International Journal of Environmental Sciences & Natural Resources
ISSN: 2572-1119

Juniper Publishers key to the Researchers

Research Article
Volume 9 Issue 5 - April 2018
DOI: 10.19080/IJESNR.2018.09.555774

Int J Environ Sci Nat Res

Advances in Research of Forest Air Anion

Gao Wei, Lu Jie*, Li Jiangrong and Tang Xiaoqin

Tibet Ministry of Agriculture and Animal Husbandry, Key Laboratory of Tibet Plateau Forest Ecology Ministry of Education, China

Submission: March 29, 2018; **Published:** April 16, 2018

***Corresponding author:** Lu Jie, Tibet Ministry of Agriculture and Animal Husbandry, Key Laboratory of Tibet Plateau Forest Ecology Ministry of Education, China, Email: tibetlj@163.com

Abstract

The author reviews the literature on air negative ions, summarizes the definitions, sources, research methods and research contents of air negative ions, and forecasts the future research content of negative air anions in order to provide a theoretical basis for municipal planning. Deep research on air anion provides direction.

Keywords : Negative air anion; Research progress; Forest

Introduction

In recent years, our country's economy has continued to grow, people's living standards have continued to improve, and China's international status has been constantly improving. The image of big countries has become increasingly clear. We are transforming from a manufacturing nation to a manufacturing powerhouse. But at the same time, we have promoted the environment before. The behaviour of development has paid a price, environmental pollution has become increasingly serious, global warming, haze, etc. have become the focus of global attention. And the people's concern is no longer just to satisfy the problem of food and clothing in daily life, but to pursue high quality and high quality of life. Environmental issues related to human health have gradually become a focus of attention and research hotspots. Air anions are also known as "air vitamins and auxins," because they are just as vitamins for humans. Although they don't need a lot, if they are kept in a low-content environment for a long time, they will affect the body's normal physiological activities and Function, and further cause various diseases [1].

Many studies have shown that the concentration of air anions in forests is higher than that in urban areas [2-5]. At the same time, the forest is rich in natural resources, charming natural landscape, good natural environment and perfect health care functions because of its multiple functions such as fixing carbon and releasing oxygen, conserving water, producing organic matter, and purifying the atmosphere [6]. The most important terrestrial natural ecosystem has also become a hot spot for many scholars. In this paper, based on the previous research on the negative ion of forest air, we focused on the research methods, research contents and future issues that need to be studied in the air ion in recent years, with a view to providing research for the development of forest and air negative ions in China [7].

Definition and Source

Definition

Negatively charged single gas molecules and light ion clusters are called air anions [7]. Air anions can be divided into three categories according to their particle size, as shown in Table 1. From Table 1, it can be seen that the larger the particle size, the smaller the mobility. The commonly used air anion refers to a small ion with a particle size of 0.001-0.003, which has relatively good biological activity, but the time of survival in different environments is not the same. In a poor environment, such as an industrial area It may survive for a few seconds; in a good environment it may survive for more than ten minutes beside a waterfall. In normal air, the concentration ratio of positive and negative ions in air is 1.15:1. Medical research shows that different concentrations have different effects on human body, and the higher the concentration, the more beneficial to the human body. The lowest concentration in the forest is 400 cells/cm^3, and the minimum concentration in the general urban area is 250 cells/cm^3. Below these limits, the human body will meet the human body. Different degrees of harm, When the air anion concentration reaches more than 700/cm^3, people will feel fresh air; when the air anion reaches 1000/cm^3, the biological effect can be met; when the air negative ion concentration reaches 10,000/cm^3 or more, disease.

Table 1: Air Anion Classification Table.

Species	Ion Mobility (cm^2/Vs)	Ion Diameter (μm)
Small ion	>0.4	0.001-0.003
Medium ion	0.04-0.4	0.003-0.030
Large ions	<0.04	0.03-0.10

Source

Neutral molecules or atoms in the air receive sufficient energy to disengage the outermost electrons of the nucleus from the bond of the nucleus due to the force of the outside world, and thus jump out of orbit to become free electrons. The electrons leaving the orbit due to its free path (10-8) is extremely short, has oxyphilicity, hydrophilicity, and is easily combined with oxygen to form air anions [8]. According to their sources can be divided into two categories: natural production and artificial conditions produced as shown in Table 2.

Table 2: Sources of Air Anions.

Naturally Occurring	Artificially Generated
A. Ionizing agent (radioactive material, cosmic rays, ultraviolet rays)	A. Corona discharge
B. Hydrolysis of water molecules (Lenade effect of waterfalls, rolling effect of waves, falling of rainstorms)	B. Water generation
C. Plant tip discharge, photovoltaic effect of green plants	C. Radiation
D. Physical processes (volcanic eruptions, forest fires, lightning, thunderstorms, dust storms, snow storms)	

Research Status at Home and Abroad

Abroad

In his work in 1780, Bertholon proposed that atmospheric ionization affects the health of all people, including normal people and patients [9]. In 1892 the German scholar Sehap discovered the phenomenon of charged air [8]. Later, British scholar Wilson and French scholars Elster and Geitell confirmed the presence of positive and negative ions in the air. This marked the official start of research on air negative ions. In 1902 Aschkinass affirmed the biological significance of air negative ions. In 1931 German doctors discovered the physiological effects of negative air ions on the human body. In 1932, American CRA's Hamson invented the world's first medical air negative ion generator. Since then, the study of air anions has been popularized in Europe, the United States, Japan, and other countries. It has experienced three waves in the 1930s, 50s, and 70s [10].

Domestic

The field hospital in the liberated areas of China had used air mist therapy. The content of air anions appeared in the literature of the 1950s. In 1978, Dr. Shahavat of Iran introduced an electronic instrument-biological filter, which is known as negative ionization in our country. The predecessor of the device, the appearance of these instruments laid the material foundation for the study of air anion in China [11]. The study of air negative ions in China began with Xia Lianbo's research on the negative effects of atmospheric negative ions on human biological effects. Afterwards, the research on air negative ions has experienced two developmental climaxes in the early 1980s and early 1990s in China [12]. In the 1980s, mainly based on the biological effects and mechanisms of negative air ions, air negative ions were used in the early 1990s due to their ability to sterilize, remove dust, deodorize, enhance cardiac activity, improve sleep quality, promote metabolism, enhance immunity, and resist immunity.

Mid-term air anion has become a research hotspot in health care. As a result, the construction of tourism and health facilities such as forest baths, forest hospitals, and air anion breathing zones has been established. Since the 21st century, air negative ions, which are one of the air quality indicators, have been developed. Tourism and health care resources are being developed in depth, and the determination of air negative ion concentration in different environments (mostly scenic spots, tourism development zones) and influencing factors have been gradually improved [13]. In recent years, experts in various fields such as tourism planning, environmental science, forestry planning, and ecology have paid more attention to the study of air anions and applied multidisciplinary content to their research including mathematical statistics methods and geography 3S technologies. In 2013, it began to carry out monitoring and pilot work, combined with monitoring practices, completed the preparation of "Air Negative (Oxygen) Ion Monitoring Technical Specifications" and "Air Negative (Oxygen) Ion Concentration Monitoring Site Construction Technical Specifications" forestry industry standards [14]. China has also incorporated air negative oxygen ion monitoring into the meteorological monitoring system [15]. It will soon be able to achieve national forecasts and provide a great guide to people's travel.

Research Methods

Monitoring instruments

According to recent researches, the commonly used instruments for determining the concentration of air anions in China are Nissan's KEC Series and COM3200 PRO, the domestically produced WIMDH and DLY Series, and the American-made AIC Series, among which the highest frequency of use is. The DLY series produced in China. This type of instrument is based on the principle of parallel plate type and is a special instrument for measuring gas ions in the atmosphere. It has accurate measurement, high sensitivity, strong moisture resistance, and easy to use, but it usually cannot solve the impact of static electricity and outside air flow; frequency of use The second KEC series is based on this principle; the third-ranked COM series is based on the design principle of the capacitor method, which collects the charge carried by air ions through a cylinder, and then measures the current formed by these charges and samples. Air flow, finally converted to ion concentration, which can well solve the impact of air flow and static electricity, in addition to more convenient to clear, but the sales price in the market is relatively expensive [16].

Monitoring point selection

Based on the typicalness and comprehensiveness of monitoring point selection, usually 2 or more monitoring points are selected. Zhang Shuangquan selected two sites to

How to cite this article: Gao Wei, Lu Jie, Li Jiangrong, Tang X. Advances in Research of Forest Air Anion. Int J Environ Sci Nat Res. 2018; 9(5): 555774. DOI: 10.19080/IJESNR.2018.09.555774

study air anions [17]. Feng Yiming selected five observation points to study the air negative ions in different habitats [2]; Tan Jing et al. selected 30 monitoring sites in 27 scenic spots in Hubei Province to study the negative air ions in Hubei Province [18] and generally selected outlying locations such as urban areas. Compare them to reflect that the forest can increase the concentration of air anions. There are also monitoring station data as the research object.

Monitoring methods

In order to follow the truthfulness, scientificity, and rigor of the research, the average researcher will observe the time of the year and select days of fine weather in each month or months in spring, summer, autumn, and winter (except for research. The study of the relationship between weather conditions and air anion), taking its average value for research, there are a few studies of maximum and minimum values, measured every day or every 2 hours from day to day during the day. Measured three times a day in three time intervals, the average of four directions will be taken at each measurement [1,3,19,20]. Due to the development of the instrument, it has become possible to monitor all weather without any hindrance. Cao Jianxin and others used the 7-year data of WIMD-A automatic monitoring as the research object, analyzing the distribution characteristics of air negative ion concentration and the main pollution factors of climate and climate the relevance of things [13].

Treatment methods

The researchers used more processing methods to use Excel to collate data, obtain average values, and study the trend of related factors. SPSS was used to study the fitting of air negative ions and impact factors. A few researchers used 3S technology to study the entire region. Concentration level distribution map, using Matlab and other software to study the air negative ions and the impact factor fitting. Feng Yiming studied the correlation between air negative ions and meteorological factors such as temperature, humidity, wind speed, and atmospheric pressure through SPSS, and was positively correlated with T and H. It was found that air negative ion concentration was affected by wind speed to a certain extent, and atmospheric pressure was negative to air ions. The effect of concentration on performance is weak [2]. Tan Jing et al. used the ARCGIS to draw a map of air negative ion concentration in Hubei Province through the study of 30 monitoring points [18]. Wu Di used Matlab software to estimate the air negative ion concentration and the ambient temperature and humidity index. The results showed that the cubic function curve fit was the best [21].

Research Content

The law of time and space

At different time periods, the concentration of air anions is different, and it will show certain rules. Some scholars believe that the daytime concentration is < nighttimes concentration [13]. Studies by Zhao Lei et al. showed that the concentration of air anions appeared to be high at night and low during the day, with the maximum occurring in the morning and the minimum appearing at noon [22]. Shao Hairong and other studies showed that the maximum value of air anion appeared at 9:00 to 11:00, the next largest value at 4:00 to 5:00, and the minimum at around 23:00 [23]. The concentration of air anions is sinusoidal throughout the day, low during the day and high at night. The highest value was reached around 6:00 and the lowest value was reached around 13:00 and 20:00 [24].

Wang Rongxin's research showed that the airborne negative ion concentration in the five forests of mixed forests of Platycladus orientalis, Platycladus orientalis, Pterocya falcata, Quercus variabilis, and Quercus variabilis were bimodal during the daytime. Morning peaks are around 10:00, and afternoon peaks are around 16:00 [1]. In different seasons, the developmental stages of plants are different, and various meteorological factors are changing. The concentration of air negative ions in various environments is also different. Most researchers believe that the concentration of air negative ions in different seasons is: summer> autumn> spring> winter [25]. However, some researchers believe that summer> spring> autumn> winter [26]. Due to the heterogeneity of space, there are large differences in space and time, and the content of air anion in different regions is different. The study agreed that the forest area is higher than the urban area. Different types of green space, air anion content is not the same [27,28].

Influencing factors

Due to the non-uniformity of the monitoring principles of air anions, the diversity of evaluation standards, and the complexity of the environment, even if the same influencing factors are studied, it may lead to different results. The influencing factors of each researcher's research can be divided into meteorological factors and environmental factors.

Weather factors

Most studies have shown that air negative ion concentration is negatively correlated with temperature and positively correlated with relative humidity [29,30]. Some researchers also proposed the opposite view that air negative ion concentration is positively correlated with temperature and negatively correlated with relative humidity [31]. Huachao research shows that the relationship between air negative ion concentration and temperature and humidity varies according to different seasons and ranges. Spring and winter are not related to temperature and humidity. Summer has a significant negative correlation with temperature and positive correlation with relative humidity.

The temperature-humidity correlation is not obvious; when the temperature is less than 16°C, it has a positive correlation with the temperature; when the temperature is between 16°C-32°C, the temperature has a negative correlation; when the humidity is less than 64%, it is negative with the relative humidity. Relevant, when relative humidity is between 64% and 96%, relative humidity is positively correlated with [25].

How to cite this article: Gao Wei, Lu Jie, Li Jiangrong, Tang X. Advances in Research of Forest Air Anion. Int J Environ Sci Nat Res. 2018; 9(5): 555774. DOI: 10.19080/IJESNR.2018.09.555774

In addition, the two factors of temperature and humidity are converted into a comprehensive factor, the temperature and humidity index, to study the relationship between the concentration of air and negative ions. It is believed that the concentration of air negative ions in different plant structural environments is affected by different degrees, and the structure of plants is more complicated. The greater the influence, the higher the air negative ion concentration is when the temperature and humidity index is about 800 [21]. Cao Jianxin and other studies have shown that there is a positive correlation with the annual average relative humidity, the number of annual thunderstorm days, the number of annual rain days, and the total annual rainfall; and there is a negative correlation with the annual average temperature and annual sunshine hours, but the annual mean value of air negative ion concentration and the annual average value of meteorological elements.

The correlation test was not significant [13]. Li Bing research shows that the air negative ion concentration is negatively correlated with the dew point temperature in spring and positively correlated with the light intensity, and has no significant correlation with wind speed, coldness, pressure, and wet bulb temperature; positive correlation exists between air negative ion concentration, wet bulb temperature and dew point temperature in summer. There was no significant correlation between wet bulb temperature, wind cold, pressure, and light intensity; autumn negative air ion concentration dew point temperature, wet bulb temperature, and wind cold were negatively correlated with pressure, and correlated positively with wind pressure and light intensity [32]. More studies have shown that rainy days> sunny days> cloudy days> heavy fog [33,34].

Environmental factors

More studies have shown that the concentration of vegetation structure is complex structure> simple structure, but there are nuances in the specific aspects. Wu Di considered that the arborvitae> quebracho> grater> shrub> qiao> irrigated> grass [21]. Pan Jianbin studies showed that the composite> double layer (shrub> Qicao> Qiao irrigation)> single layer (herb floor> shrub> arbor) [28]. The ability of different vegetation types to produce negative air ions is different. According to Shao Hairong, the average annual concentration in coniferous forests is higher than that in broad-leaved forests, while in broad-leaved forests and coniferous forests in spring and summer and in contrast in autumn and winter [23]. Wang Hongjun's research shows that there is no significant difference in the annual mean concentrations of artificial coniferous forests and artificial broad-leaved forests with similar hierarchical structures, but the time at which the peak value of air anion concentration appears is different [35].

Xu Zhaohui's research shows that the contribution of conifers to air anion in winter is 49.07%, the contribution of broad-leaved trees is 12.49%, and coniferous forest> broad-leaved forest [36]. Different kinds of plants have different physiological characteristics, different external forms, and different surrounding environments. The concentration of air negative ions produced by them is not the same, but they are of little concern. Wu Jiyou studied the concentration of air negative ions produced by eight species of garden trees. The results showed that: Shenshuijing> Podocarpus> Ledong pseudo-unisexual magnolia> Manglietia indica> Southern manglietia> Jinyexiaoxiao> Lechang with laughter> Liriodendron [29]. The concentration of air negative ions produced during different growth stages differs. According to research conducted by Xiu Xiuzheng, at the early stage of growth, mixed forest> coniferous forest> broad-leaved forest> wetland> economic forest; middle growth period, economic forest> wetland> mixed forest> broad-leaved forest> In coniferous forests, the concentration of air anions in the middle of growth is four times that of the initial stage of growth [11].

According to Wang Rongxin's research, the content of air anion in different age classes is different. The mixed forest of Pinus uniflora and Platycladus orientalis> Platycladus orientalis> Platycladus orientalis> Quercus variabilis in the same age forest> Quercus variabilis is a differentiating forest [1]. In general, there are many studies on the relationship between vegetation characteristics and air anion concentrations, but there is no unified conclusion, and only a few studied the contribution rate of plant type to air negative ions. The contribution of specific tree species is not clear. Cao Jianxin and other studies have shown that air negative ion concentration is negatively correlated with the concentration of sulfur dioxide, nitrogen dioxide, and carbon monoxide in fine particles, and positively correlated with ozone concentration [13]. Li Bing's research shows that there is a negative correlation between PM2.5 in spring and summer and no significant PM2.5 in autumn and autumn [32]. According to Ding Wenci et al., the concentration of air anion increased first and then decreased with increasing altitude [37]. In the study of air negative ions and water bodies, the research conclusions have been agreed: moving water> static water, waterfall> falling water> streams, and also related to the size of the water area [38,39]. Building materials also have an effect on the concentration of negative air ions. Shi Qiang and other studies have shown that the order of the concentrations of different material huts from big to small is: bamboo house> wooden house> stone house [30].

Practical applications

Air anions have many benefits for the human body. Whether as one of the air quality indicators or because of its biological effects, it has become a hot spot for forest tourism and forest health research. Now it has become one of the indicators for evaluating ecological benefits. Many studies have used it as an indicator of ecological benefits [28] and calculated its ecological value through mathematical statistics [40]. There are also researches on the combination of influencing factors and

How to cite this article: Gao Wei, Lu Jie, Li Jiangrong, Tang X. Advances in Research of Forest Air Anion. Int J Environ Sci Nat Res. 2018; 9(5): 555774. DOI: 10.19080/IJESNR.2018.09.555774

mathematical statistics methods to construct an air negative ion prediction model [24] in order to serve as a meteorological factor for its forecast, to remind people to pay attention and guide people to travel.

Discussion

At present, studies on the negative ion of forest air have resulted in different results due to the non-uniformity of monitoring principles, the diversity of evaluation criteria and the complexity of the environment, the artificial nature of monitoring, and the intermittent and short-term nature of monitoring. Most studies focus on local research on a scenic spot. The development level of forest tourism health projects is not enough. In view of this situation, the author thinks: (a) strengthen the research on the principle of air negative ion collection, and strive to achieve high accuracy, high quality assurance, and real price benefits. (b) To achieve long-term automatic point-to-point monitoring as soon as possible so as to exclude human influences and more accurately study the relationship between them and impact factors. (c) Because of its functional diversity, air anion has become a research hotspot in ecology, forestry, tourism, biology, medicine, and agronomy.

It is necessary to strengthen the cooperation and exchanges of various disciplines, study its internal mechanism in depth, find out the influencing factors, and provide theoretical guidance for municipal planning. (d) Application of mathematical statistics methods, establishment of prediction models, becoming a member of meteorological factors, guiding people's travel. (e) Develop unified standards as soon as possible so that the results of the studies are comparable. (f) Strengthen the number of monitoring points in each region, comprehensively understand the distribution of air negative ions in each region, and realize the visualization of concentration distribution in each region. (g) Strengthen the development of forest tourism health projects. Combining various modern health projects such as ecological foods to develop air anion health restaurant, combining beauty spa and fitness sports, and developing local cultural characteristics such as tea culture, opera culture and so on.

References

1. Wang Rongxin (2016) Study on the Two Atmospheric Functions of Eucalyptus urophylla Forest in Jiulongshan, Beijing D. Master Degree Dissertation of Chinese Academy of Forestry, China.
2. Feng Yiming (2017) Temporal and Spatial Characteristics of Air Negative Oxygen Ions in Different Habitats of Urban Ecosystem. Master thesis of Inner Mongolia Agricultural University, Mongolia.
3. Zhou Deping, Yan Weihua, Wen Rihong (2015) Observation of Negative Oxygen Ions and Analysis of Air Quality in Lushan National Forest Park. Journal of Arid Land Resources and Environment 29(3):181-187.
4. Mao Chengzhong, Yu Nailian, Du Jiale (2014) Comparative Analysis of Air Negative Oxygen Ions in Typical Urban and Forest Areas. Meteorological Science and Technology 42(6): 1083-1089.
5. Hu Xisheng, Liu Dongxiang, Hong Wei (2012) Evaluation of air negative ions effect in different types of green space in Fuzhou City. Journal of Agricultural Sciences 2(10): 42-45.
6. Wu Tengfei (2015) Evaluation of the functional value of forest ecosystem services in Nanxian County. Master thesis of Central South University of Forestry and Technology, Russia.
7. ZHANG Zhipan, YU Yiwu, MENG Minghao (2006) Research progress of air anion in tourism environment. Journal of Zhejiang Forestry College 23(1): 103-108.
8. YAO Chengsheng (2005) Study on the Distribution and Development of Air Anion in Yuelu Mountain. Master thesis of Hunan Normal University, China.
9. BR Jovani, SB Jovani (2001) The effect of high concentration of negative ions in the air on the chlorophyll content in plant leaves. Water Ai & Soil Pollution 129(1-4): 259-265.
10. Shihdt, Boettiger D, Buck CA (1997) EPpitopes of adhesion-pertur-bing monoclonal antibodies map within a predicted alpha-helical domain of the integrin beta 1 subunit. Cells 110(20): 2619-2628.
11. Yan Xiujing (2009) Temporal and Spatial Distribution of Negative Ions in Forests and Wetlands in Qingdao. Doctoral Dissertation of Beijing Forestry University, China.
12. Zhang Shuangquan (2011) Study on Negative Air Ion Tourism Resources in Shennong Valley National Forest. Master's Dissertation of Central South University of Forestry and Technology, China.
13. Cao Jianxin, Zhang Guigui, Zhang Youjie (2017) Distribution of negative air ions in seashore and forest environment and its relationship with environmental factors. Journal of Eco-Environment 26(8): 1375-1383.
14. Huang Guilin, Liao Chengzhang, Ma Shangyu (2012) National Air Negative (Oxygen) Ion Monitoring Progress. Forest and Humanity pp. 212-213.
15. Liu Ye, Song Laiping, Liu Baiyang (2017) Analysis on the Construction of Negative Oxygen Ion Monitoring System for Local Forestry in Hulun Buir City. Journal of Forest Protection Technology (12): 70-71.
16. Han Mingchen (2011) Evaluation of Urban Forest Health Function Index: A Case Study of Beigong National Forest Park. Beijing. PhD dissertation of Chinese Academy of Forestry Sciences, China.
17. Zhang Shuangquan, Tan Yimin, Wu Zhangwen (2011) Study on the relationship between air anion concentration and air temperature and humidity. Journal of Central South Forestry University, 31(4): 114-118.
18. Tan Jing, Chen Zhenghong, Luo Xuerong (2017) Study on the Distribution of Air Negative Ions in Different Types of Forest in the Botanical Garden of Heilongjiang Province. Resources and Environment in the Yangtza Basin 26(2): 314-323.
19. Ping Lian (2016) Study on soil physicochemical properties and microclimate characteristics of three kinds of artificial forest in Yueliangshan, Jiangsu Province. Master thesis of Nanjing Forestry University, China.
20. Su Wei (2017) Spatiotemporal distribution characteristics of PM2.5 and PM10 in Nanchang and the control mechanism of urban forest. Jiangxi Agricultural University, China.
21. Wu Di, Li Jiashan, Zhang Dongyou (2017) The relationship between the concentration of forest air anion and the environmental temperature and humidity index. Journal of Forest Engineering 33(6): 25-30.
22. Zhao L, Wu KN, Chen M (2016) Study on the distribution and prediction equation of negative oxygen ion concentration in major scenic spots in Hainan Province. Journal of Anhui Agricultural Sciences 44(29): 189-191.
23. SHAO Hairong, HE Qingxuan, ZHAI Haiping (2005) Temporal and Spatial Variations of Air Anion Concentration in Beijing. Journal of Beijing Forestry University (Natural Science) 27(3): 35-39.
24. Ding Lihua, Gu Zhenhai, Wu Dan, Cheng Chuang (2017) Establishment of negative oxygen ion concentration prediction model in Kaihua County. Zhejiang Agricultural Sciences 58(11): 1957-1960.

How to cite this article: Gao Wei, Lu Jie, Li Jiangrong, Tang X. Advances in Research of Forest Air Anion. Int J Environ Sci Nat Res. 2018; 9(5): 555774. DOI: 10.19080/IJESNR.2018.09.555774

25. Hua Chao (2011) Study on Climate Comfort and Air Quality of Different Forest Communities in Qiandao Lake. Master's Dissertation of Zhejiang Agriculture and Forestry University, China.

26. Zhang Zhiyong (2014) Dynamic Analysis of Forest Ecological Health Function in Typical Cities of Hangzhou. Master thesis of Beijing Forestry University, China.

27. Chen Yuru, Yang Xiaoke, Fu Weicong (2016) Variation characteristics of negative ion concentration in Longyan National Forest Park during winter. Journal of Jiangxi Agricultural University 38(6): 1119-1126.

28. Pan Jianbin (2011) Ecological Benefits of Beijing Olympic Forest Park Greenland. Doctoral Dissertation of Beijing Forestry University, China.

29. Wu Jiyou, Cheng Zhenghong, Long Yingzhong (2003) Changes of air anions in forest tree species. Journal of Nanjing Forestry University (Natural Sciences Edition) 27(4): 78-80.

30. Wu Chu Ji, Zheng Qun Ming, Zhong Lin Sheng (2001) Study on Air Anion Level in Forest Recreation Area. Forestry Science 37(5): 75-81.

31. Shao Hairong, He Qingyi (2000) Forest and Air Negative Ions. World Forestry Research 13(5): 19-23.

32. Li Bing (2016) Study on the Correlation between Air Anions and Environmental Factors in Heilongjiang Forest Botanical Garden. Northeast Forestry University Master's Dissertation, China.

33. He Ning, Lin Mingli, Zhao Hongyun (2016) Correlation Analysis of Variation of Negative Oxygen Ion Concentration and Meteorological Elements in Xiangtan. Guizhou Meteorology 40(2): 65-69.

34. Cao Menglu, Cheng Nanyang (2016) Air Anions Change Monitoring and Health Value Development of Zijinshan National Forest Park. Journal of Anhui Agricultural Sciences 44(12): 212-215.

35. Wang Hongjun (2004) Effect of Urban Forest Structure on Air Anion Level. Journal of Nanjing Forestry University: Natural Science Edition 28(5): 96-98.

36. Xu Zhaohui (2004) Study on air negative ion resources in major forest tourism areas in Anhui Province. Master thesis of Anhui Agricultural University, China.

37. Ding Wenci, Zhao Yuzhi (2017) Distribution and Evaluation of Negative Air Anion in Qixianling National Forest Park in Winter. Journal of Hainan Tropical Ocean University 24(5): 36-41.

38. Lan Dongxiang, Zeng Xiaorong, Wang Lianghe (2016) Air Negative Oxygen Ion Resource Assessment of Baiyun Forest Park in Lishui. Chinese Journal of Forestry Science 44(4): 48-50.

39. Xie Xueyu (2014) Forest Park Health Care Project Planning Based on Air Anion Resource--A Case Study of Zhaichangshan Forest Park in Huidong County. Master degree thesis of Central South Forestry University, China.

40. Li Jiashan, Wang Shuyu, Qi Chao (2015) Evaluation of Air Anion Concentration Levels and Ecological Benefits of Coniferous Forests in Mohejiao Village. Journal of Forest Engineering 31(4): 18-21.

DOI: 10.19080/IJESNR.2018.09.555774

How to cite this article: Gao Wei, Lu Jie, Li Jiangrong, Tang X. Advances in Research of Forest Air Anion. Int J Environ Sci Nat Res. 2018; 9(5): 555774. DOI: 10.19080/IJESNR.2018.09.555774