most non-metallic and most electronegative element among the known elements. Its atomic radius is extremely small (the covalent radius of fluorine is 0.071 nm, and the ionic radius of fluorine is 0.133 nm). Electron propensity causes fluorine to be highly oxidizing, which directly reacts chemically with many components in the air, such as hydrogen, water, and nitric oxide [4]. Fluorine in the natural environment will have certain effects on organisms.

(2) Source of fluorine pollution

Fluorine pollution refers to the environmental pollution caused by fluorine and its compounds, which is mainly divided into natural factor pollution and human factor pollution. Fluorine has strong mineralization ability. The fluorine-containing minerals in various ores in nature are mined or weathered, which makes the fluorine element migrate and transform, and some are transferred to other minerals, while some fluorine enters the groundwater. This will form high fluoride groundwater, cause fluorine pollution, and then easily lead to the prevalence and spread of fluoride diseases [5]. Man-made pollution mainly comes from emissions from phosphate fertilizer production and coal combustion, while the electronics industry, glass industry and etching process can cause significant increases in fluoride concentrations in surface water. Excessive fluoride intake by animals can have toxic effects on growth, learning and memory abilities, blood and feeding efficiency. After plants absorb fluoride in contaminated soil, the absorbed fluoride will be transferred to young shoots, causing physiological, biochemical and structural damage, and even cell death. The harm caused by high fluoride water to the human body has not been paid attention to for a long time, resulting in the serious neglect of the treatment of high fluoride water, which has a great impact on human physical and mental health. Until the 1970s and 1980s, the discovery of endemic fluoride disease promoted people's attention to fluoride pollution. Today, the development of fluoride-containing water (including natural drinking water sources and wastewater treatment) treatment technology has become the key to fluoride pollution control. Research hotspot [6].

2.2. Fluorine Pollution Control Technology

The fundamental measure for the prevention and treatment of endemic fluorosis lies in the selection of water sources that meet the safety requirements [7]. There are two ways to choose, one is to choose a suitable water source, and the other is to reduce the fluorine content in the water body through various methods to become a suitable water source. The selection of suitable water sources is often restricted by various conditions. In most cases, fluoride-containing water is treated to obtain suitable water sources by reducing the fluorine content. Domestic fluorine removal technologies mainly include ion exchange method, membrane treatment method, flocculation precipitation method, electrodialysis method, reverse osmosis method, electrocoagulation method, etc. However, most of these methods have the disadvantages of high operation and maintenance costs, secondary pollution and complicated treatment processes [8]. The adsorption method to remove fluorine in water has been considered by scholars to be the most suitable method, because the adsorption method has high fluorine removal efficiency, simple operation, and most of the adsorbents have a wide range of sources and low prices. most method. The following are some control methods of fluorine pollution [9].

(1) Ion exchange method

The principle of the ion exchange method is to let water flow through the ion exchange layer of the ion exchanger to remove unwanted ions. The ion exchanger is divided into cation exchanger and anion exchanger. In the process of ion exchange, any counter ion leaving the surface of the ion exchanger is equimolarly replaced by another counter ion to maintain the electroneutrality in ion exchange, which is a fast and reversible process [10]. The fluorine removal efficiency of composite resin is higher, and it is easy to regenerate, but other beneficial minerals will be removed at the same time as fluorine removal [11]. In the exchange sequence, the selective adsorption coefficient of fluoride ions is the smallest, indicating that the resin has a low adsorption capacity for fluoride ions, and the interference of other ions is large, so the ion exchange method is not suitable for

removing fluorine in water [12].

(2) Membrane treatment method

Fluorine removal by membrane treatment is a method of selectively permeating fluoride ions in liquids by using special membranes. Membrane separation technologies mainly include ultrafiltration, electrodialysis and pervaporation. The advantages of membrane treatment for fluorine removal are simple equipment, convenient and safe operation, high operational reliability, and less pollution to the environment [13].

1. Electrodialysis

Electrodialysis refers to the process of removing ionic components from an aqueous solution using an ion exchange membrane under the action of an electric field. Some researchers have used electrodialysis to treat fluoride ions in brackish water and found that the fluoride removal effect without chemical pretreatment is better, and it is more suitable for environmental requirements. Like reverse osmosis, electrodialysis is also a type of membrane method for fluorine removal, which has the advantages of high removal rate and no use of chemicals. But because it can remove all the ions in the water, some essential minerals and ions are also removed from the drinking water, which is not up to the drinking water standard. Therefore, sludge disposal, high initial membrane costs, remineralization process and operating costs make membrane processes economically unsuitable and environmentally unsustainable.

2. Nanofiltration

Nanofiltration is a relatively new process and its separation performance is between reverse osmosis and ultrafiltration. Compared with other monovalent ions, fluoride ions are more easily combined with water due to their higher charge density, so fluoride ions are more easily retained by nanofiltration membranes. Although nanofiltration and reverse osmosis processes are similar, nanofiltration produces the same permeate flux at lower pressures. In the treatment of high fluoride water, the nanofiltration process can provide partial defluorination, and the optimal fluorine content in the permeate can be achieved by adjusting the operating conditions.

2.3. Research on Animal Husbandry

The development level of modern animal husbandry in my country is in a stage of rapid growth as a whole, but there is no complete evaluation index system for modern animal husbandry, and there are obvious regional differences in the level of animal husbandry [14]. At present, the problems exposed by the development of animal husbandry in my country are: insufficient research and promotion of advanced technology; without scientific breeding technology, it is difficult to meet the needs of modern animal husbandry and social development; animal products have high drug residues, resulting in animal products with some drugs Affect human health; backward breeding equipment causes serious environmental pollution. These problems have exposed the problems that need to be solved urgently in the development of animal husbandry in our country. My country's animal husbandry has become a pillar industry of the agricultural and rural economy, and the status of animal husbandry in agriculture has been gradually strengthened, but it still faces problems such as rising breeding costs and difficulty in solving resource constraints. The enlightenment of the development of green organic animal husbandry abroad to my country is that the government should actively promote the development of green animal husbandry and establish a relatively complete legal system and institutional animal husbandry.

2.4. Research on the Countermeasures for the Development of Animal Husbandry

The effective measures to improve the high-quality development of my country's animal husbandry are: first, to deepen reform and improve public service capabilities; second, to transform into a green ecological cycle; third, to actively promote the construction of a new animal husbandry system and vigorously develop animal husbandry refined products; four It is the transformation of the breeding model to standardization and intensification; the fifth is to increase the cultivation of talents and technologies, and the transformation to the drive of technological innovation; the sixth is to strengthen the financial expenditure to promote the transformation of animal husbandry to a typical demonstration [15].

Under my country's low-carbon economy, animal husbandry will have a lack of technological innovation and low awareness of environmental protection. In view of these problems, this paper analyzes the current my country's animal husbandry from policy guidance, nutrition regulation, feed processing, enhancement of technological innovation, promotion of circular breeding and other negative aspects countermeasures. The opinions and suggestions on the sustainable development of my country's animal husbandry were put forward from five aspects: establishing a sustainable development mechanism for breeding and breeding, actively developing new business development models, and promoting new business models to create a market environment for the sustainable development of animal husbandry.

3. Investigation and Research on Biological Monitoring Index of Fluorine Polluted Animal Husbandry Ecological Environment Based on Machine Learning Algorithm

3.1. Data Analysis

Species diversity index can be divided into diversity index (H), which all depend on the number of species in the community and the number of individuals in each group, and are several measurable indicators that reflect community diversity.

3.2. Machine Learning Algorithms

Decision tree algorithm is a very widely used machine learning algorithm, not only classification but also regression. In the basic algorithm of decision tree construction in machine learning, where c is the number of classes, and k is the total number of divisions. I(.) is an index to measure the degree of impurity of the node, N is the number of samples of the node, and K is the number of attribute values of the variable corresponding to the node. The specific algorithm formula is as follows:

$$\Delta = I(\text{parent}) - \sum_{j=1}^{k} \frac{N(v_j)}{N} I(v_j) \tag{1}$$

3.3. Diversity Index

Shannon-Wiener index, referred to as Shannon index, is currently the most widely accepted and widely used diversity index by ecologists. H represents the complexity of the community, and the larger H is, the greater the amount of information the community contains. Among them, H is the

diversity index, and P_i is the proportion of individuals belonging to species i in all individuals. The specific formula for calculating the biodiversity index is as follows:

$$H = -\sum_{i=1}^{s} P_i \log_2 P_i \quad (2)$$

4. Analysis and Research on Biological Monitoring Index of Fluorine Polluted Animal Husbandry Ecological Environment Based on Machine Learning Algorithm

4.1. Alarm Value and Classification Standard of Poultry Manure Load

When the alarm value R is 0.5 and below, it indicates that the livestock and poultry manure in this area can be completely absorbed and tolerated by the farmland environment, and it does not pose a threat to the environment. As the alarm value R gradually increases, the livestock and poultry manure gradually exceeds the amount of farmland. The threat of environmental pollution caused by the amount of consumption or tolerance will become greater and greater. The alarm value of livestock and poultry manure load is divided into six levels. The higher the number, the more serious the threat of livestock and poultry manure to the environment is. The alarm value and classification standard of poultry manure load are shown in Table 1:

Table 1. The alarm value and grading standard of the loading quantity of animal manure

Alert value(r)	Pollution level	Pollution level
⩽0.5	I	No
0.5~0.8	II	A little
0.8~1.1	III	Have
1.1~1.7	IV	More serious
1.7~2.8	V	Serious
⩾2.8	VI	Very serious

4.2 Environmental Impact of Fluorine-Contaminated Livestock and Poultry Manure and Other Pollutants

The annual excretion of livestock and poultry manure is determined according to the daily excretion coefficient of livestock and poultry manure recommended by the State Environmental Protection Administration, combined with the growth period of livestock and poultry in local animal husbandry. Cattle feeding is generally not slaughtered in that year, and the number of cattle in stock at the end of the year is the number of cattle raised in that year. The growth period of pigs,

sheep and poultry is generally within one year. The annual excretion coefficients of pollutants such as livestock and poultry manure and urine in Dongting Lake area are shown in Table 2 and Figure 1:

Table 2. The manure excretion coefficient of livestock and poultry every year

Livestock and poultry species	Annual waste discharge	Annual urine output	Ammonia nitrogen
Hog	0.514	0.951	0.008
Cattle	12.325	8.69	0.083
Sheep	1.205	0.415	0
Fowl	0.036	0	0.00034

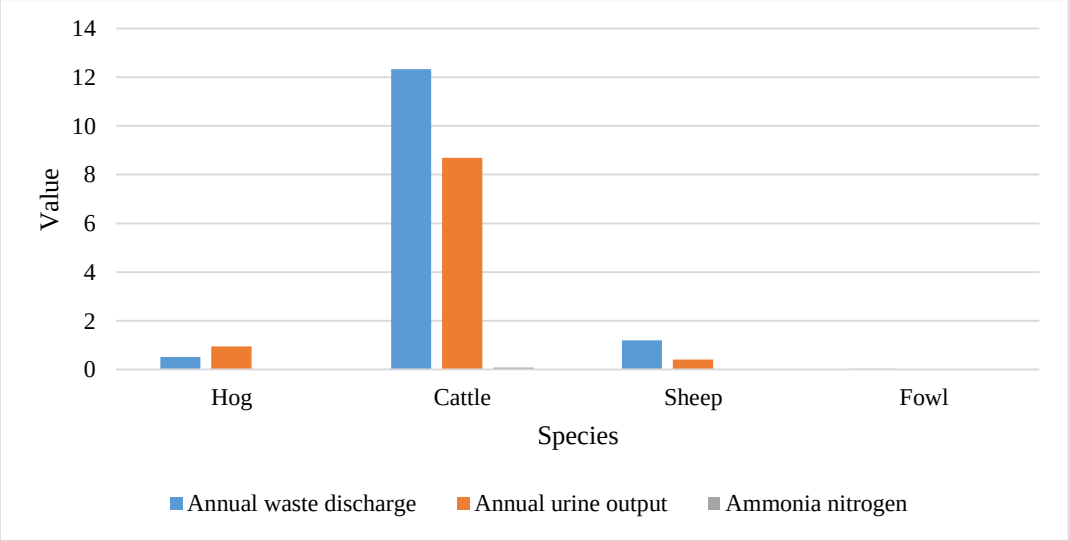

Figure 1. Fluorine pollution of livestock, poultry, manure and urine pollution coefficient (t / head)

4.3. Biological Monitoring Indicators of Ecological Environment of Various Livestock and Poultry in Fluorine-Contaminated Animal Husbandry

Statistical estimates of the livestock and poultry feeding volume in various places show that the annual discharge of livestock and poultry manure is equivalent to pig manure equivalent. The biological monitoring indicators of various types of livestock and poultry ecological environment in fluorine pollution animal husbandry are shown in Table 3 and Figure 2:

Table 3. Fluorine contamination in livestock and poultry manure and urine

Project	Fluorine /%	Pig manure equivalent conversion coefficient
Pig manure	0.85	2.01
Pig urine	0.43	1.72
Shard	0.61	1.83
Niu urine	0.93	2.32
Sheep manure	0.93	2.32
Sheep urine	0.722	2.032
Fowl	2.03	3.02

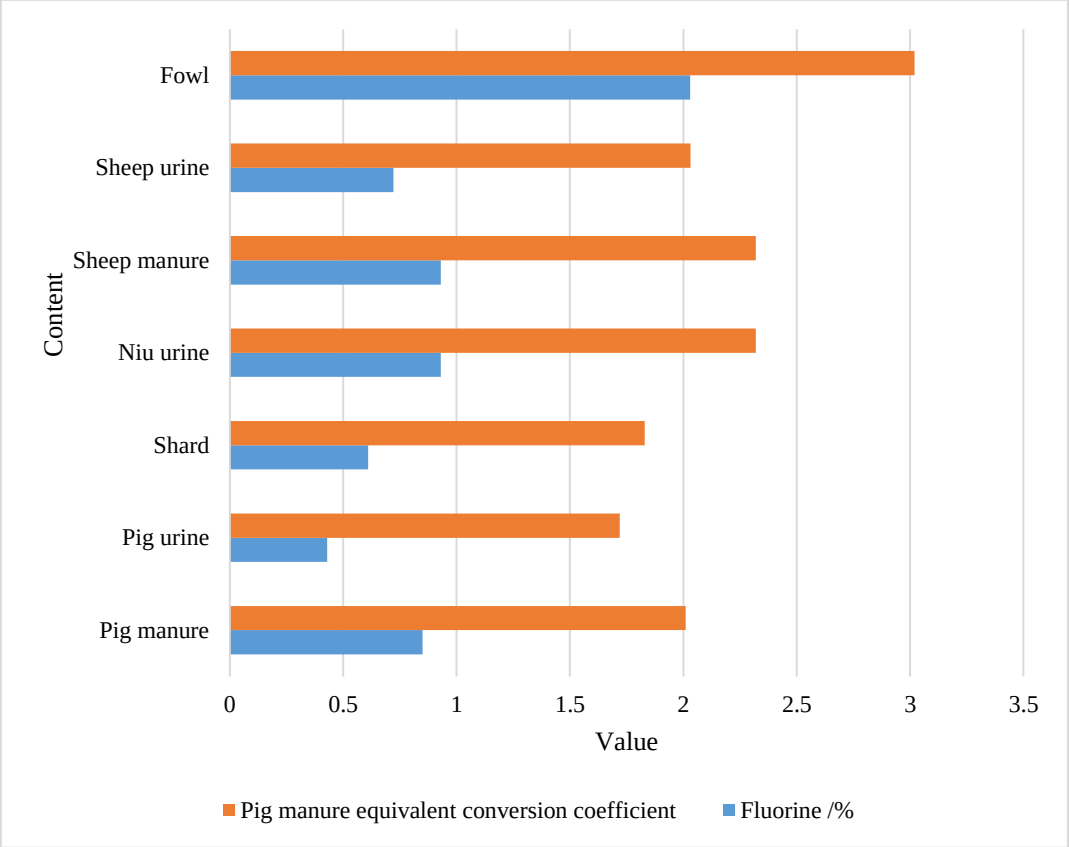

Figure 2. Comparison diagram of the amount of conversion of fluorine pollution in animal husbandry

5.Conclusion

Livestock and poultry manure contains a large amount of nitrogen and other nutrients. If it is used and handled properly, it can turn waste into treasure, harm into profit, and become a nutrient-rich organic fertilizer or even feed. However, if these wastes cannot be used and dealt with rationally, fluorine-polluted animal husbandry will inevitably lead to waste of organic nutrient resources and destruction of ecological balance. Since fluorine pollution has a huge impact on the animal husbandry ecological environment, in order to protect the animal husbandry ecological environment and form a good ecological circle, the biological monitoring of the animal husbandry ecological environment of fluorine pollution has been studied. There are still many deficiencies in this study. Post research added a helping hand.

Funding

This work was supported by the Social Science Foundation of Hunan Province of China (Grant No.18JD54&18YBA341), the Project of Hunan Province Social Science Achievement Review Committee (Grant No.XSP20YBC158) , the Project of Changde city Social Science Achievement Review Committee(Grant No.CSP22YC108) and the Scientific Research Project of Hunan University of Arts and Sciences (Grant No.21ZD06).

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

References

[1] *Ebatetou E A, Josué Richard Ntsimba Nsemi, Moukassa D . Benzene Monitoring and S-Phenylmercapturic Acid Determination of Workers at Oil Sites in Congo-Brazzaville. Occupational Diseases and Environmental Medicine, 2021, 9(3):12-12. https://doi.org/10.4236/odem.2021.93010*

[2] *Tarasenko V F, Panchenko A N, Kozhevnikov V V . Efficient lasing in mixtures of helium and fluorine in diffuse discharges formed by runaway electrons. Quantum Electronics, 2020, 50(10):900-903. https://doi.org/10.1070/QEL17384*

[3] *Kallinen A, Boyd R, Lane S, et al. Synthesis and in vitro evaluation of fluorine-18 benzimidazole sulfones as CB2 PET-radioligands. Organic & Biomolecular Chemistry, 2019, 17(20):5086-5098. https://doi.org/10.1039/C9OB00656G*

[4] *Eva A, Ngel B, Michael T, et al. A bacterial community-based index to assess the ecological status of estuarine and coastal environments. Marine pollution bulletin, 2018, 114(2):679-688.*

[5] *Shiomoto A, Kamuro Y . Seasonal variation of water-column light utilization efficiency for primary production in Saroma-ko Lagoon. Journal of the Marine Biological Association of the United Kingdom, 2021, 101(1):39-47.*

[6] *KANG, Zhenjun Y, Bin L, et al. Phaeocystis globosa Bloom Monitoring: Based on P. globosa Induced Seawater Viscosity Modification Adjacent to a Nuclear Power Plant in Qinzhou Bay, China. Journal of Ocean University of China, 2020, v.19(05):223-236. https://doi.org/10.1007/s11802-020-4481-6*

[7] *Michael K, Cedric M, Pali S, et al. Biological Variation of Donor-Derived Cell-Free DNA in Stable Lung Transplant Recipients. The Journal of Applied Laboratory Medicine, 2022(4):4-4.*

[8] *Tinotenda M, Tatenda D, William F P . Biological monitoring in southern Africa: A review of the current status, challenges and future prospects. Science of The Total Environment, 2019, 648(1):1492-1499.*

[9] *Schrandt M N, Macdonald T C, Sherwood E T, et al. A multimetric nekton index for monitoring, managing and communicating ecosystem health status in an urbanized Gulf of Mexico estuary. Ecological Indicators, 2021, 123(8):107310-107310. https://doi.org/10.1016/j.ecolind.2020.107310*

[10] *Tursi A, Vietro N D, Beneduci A, et al. Low pressure plasma functionalized cellulose fiber for the remediation of petroleum hydrocarbons polluted water. Journal of Hazardous Materials, 2019, 373(7):773-782. https://doi.org/10.1016/j.jhazmat.2019.04.022*

[11] *Calabrese E, Rispo A, Zorzi F, et al. 345 Ultrasonography Tight Control And Monitoring In Crohn's Disease During Biological Therapy: A Multicenter Study - ScienceDirect. Gastroenterology, 2020, 158(1):0-0.*

[12] *Seehausen M L, Timm C, Jones I M, et al. Reproductive life-history traits of the classical biological control agent Hypena opulenta (Lepidoptera: Erebidae): Using agent biology to*

support post release monitoring and establishment. Biological Control, 2019, 135(1):95-101.

[13] Anitha C, Syed A S, Sundar M . Influence of particle size in fluorine free corrosion resistance superhydrophobic coating - Optimization and stabilization of interface by multiscale roughness. Journal of Alloys & Compounds, 2018, 765(1):677-684. https://doi.org/10.1016/j.jallcom.2018.06.214

[14] Lucovsky G, Yang H . Fluorine atom induced decreases to the contribution of infrared vibrations to the static dielectric constant of Si–O–F alloy films. Journal of Vacuum Science & Technology A Vacuum Surfaces & Films, 2018, 15(3):836-843. https://doi.org/10.1116/1.580717

[15] Nemchinova N V, Barauskas A E, Baranov A N . Choosing the Reagent to Leach Fluorine from Spent Pot Lining of Aluminum Electrolysis Cells. Materials Science Forum, 2022, 1052(1):488-492. https://doi.org/10.4028/p-3ss26h

[16] Racaru L V, Sinigaglia M, Kanoun S, et al. Fluorine-18-fluorocholine PET/CT parameters predictive for hematological toxicity to radium-223 therapy in castrate-resistant prostate cancer patients with bone metastases: a pilot study. Nuclear Medicine Communications, 2018, 39(7):1-1.

[17] Hou J Q, Kovacs M S, Dhanvantari S, et al. Development of Candidates for PET Imaging of Ghrelin Receptor in Disease: Design, Synthesis and Evaluation of Fluorine-bearing Quinazolinone Derivatives. Journal of Medicinal Chemistry, 2018, 61(3):1-1. https://doi.org/10.1021/acs.jmedchem.7b01754

[18] Kuwahara H, Kagoshima T, Nakada R, et al. Fluorine and chlorine fractionation during magma ocean crystallization: Constraints on the origin of the non-chondritic F/Cl ratio of the Earth. Earth and Planetary Science Letters, 2019, 520(1):241-249. https://doi.org/10.1016/j.epsl.2019.05.041