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Survey and analysis of the current status of polychrome paintings diseases in Jingshan Park

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Abstract: Beijing Jingshan Park, as an important historical and cultural heritage on the central axis of Beijing, its architectural polychrome paintings not only have high artistic value, but also reflect the exquisite skills of ancient architectural decorative crafts. However, with the passage of time, these paintings are facing the threat of various diseases. This paper carries out a comprehensive investigation and analysis of the oil-decorated paintings in Jingshan Park, Beijing, through the field research of the oil-decorated paintings in Jingshan Park, found that due to the interaction of environmental factors, animal activities, man-made factors, paintings made of materials and other factors caused by the 16 kinds of diseases, which is the highest ratio of pigment peeling, fissures and accumulation of dust. Through the analysis of the diseases, corresponding protection and restoration suggestions were made to provide a basis for the development of scientific and reasonable protection and restoration programs to continue its historical and cultural value.

1. Introduction

Jingshan Park, facing the Forbidden City in the south and the North Sea in the west, is located in the northern part of the center section of Beijing's Central Axis, which is the high point of the Central Axis and the second largest ancient building complex on the Central Axis in terms of area. As a royal garden and an important part of Beijing's central axis, its architectural layout inherits the design concept and idea of central axis symmetry[1].

Jingshan Park buildings painted with polychrome paintings, including the Wansui Gate, Qiwang Tower, Zhoushang pavilion, Guanmiao pavilion, Wanchun pavilion, Jifang pavilion, Fulan pavilion, Shanyouli Gate, Shanzouli Gate, the eastern and western auxiliary halls of the temple for State Protection and Loyalty, the temple for State Protection and Loyalty, the Guande Gate, the eastern and western auxiliary halls of the Guande Temple, Guande Palace, JiuJu Memorial Archway, Shouhuang Gate, the Divine Kitchen, the two wells Pavilion, the eastern and western auxiliary halls of the hall of Imperial Longevity, the two pavilions built over a stone tablet, Shouhuang Hall, the

Temple of the Mianxi Hall, the diffraction of the Yanqing Hall and other 28 Building. Among them, 12 buildings are involved in the investigation of internal and external architectural polychrome painting, including the eastern and western auxiliary halls of the temple for State Protection and Loyalty, the temple for State Protection and Loyalty, Guande Palace,the Divine Kitchen, the two wells Pavilion, the eastern and western auxiliary halls of the hall of Imperial Longevity, the two pavilions built over a stone tablet, Shouhuang Hall.

As an important royal garden in the Ming and Qing dynasties, the polychrome paintings painted on the buildings of Jingshan Park belong to the official architectural paintings, of which the spinning polychrome painting, and the seal polychrome painting are the main ones. The architectural polychrome painting in the park use wooden structure as the support body, and in turn, the wooden structure is superimposed on the ground battle layer, pigment layer, gold layer (part of the polychrome paintings without gold layer, such as Yawu ink polychrome painting), varnish layer.

2. Current status of domestic research

Wang Liqin and others on the Xi'an Drum Tower’s architectural polychrome paintings disease investigation and simulation experiment analysis, found that ultraviolet rays, temperature and humidity and atmospheric precipitation, oil fumes and rainfall caused by color fading, chalking, cracking, shedding, smoky paintings and other diseases[2]. Dong Peipei through the ancient architecture of Qufu Confucius temple painting survey, summarized the protection and restoration of the preliminary investigation of the technology and methods for the protection and restoration of the Confucius temple building painting as a case[3] . Zhang Yu to the Qing Xiling Taidongling architectural paintings as an example, its site disease survey records, summarized a total of 20 kinds of paintings disease. For different buildings, components, analysis of the type of disease, distribution, causes, disease assessment summary, for the Qing Xiling architectural paintings overall protection and restoration program to lay the foundation for preliminary research[4] . Wang Jingyi introduced the labrang monastery polychrome painting pollutant adhesion disease types, for the color painting damage degree and by the type of disease put forward the corresponding protection and repair methods[5] . Liu Cheng etc. Xuanzhen Guan Hall color painting disease causes analysis, and according to the type of disease, cause of disease，put forward the corresponding protection and repair countermeasures[6]. Lv Haiping etc. analyzed the type, characteristics and current situation of the Shenyang Imperial Palace west eaves polychrome paintings, explore the survival of the Qing official-style paintings in the environment of the cold region[7] . Gao Na etc. through on-site observation, from disease identification, disease type, disease measurement results, disease nature, etiology analysis, etc. to analyze and repair the DaCiYanFu Palace pair of polychrome painting on[7][8].

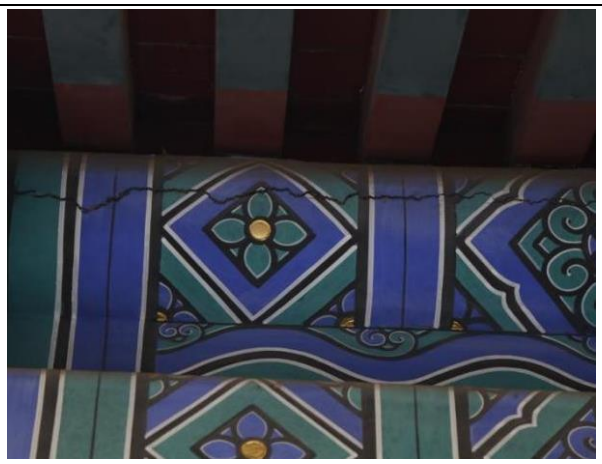
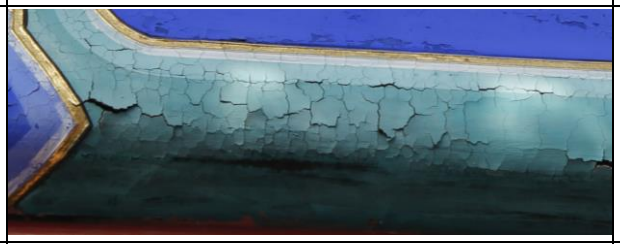
3. Survey Methods and Classification of Jingshan polychrome painting

Take literature analysis and field research combined with the way of Jingshan Park existing open area of the building oil painting disease existing investigation, recording and analysis. Factors affecting the oil painting of ancient buildings in Jingshan Park can be divided into natural factors, human factors, and the material and production process of the oil painting itself. According to the industry standard "Ancient Architectural Painting Diseases and Illustrations"[9] released in 2010, the

current situation of Jingshan Park architectural oil painting is investigated and analyzed, and the painting diseases can be divided into four categories: structural diseases, pigment layer diseases, surface contamination and erosion diseases, and man-made damages.

3.1 Structural Diseases (Table 1)

Table 1: Structural Diseases

Disease name	Placement	Photograph	Disease description
Fissure	interior eaves of the eastern auxiliary halls of the temple for State Protection and Loyalty		Polychrome paintings support body, ground battle layer, pigment layer or gold layer appeared gap phenomenon
Cracking	Wansui Gate		Polychrome paintings color painting ground battle layer, pigment layer formed by the mesh cracking.
Uplifting	Wansui Gate		Upturned edges and even rolled up edges caused by cracks, fissures, and other diseases.
Deep loss	interior eaves of the pavilion built over a stone tablet		The ground battle layer is detached from the base of the wood member, creating a noticeable hollow or missing area.

3.2 Pigment layer disease (Table 2)

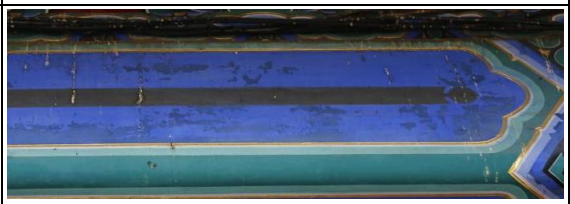
Table 2: Pigment layer disease

Disease name	Placement	Photograph	Disease description
Loss of paint	exterior eaves of the Shouhuang Hall		The pigment layer detaches resulting in exposure of the underlying material.
Gold foil loss	exterior eaves of the Qiwang Tower		The gold layer of the color painting is detached from the pigment layer.
Change color	interior eaves of the pavilion built over a stone tablet		Color painting pigment hue change.
Colour fading	Shouhuang Gate		The phenomenon of colored paint fading or disappearing.

3.3 Surface Contamination and Erosion Disease (Table 3)

Table 3: Surface contamination and erosion disease

Disease name	Placement	Photograph	Disease description
Blackening of overprint varnish	interior eaves of the Shouhuang Hall		Overall darkening of the varnish layer with the appearance of oil stains.
Dust accumulation	exterior eaves of the Fulan pavilion		The surface of the color painting is covered with dust.

Fouling	Shanyouli Gate		A mixed dirt layer formed on the surface of a color painting by combining the aging components of the painting, dust and moisture in the air.
Water damage	Well pavilion		Rainwater erosion leaks on the surface of the color painting and leaves traces, often accompanied by mud stains.
Soot contamination	interior eaves of the temple for State Protection and Loyalty		Smoke pollution from incense, fireworks, etc. adheres to the surface of colored paintings.
Animal damage	Shanyouli Gate		Damage such as animal excrement and cobwebs appearing on the surface of colored paintings.
Microbial damage	exterior eaves of the Jifang Pavilion		Bacterial spots and mold on the surface of the color painting.

3.4 Human-made damage (Table 4)

Table 4: Humen-made damage

Disease name	Placement	Photograph	Disease description
Human-made damage	Wansui Gate		polychrome painting are damaged by penetration of metal components, piping and equipment, as

	exterior eaves of the Zhoushang pavilion		well as improper repairs and other actions.
	exterior eaves of the Qiwang Tower		

4. Characterization of the disease of Jingshan color painting

4.1 Analysis of interior polychrome paintings (Table 5)

Table 5: Analysis of interior polychrome paintings

Serial number	Placement	Type of disease
1	the eastern and western auxiliary halls of the temple for State Protection and Loyalty	Fissure, Cracking, Uplifting, Dust accumulation, Human-made damage
2	the temple for State Protection and Loyalty	Fissure, Cracking, Uplifting, Deep loss, Loss of paint, Gold foil loss, Change color, Blackening of overprint varnish, Fouling, Soot contamination, Microbial damage, Human-made damage
3	the Guande Palace	Fissure, Cracking, Uplifting, Deep loss, Loss of paint, Gold foil loss, Change color, Blackening of overprint varnish, Fouling, Human-made damage
4	the Divine Kitchen	Human-made damage
5	the eastern and western auxiliary halls of the hall of Imperial Longevity	Fissure, Dust accumulation, Water damage, Human-made damage
6	the two pavilions built over a stone tablet	Fissure, Cracking, Uplifting, Deep loss, Loss of paint, Gold foil loss, Change color, Dust accumulation, Fouling, Water damage, Animal damage
7	Shouhuang Hall	Cracking, Uplifting, Gold foil loss, Change color, Blackening of overprint varnish, Fouling

4.2 Analysis of exterior polychrome paintings(As shown in Table 6)

Table 6: Analysis of exterior polychrome paintings

Serial number	Placement	Type of disease
1	the Wansui Gate	Fissure, Cracking, Uplifting, Loss of paint, Change color, Blackening of overprint varnish, Animal damage, Human-made damage
2	the Qiwang Tower	Fissure, Cracking, Uplifting, Deep loss, Loss of paint, Gold foil loss, Change color, Dust accumulation, Fouling, Animal damage, Microbial damage, Human-made damage
3	the Zhoushang pavilion	Fissure, Cracking, Loss of paint, Dust accumulation, Animal damage, Microbial damage, Human-made damage
4	the Guanmiao pavilion	Fissure, Cracking, Uplifting, Deep loss, Loss of paint,Change color, Dust accumulation, Fouling, Microbial damage，Human-made damage
5	the Wanchun pavilion	Fissure, Cracking, Uplifting, Loss of paint, Change color, Dust accumulation, Animal damage, Human-made damage
6	the Jifang pavilion	Fissure, Cracking, Uplifting, Loss of paint, Dust accumulation, Fouling, Microbial damage, Human-made damage
7	the Fulan pavilion	Fissure, Cracking, Uplifting, Loss of paint, Change color, Dust accumulation, Fouling, Microbial damage, Human-made damage
8	the Shanyouli Gate	Fissure, Cracking, Uplifting, Loss of paint, Change color, Dust accumulation, Fouling, Water damage, Animal damage, Microbial damage, Human-made damage
9	the Shanzouli Gate	Fissure, Cracking, Uplifting, Loss of paint, Change color, Blackening of overprint varnish, Dust accumulation, Fouling, Water damage, Animal damage, Human-made damage
10	the eastern and western auxiliary halls of the temple for State Protection and Loyalty	Fissure, Cracking, Uplifting, Blackening of overprint varnish, Water damage, Human-made damage
11	the temple for State Protection and Loyalty	Fissure, Cracking, Uplifting, Dust accumulation, Fouling, Water damage, Human-made damage
12	the Guande Gate	Fissure, Uplifting, Loss of paint, Gold foil loss, Change color, Blackening of overprint varnish, Dust accumulation, Fouling, Animal damage, Human-made damage
13	the eastern and western auxiliary halls of the Guande Temple	Dust accumulation, Fouling, Microbial damage, Human-made damage
14	the Guande Palace	Change color, Dust accumulation,

15	the JiuJu Memorial Archway	Fissure, Cracking, Uplifting, Loss of paint, Gold foil loss, Dust accumulation, Animal damage, Human-made damage
16	the Shouhuang Gate	Fissure, Cracking, Uplifting, Loss of paint, Gold foil loss, Change color, Dust accumulation, Fouling, Animal damage, Human-made damage
17	the Divine Kitchen	Fissure, Dust accumulation, Fouling, Water damage, Human-made damage
18	the two wells Pavilion	Cracking, Dust accumulation,
19	the eastern and western auxiliary halls of the hall of Imperial Longevity	Fissure, Loss of paint, Blackening of overprint varnish, Dust accumulation, Animal damage, Human-made damage
20	the two pavilions built over a stone tablet	Blackening of overprint varnish, Fouling, Water damage, Microbial damage, Human-made damage
21	the Shouhuang Hall	Cracking, Uplifting, Loss of paint, Animal damage, Human-made damage
22	the Temple of the Mianxi Hall	Fissure, Cracking, Uplifting, Loss of paint, Dust accumulation, Fouling
23	the diffraction of the Yanqing Hall	Cracking, Loss of paint, Dust accumulation, Animal damage

4.3 Comparison of exterior and interior eaves

The exterior and interior eaves of the eastern auxiliary halls of the hall of Imperial Longevity’s architectural polychrome paintings belongs to the Yanzhuomo Stone-Ground Jade-Like Spiral Pattern Color Painting, inner eaves color painting and outer eaves color painting repair time is similar, so the two as an example for comparison, in order to explore the impact of the natural environment on the inner eaves color painting and the outer eaves color painting disease.

4.3.1 Structural Diseases

The fissures of the polychrome painting on the inner eaves of the East Annex Hall are relatively fine, with no cracking and warping phenomena. Outer eaves color painting fissure degree is deeper, around the beginning of cracking tendency, and triggered a slight warping of the pigment layer.(As shown in Fig. 1)

Fig. 1(1) Inside Eave - Fissure

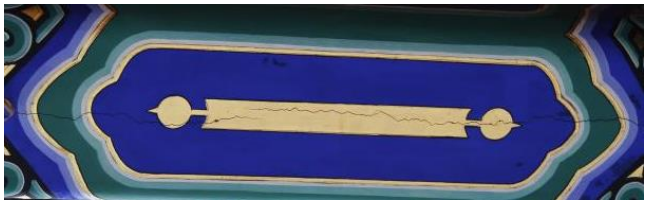


Fig. 1(2)Outside Eave - Fissure

4.3.2 Pigment layer disease

The pigments of the inner eaves are well preserved, and there is no disease of the pigment layer. The pigments of the colorful paintings on the outer eaves are peeling off more seriously.(As shown in Fig. 2)

Fig. 2(1) Inner Eaves - pigment layer intact

Fig. 2(2) Outer Eaves – Loss of pain

4.3.3 Surface Contamination and Erosion Disease

4.3.3.1 Dust accumulation

Inside the eaves of the color painting accumulation of dust is thin, color painting content is still relatively clear to see. Outer eaves color painting accumulation of dust is thicker, by the accumulation of dust obscured part of the color painting identification edge is more difficult.(As shown in Fig. 3)

Fig. 3 (1) Inner Eaves - Dust accumulation

Fig. 3 (2)Outer Eaves - Dust accumulation

4.3.3.2 Animal damage

There is no animal damage to the interior gable paintings and animal droppings appear on the exterior gable paintings.(As shown in Fig. 4)

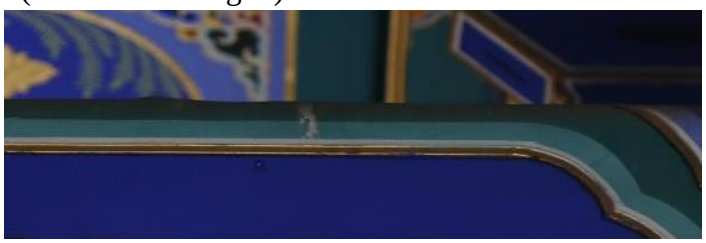


Fig. 4 Eaves - animal damage

5. Conclusion

In the Jingshan Park architectural painting disease, a total of 24 fissure were found, cracking 23, the deeps loss 5, Loss of paint 28, Gold foil loss 10, Change color 14, Dust accumulation 22, Fouling 16, water damage 8, animal damage 12, microbial damage 11, human-made damages 20, blackening of overprint varnish 10.

Beijing belongs to the temperate monsoon climate. Spring is windy, and the accompanying dust,

sand, sandstorms are very easy to make the polychrome painting accumulate dust, scale and other diseases. In recent years, the highest summer temperature in Beijing is up to more than 40℃, and heavy rainfall often occurs in July and August, with an average annual precipitation of about 600 mm, and 75% of the annual precipitation is concentrated in the summer[10], which leads to high humidity in the air, triggering water stains on the surface of the polychrome painting, and breeding microorganisms. Since 2007, Beijing has become an area of heavy acid rain pollution[11], and the acidic substances in the rainwater may also cause significant fading and discoloration problems in the paintings. Autumn and winter seasons are cold and dry, the sudden change of temperature will cause thermal expansion and contraction of wood, resulting in color painting fissure, cracks, uplifting and other diseases. Inner eaves color painting fissure is relatively small, outer eaves color painting fissure is larger, and gradually began to trigger other diseases. Inside the eaves color painting due to the wooden structure of the shelter, color painting surface accumulation of dust is less, while outside the eaves color painting due to no object shelter produced a thicker accumulation of dust phenomenon. In addition, the colorful paintings on the outer eaves also produce the appearance of animal feces, with the passage of time, the moisture in the animal feces, organic acids and other substances will cause the colorful paintings of fading, changing, which will lead to the peeling of pigments, warping and other diseases. Furthermore, rain, dust, ultraviolet irradiation and other factors will further deepen the disease types and degree of polychrome paintings, day after day, the degree of disease of the outer eaves polychrome paintings will inevitably be deeper than the degree of disease of the inner eaves polychrome paintings. In addition, the intensity of ultraviolet rays will also lead to color fading, varnish layer blackening and other diseases, especially for some organic pigments, long time ultraviolet irradiation will accelerate its decomposition and aging.

Repair of ancient architectural polychrome paintings should first be fully detailed investigation and assessment of the disease, the development of targeted repair programs, for the more complete paintings can be used back to paste the way to repair and reinforcement. For the color painting cannot be pasted back should be in accordance with the principle of maintaining the authenticity, as far as possible, using raw materials and the original process of color painting repair.

For oil-decorated paintings, dust in the air, changes in temperature and humidity, precipitation, ultraviolet irradiation, animal activities and other external environmental factors can cause damage to paintings. First of all, regular dusting of polychrome painting can reduce the dust and pollutants adhering to the surface of polychrome painting. Secondly, for the inner gable paintings, keep the indoor temperature and humidity stable, can reduce or lower the chance of disease. Although the outside eaves color painting cannot control the change of temperature and humidity, but you can carry out regular testing, record the disease situation, and take timely measures to protect and repair. For the eave paintings often appear animal damage, can be solved by installing the bird net to solve.

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