

# Fireworks on the Sumida River

Damien Liu-Brennan<sup>a\*</sup> and Tadao Yoshida<sup>b</sup>

<sup>a</sup>Macquarie University (Japanese Studies), Sydney, NSW, Australia, 2109

Email: damien.liu-brennan@students.mq.edu.au

<sup>b</sup>Ashikaga Institute of Technology, 286-1 Omae-cho, Ashikaga-shi, Tochigi-ken, 326-8558, Japan

Tel: +81 284 62 0605, fax: +81 284 62 0976, email: yoshida@ashitech.ac.jp

**Abstract:** *Fireworks (hanabi) were originally displayed on the Sumida River in 1733 as a memorial service for the victims of starvation due to crop failures and plague, and an epidemic of cholera. The fireworks display originated as the “Ryōgoku Kawabiraki Hanabi” (Ryōgoku River-Opening Fireworks) with only 20 fireworks displayed. Although the display has experienced several interruptions historically, it has evolved into what is known today as the “Sumidagawa Hanabi Taikai” (Sumida River Fireworks Display). Currently, a total of about twenty thousand hanabi shells are displayed from two separate firing locations on the river, and in conjunction with this, a fireworks competition is held at one of the locations. This paper describes the history, evolution, and current status of the display.*

**Keywords:** *Sumida River; fireworks history, Japanese fireworks, hanabi, Kagiya, Tamaya, Ryōgoku*

## Introduction

Fireworks (*hanabi*) were introduced to Japan over 400 years ago and have since established a significant position in Japanese society and culture. The Sumida River stands testament to this with a continuing tradition of fireworks for over 275 years. Ironically, the historical documentation of fireworks in Japan is sporadic and somewhat incomplete, whilst documentation in English is minimal and usually confined to one or two paragraphs of general content consubstantially recounted in book chapters or seasonal articles. This can be exemplified by the reputable Sumida River Fireworks Festival, which, whilst arguably the most recognized fireworks festival in Japan, has only some aspects of its history known, with consideration rarely going beyond a brief account and handing down of the Kagiya and Tamaya legend; and perhaps a general understanding of the circumstances behind the origins of the festival, with little or no reference to recent or current

events.

Taking this into consideration, this paper intends to collate the history and evolution of Sumida River fireworks, increase the scope of current understanding with further annexation, and update the status of Sumida River fireworks history with the addition of recent and current events.

## Origin of Ryōgoku River-opening fireworks

In 1732, Japan was devastated by nationwide crop failures and a plague in which nearly one million people died from the ensuing famine. Furthermore, in Edo (now Tokyo), a cholera epidemic broke out infecting many people and causing many further deaths and it was said that many corpses were discarded on the streets.<sup>1</sup>

The following year, to alleviate superstition associated with these tragic incidences, Tokugawa Yoshimune,<sup>2</sup> the 8th Tokugawa Shogun, held a

---

*Article Details*

*Manuscript Received:- 19/01/2009*

*Publication Date:-19/03/2009*

---

*Article No: - 0071*

*Final Revisions:- 19/03/2009*

*Archive Reference:-805*

---

*suijin* festival (water god ritual) at Ryōgoku, where prayers were offered to the *suijin* (water god) to ward off evil spirits and assuage the souls of the dead. This coincided with the annual *kawabiraki* (a river or port opening festival) which was held in the cool of the evening on 28 May, 1733 (based on the old Japanese calendar), the first evening of the summer season. The *kawabiraki* signaled the opening of the river for boating activities and prayers were offered for safety on the river and at sea throughout the summer season (May 28 to August 28). During the summer season, people relaxed along the riverbanks or on various types of boats while enjoying the cool breeze of the summer evenings. The *misemonokoya* (show booths) around Ryōgoku were crowded and *yataimise* (portable stalls) along the riverbanks were allowed to open until late in the night. Also, on May 28, the riverside restaurants at Ryōgoku held a *kawasegaki* (a special memorial service for those who had drowned in the river).

As part of the memorial and *kawabiraki*, fireworks were displayed at Ryōgoku by the 6th generation master of the Kagiya (house), and the number of fireworks displayed was said to be about 20. Black powder consisting of saltpeter, sulfur, and charcoal, was used for fireworks but was not able to give such bright colors as seen today. Nevertheless, the citizens of Edo at that time were delighted by the fireworks display.

1733 thus marks the commencement of the *Ryōgoku kawabiraki hanabi* (Ryōgoku River-Opening Fireworks), which has since evolved into the Sumida River Fireworks Display.

## Emergence of Kagiya and Tamaya

The Kagiya name began in 1659 when Kagiya Yahei, from Shinohara-mura (located in the present Nara Prefecture), came to Edo and opened a fireworks shop (house)<sup>3</sup> at Yokoyama-chō, thus founding what would become the Kagiya dynasty. Fireworks were already popular in Edo before the arrival of Kagiya, however, due to the impending hazard of fire amongst the large numbers of wooden houses and shops, several official notices had been issued (notably in 1648, 1652, 1655, 1670, and 1680)<sup>4,5</sup> forbidding fireworks to be displayed in most areas and outlining harsh penalties such as expulsion from the city for anyone responsible for

causing fire damage. Despite this, Kagiya obtained a good reputation earned by making specialized fireworks, like Roman candles, that shot out two or three stars.<sup>4</sup>

In about 1700, the 4th generation master of the Kagiya (house) was appointed as a purveyor to the Tokugawa Shogunate and was officially recognized as the first private fireworks manufacturer. By this time, fireworks usage was restricted to the surrounds of the Sumida River which had become somewhat of a playground for fireworks. Many river craft such as *chokibune* (small open boats), *yanebune* (roofed boats), and *yakatabune* (larger specialized roofed pleasure ships) appeared on the waters in the cool of the summer evenings hosting patrons who would relish in the festivities. During this period, the nobility and rich merchants of Edo often rivaled each other by financing Kagiya to display fireworks for them.

In 1808, a talented apprentice in the Kagiya (house) by the name of Seishichi emerged, demonstrating excellent skills. The 8th generation master of the Kagiya (house) helped Seishichi set up his own business at Yoshikawa-cho, thus branching out from the Kagiya (house). Seishichi took on the name Tamaya Ichibei and after not too long his reputation exceeded that of his former master.<sup>6</sup> Consequently, the Ryōgoku *kawabiraki* saw both Kagiya and Tamaya preparing separate ships of fireworks at the upper and lower streams of the Ryōgoku Bridge and competing with each other by displaying their new creations. Both houses were renowned as the most outstanding *hanabishi* (fireworks masters) of the time and shouts of encouragement: “*Tamaya! Kagiya!*” were echoed across the Sumida River as each launched their creations, and it could be said that this event united people from the two domains on either side of the river.

On 14 October, 1843, a fire broke out in the Tamaya storehouse and the conflagration destroyed many houses in the neighborhood. This was considered unfavorable fortune as it occurred the day before Tokugawa Ieyoshi, the 12th Tokugawa Shogun, was to visit and pay respects at the ancestral Tōshōgū Shrine in Nikkō (enshrining the founder of the Tokugawa Shogunate, Tokugawa Ieyasu). As a result, Tamaya was banished from Edo and the Tamaya (house) lapsed from existence.

Meanwhile, the Kagiya (house) continued and evolved into a lasting dynasty. After 12 generations, however, it was succeeded by the Amano family when, in 1949, Amano Hutoshi took control and became the 13th generation master of the Kagiya (house). The Kagiya dynasty still continues today although in a different capacity as the tradition of manufacture has been discontinued and the company, whilst maintaining the Kagiya name (Sohke Hanabi Kagiya Co.), concentrates on fireworks design and event management. Currently the Kagiya (house) is in its 15th generation with Amano Akiko succeeding her father, Amano Osamu, in 2000 to become the first female director of the Kagiya dynasty.<sup>7</sup> This year, 2009, marks the 350th anniversary of the Kagiya dynasty.

Despite the foregoing fate of the Tamaya (house) and the continuing success of the Kagiya (house), their exploits have significantly contributed to Japanese culture and both the names 'Kagiya and Tamaya' have become immortalized in Sumida and Japanese history.

### Fireworks of the Edo period (1603–1868)

During the Edo period, fireworks which had previously been expensive entertainment for the nobility became available to the common people. Shops in Edo opened to sell fireworks to the general public and fireworks specifically made for children to play with were also available. Fireworks vendors called “*hanabi! hanabi! nezumi, tebotan, konguruma, karakurihanabi, hanabi!*” indicating the various types of fireworks available. A *nezumi hi* (rat fire), was a firework that scuttled along the ground like a rat; a *konguruma* one that spins on the ground; *tebotan* (hand peony) similar to the present day *senkō hanabi* (hand held sparkler); and *karakuri* (mechanism) akin to set piece fireworks.

A fireworks display program *ca.* 1800 displayed further names that appeared as fireworks in the Edo period such as *ryūsei, uchidashi, tsunabi utsushi kanagasa*, and *uchiage*.

A *ryūsei* (rising dragon/shooting star) would shoot skyward with a tail, emulating a dragon flying through the sky; an *uchidashi* was a ground shooting firework; *tsunabi utsushi kanagasa* was perhaps a firework like a traditional Japanese *tsunabi* (rope fire) firework; and an *uchiage*

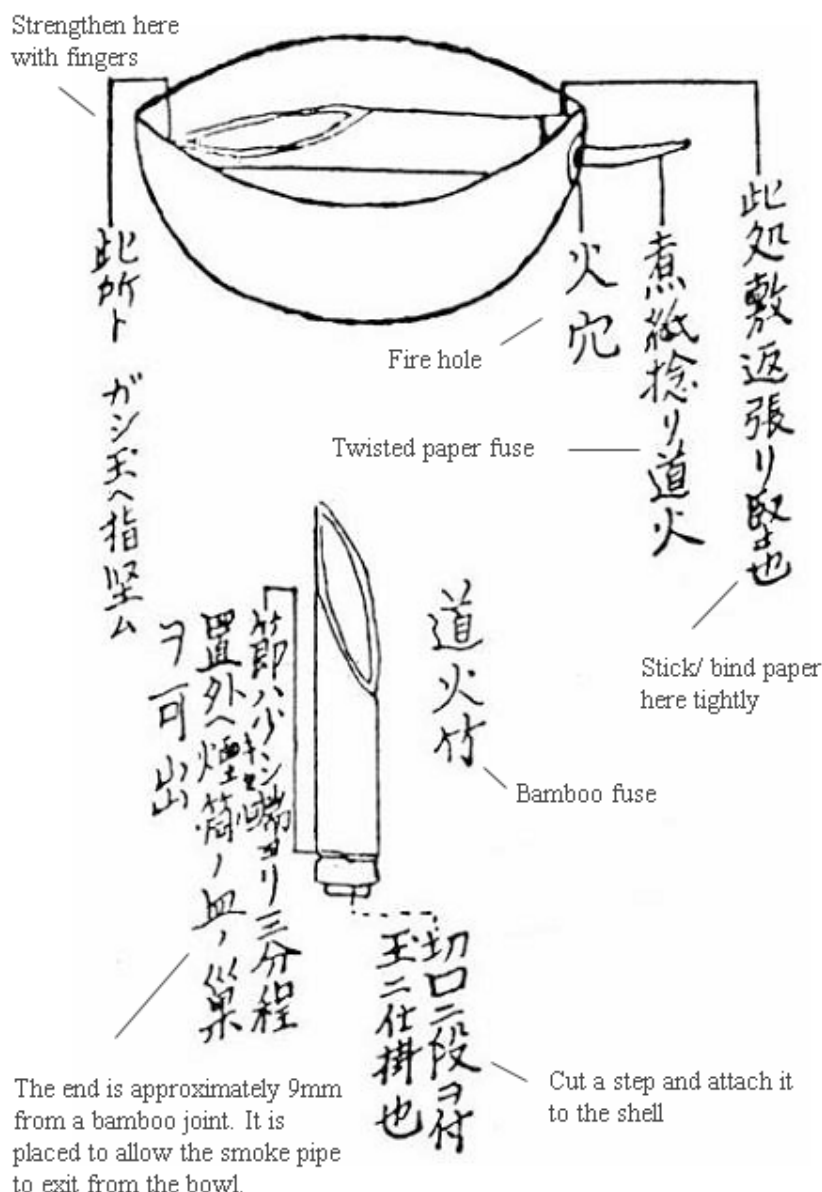
(launched firework/skyrocket) was a new firework of the time that may have been a prototype for the modern day round shell.

Prior to the Edo period, Japan was at one stage the world leader in gun manufacture,<sup>4</sup> however, under the Tokugawa Shogunate, gunnery was abolished and the necessity for gunnery craftsmen diminished, thus many of these craftsmen turned to making fireworks. The *daimyō* (feudal lords) who had residences along the Sumida River could view fireworks from their mansions and were inspired by the displays, thus many *daimyō* promoted these craftsmen and employed them to develop and display fireworks for them. Fireworks made under the *daimyō* were known as *buke hanabi* (warrior fireworks) and were often displayed in competitions with other *daimyō*. Of particular note was the development of *noroshi hanabi* (signal fire fireworks) for warriors that could be shot high into the sky as beacons. These were the likely prototype for the round Japanese firework shells of today. Figure 1 shows a structural picture of a round signal shell, as described in a secret hand written document by the Yasumori School dating back to 1756.

### Fireworks in *ukiyo-e*

In the 19th century, fireworks on the Sumida River became the subject of *ukiyo-e* (literally, pictures of the transient world) and *nishiki-e* (literally, multicolor pictures), types of wood block prints. The area around Ryōgoku had become renowned as a pleasure quarters and the everyday frivolities of the area, such as teahouse and restaurant activity, sumo wrestling, indulgence with geisha, and river life, were often depicted in prints. As fireworks were a prominent part of the river life, depictions of fireworks featured in many prints, often showing the various styles of fireworks of the time (Figures 2 and 3).

One of the most famous color prints depicting fireworks and the river life at Ryōgoku is “*Meisho Edo hyakkei Ryōgoku hanabi*” (100 Famous Views of Edo: Fireworks at Ryōgoku) by Utagawa Hiroshige (Figure 2), which depicts a shooting *ryūsei* and the burst of an aerial shell next to Ryōgoku bridge, whilst onlookers are represented crowding on the bridge and in watercraft (*chokibune, yanebune* and a *yakatabune*) along



**Figure 1.** A round signal shell and its fuse developed by the Yasumori School, 1756 (Translation by T. Yoshida).<sup>8</sup>

both sides of the bridge.

Another such example (Figure 3) from a *kusazōshi* (a type of illustrated woodblock print book from the Edo period) shows *hanabishi* entertaining the patrons with different styles of fireworks whilst on a small river boat.

Further depictions of river life, festivities, and fireworks along the Sumida River continued to appear in *ukiyo-e*, *nishiki-e*, and other types of

woodblock print media throughout the Meiji period (1868–1912).

### Development of fireworks from the Meiji era (1868–1912) to the present time

Though round shells were displayed in the Edo period, it is said that fireworks with completely round bursts have only been seen since about



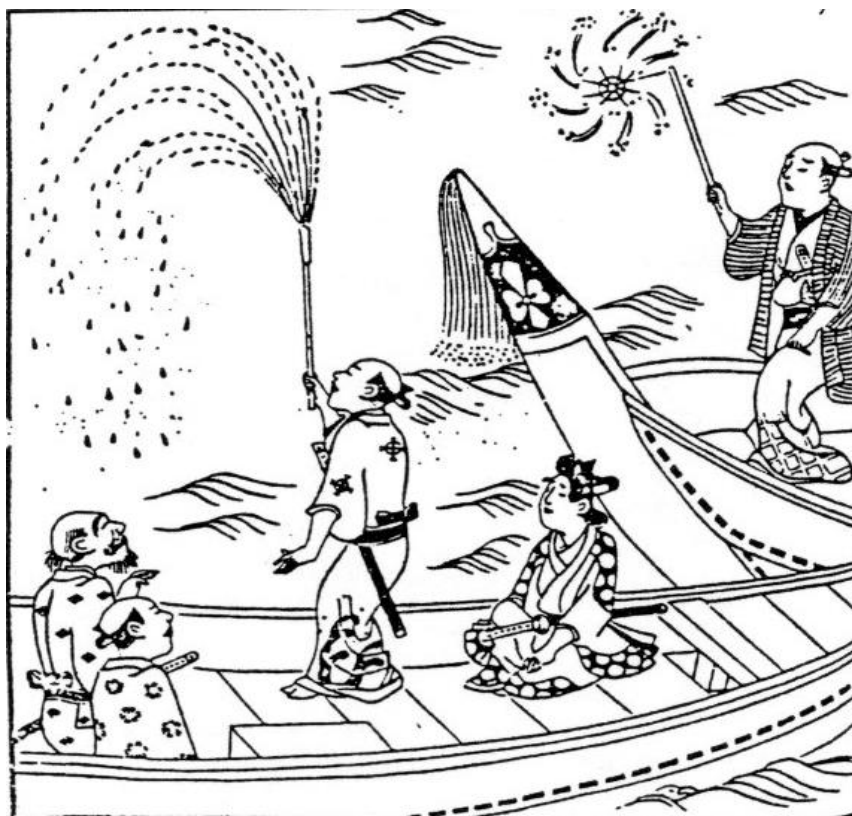


**Figure 2.** “*Meisho Edo hyakkei Ryōgoku hanabi*” (100 Famous Views of Edo: Fireworks at Ryōgoku) by Utagawa Hiroshige.

1874.<sup>1</sup> This was achieved by the efforts of the 10th generation master of the Kagiya (house) and highlights the desire for perfection and progression of fireworks sought by the *hanabishi*.

Originally, black powder was used for fireworks, in which saltpeter (potassium nitrate) was used as the oxidizer. As a consequence, the combustion temperature of the powder was too low to give bright colored flames and only dark red or amber could be achieved.<sup>9</sup> From about 1879, potassium chlorate was imported into Japan (along with

the safety match) which signified a turning point and allowed rapid advancements in fireworks technology. Using potassium chlorate as the oxidizer produced a significant increase in the combustion temperature allowing shells to burst with a higher velocity as well as allowing much brighter and colored flames. Metals such as magnesium, aluminium, and titanium were added to achieve higher brilliancy of light and effects such as sparkles and glitter; whilst various colored flames could be obtained by adding compounds containing sodium, strontium, barium, and copper.



**Figure 3.** Fireworks play during the Edo period depicted in a kusazōshi.

Research is still being conducted in Japan today with new colors and effects continually being developed and perfected.

Traditionally, Japanese fireworks displays were enjoyed by shooting round shells into the sky one by one; a practice still implemented today in many locations throughout Japan. However, in other countries, many fireworks were shot successively in a short time. In 1904, the 11th generation master of the Kagiya (house) went to Manila in the Philippines and witnessed such a rapid firing of shells. Subsequently, this concept was brought back and applied at the Ryōgoku Kawabiraki Fireworks Display and is commonly known today throughout Japan as a “star mine”.

The Taishō era (1912–1926) saw further advancements and refinements of aerial shell fireworks and in 1926 the *shin iri kiku* (chrysanthemum with a single pistil) was finally perfected, whilst 1928 saw the success of *yaeshin kiku hanabi* (double pistil chrysanthemum)<sup>10</sup> demonstrating the high level of precision

and skill that Japanese pyrotechnicians had acquired (Figure 4). These kinds of multi core chrysanthemum shells have come to be regarded as the representative fireworks of Japan.<sup>9</sup> Despite the usage of star mines at the Sumida River Fireworks Display, it is still these types of aerial shells that are the highlight; however, due to the narrow display area of the river, which is lined with buildings (Figure 5), size restrictions have been applied for safety purposes and shells larger than 4-gō (0.12 m) are prohibited from the display.

*Oodama* (large size shells), such as 10-gō (0.30 m) and larger, can be displayed in more spacious sites and are the main shells used for single shot events in other displays throughout Japan. Again *yaeshin kiku* and other multi-core chrysanthemum shells are typical of the fireworks that are displayed at these events.

‘Set piece’ fireworks have been used for a long time, especially in Europe; however, in Japan they only became popular during the Meiji period when colored flame compositions could be used in



**Figure 4.** *Yaeshin kiku (double pistil chrysanthemum)*<sup>#10</sup> (DLB 2008).

fireworks. ‘Frame set pieces’ arranged on wooden frames with various patterns and/or *kanji* (Chinese characters) and ‘wire set pieces’ arranged along ropes in the shape of Niagara Falls or Mount Fuji have been used often. The Niagara Falls set piece is still a popular inclusion at many fireworks displays today, although other set pieces have declined in popularity in Japan compared to the excitement of star mines.

Fireworks launching flags or floating figures suspended from parachutes were also once popular. Prior to the Second World War, floating figures such as ‘gold fish’ and ‘flowing fire’ could be seen, but these are no longer used in current Sumida River Fireworks displays due to the

inconvenience of tangling in overhead power lines or on buildings, and because of the inherent danger to children or others who may be injured whilst chasing them. Parachute fireworks can still be seen in some displays elsewhere in Japan.

### **Recent Sumida River fireworks displays**

Due to the disarray at the end of the Edo period as the Tokugawa Shogunate collapsed the Ryōgoku Kawabiraki Fireworks Display underwent a period of dormancy from 1863 until June 8, 1868, when it was revived with much excitement from the people. Furthermore, fireworks as a culture on the Sumida River continued to increase in popularity,





**Figure 5.** *The narrow Sumida River lined with buildings with modern yakatabune taking position. A fireworks barge can be made out under the centre arch of the Umayu Bridge (DLB 2008).*

as demonstrated by the scheduling of extra trains in 1874 to accommodate crowds, and by the sheer number of spectators crowding onto the wooden Ryōgoku Bridge in 1897 causing it to split and break apart.<sup>6</sup>

The Kagiya (house) continued to manage the Ryōgoku Kawabiraki Fireworks until just before the Second World War. However, with the onset of war, most fireworks craftsmen were subjugated into military service and/or their businesses closed or used for military purposes. Fireworks underwent another period of dormancy from 1938 to 1947 as the events of the war transpired.

August 1, 1948 saw the post-war revival of fireworks on the Sumida River and a display was once again held near the Ryōgoku Bridge. Following this, on September 18 of the same year,<sup>11</sup> the first *zenkoku hanabi konkuru* (All Japan Fireworks Competition) was held and *hanabishi* were once again able to display their skills. From 1949, the Ryōgoku Kawabiraki Fireworks Display was held simultaneously with the All Japan Fireworks Competition, co-managed by Hosoya Kakou Co.

(now Hosoya Enterprise Co.) and Marutamaya Ogatsu Fireworks Co., and saw many successful displays. However, after the display in 1961, the Ryōgoku Kawabiraki Fireworks were again suspended, this time due to traffic congestion and pollution in Tokyo.

In 1978, the display was once again revived, although on a small scale, with the new name of *Sumidagawa Hanabi Taikai* (Sumida River Fireworks Display). The display site also moved upstream from the original site near the Ryōgoku Bridge to two new firing locations: the first between Sakura Bridge and Kototoi Bridge, and the second between Umayu Bridge and Komagata Bridge. This possibly served the dual purpose of alleviating traffic and pedestrian congestion as well as perhaps symbolizing the two firing sites of the two great historical masters, Kagiya and Tamaya, from the Edo period. Hosoya Enterprise Co. and Marutamaya Ogatsu Fireworks Co. separately take charge of each firing site in rotation every year. The two companies currently display about ten thousands shells each, and modern day *yakatabune* can still be seen on the river maintaining the





**Figure 6.** *Simultaneous launching from the two separate firing locations with modern yakatabune along the water (DLB 2008)*

tradition of old (Figures 5 and 6). Various aerial shell fireworks displayed at Sumida are shown in Figures 6 to 10.

### **The Sumida River Fireworks Competition**

Since 1978, The Sumida River Fireworks Competition has been held in conjunction with the Sumida River Fireworks Display. The competition is held during an interlude of the main display at the previously mentioned first firing location (between Sakura Bridge and Kototoi Bridge). The competition comprises ten competitors, of which seven are regular exhibitors and the remaining three are fireworks companies that have previously been awarded prizes at famous fireworks competitions such as the National Japan Fireworks Competitions at Tsuchiura in Ibaraki Prefecture, and Ōmagari in Akita Prefecture.



**Figure 7.** *A baby's-breath.*



**Figure 8.** *Many weeping willows.*





**Figure 9.** *All flowers garden.*

As previously stated, aerial shells are considered a highlight at Sumida and it is the creative variety of these fireworks that are judged at the competition. Each competing company launches 4-gō (0.12 m) shells successively for one minute and such things as the construction, technical attributes, and creativity are judged. The Sumida River Fireworks Competition is adjudicated by a select panel of judges (Figure 11) representing a cross section of prominent people in their respective fields. There are two judging locations, at Kōtō-ku and Sumida-ku, used in rotation each year. Judges consist of chairmen and members, including representatives of the local community. Currently the chairmen are famous Japanese artists: Ōyama Chusaku and Hirayama Ikuo. The members comprise: a man of academic standing, a master of Japanese wrestling, and an entertainer; whilst representatives of the local community come from: Tokyo-to, Yomiuri Newspaper, Tokyo Broadcasting, and Mitsui Construction Co.<sup>12</sup>

There are no strict criteria for adjudicating



**Figure 10.** *Twinkling stars.*

the competition and points are awarded at the discretion of the individual judges. Some attributes considered are such things as: how well the pattern is formed, how well the firework sits in the sky before explosion, the intensity of colors, new colors, and how evenly the stars disappear. The final ranking of the competitors is based on the accumulative scores of points awarded by the judging panel. So far, adjudicating with a panel of judges in this manner has worked well for the competition.

The most popular type of firework used for the competition is the *katamono* (pattern firework). A pattern firework that displays a more perfect shape in the sky is ranked accordingly by the judges. Examples of pattern fireworks that have been awarded prizes at previous Sumida fireworks competitions can be seen in the video freeze frame captures in Figures 12 to 14. Freeze frame capture allows a precise visualization of the firework as it bursts and opens, which may be a better method for adjudicating pattern fireworks and has been used



**Figure 11.** Judges at the Sumida River Fireworks Competition.

by judges at prior Sumida River competitions.<sup>13</sup>

### Conclusion

The Sumida River has enjoyed a long history of fireworks and has been a breeding ground for the development of fireworks and a fireworks culture that is historically significant to Japan and unique to the world. Originating as a memorial to honor the deceased and to ward off bad spirits, fireworks displays on the Sumida River have continued to

evolve, largely attributable to the two great artisans, Kagiya and Tamaya, whose names are synonymous with fireworks and have been immortalized in Sumida and Japanese history. With only a small number of historical interruptions, the culture of fireworks on the Sumida River has persisted and continues to symbolize the resplendent days of Edo so vividly depicted in *ukiyo-e* artworks.

Due to the narrowness of the Sumida River, the physical size of fireworks displayed is limited;



**Figure 12.** A diamond ring.



**Figure 13.** A new moon.





**Figure 14.** *The New Tokyo Tower.*

however, this lends itself to highlight the skills required by modern day *hanabishi* to work within these narrow limits and still continue to provide high quality displays of fireworks. As fireworks technology continues to progress, new colors and patterns are still being developed and perfected, and can be seen in the innovative works displayed at the Sumida River competition.

Whilst not the most elaborate or biggest fireworks display in Japan today, the *Sumidagawa hanabi taikai* is symbolic of fireworks culture in Japan and is certainly one of the most celebrated and highly regarded fireworks displays and competitions on the Japanese fireworks calendar.

### Acknowledgements

The authors are grateful to Mr T. Matsumoto for photos in Figures 7–10 and Miss M. Watanabe for the freeze frame video captures in Figures 12–14.

### References and Notes

- 1 T. Yoshida, “Fireworks Display on the Sumida River”, *Journal of the Illuminating Engineering Institute of Japan*, Vol. 92(7), 2008, pp. 386–389.
- 2 Japanese names are traditionally written with the family name first.
- 3 The Japanese translation of *ya* in the case of Kagiya and Tamaya is equivalent to house, shop, or guild. For clarity, the addition of “(house)” has been included after these names as an explanatory aid.
- 4 “*Hanabi-gaku Nyuumon*” (*Introduction to Fireworks*), Eds T. Yoshida and D. Ding, Pleiades Publishing, 2006.
- 5 G. Plimpton, *Fireworks: a History and Celebration*, Doubleday and Company Inc., Garden City, New York, 1984.
- 6 JICC, *Hanabi: The Fireworks of Japan*, Japan Publications, 1986.
- 7 Y. Hani, “Touched by the Hand of the Fire God”, *The Japan Times*, Sunday, August 4, 2002.

- 8 The original Japanese text is written in the classical language and whilst all care has been taken, the proposed translation may have some inaccuracies.
- 9 T. Shimizu, *Fireworks, the Art, Science, and Technique*; Pyrotechnica Publications, Austin, Texas, USA, 1996.
- 10 The Japanese term *shin* (芯) from *yaeshin* means “core” or “heart” and in terms of fireworks refers to concentric inner layers of a break or a central core (*yae* means “double”). In Japan, *shin* is often translated into English as “pistil” with the terms: double-pistil, triple-pistil, quadruple-pistil, and 5-pistil often used.  
  
The definition of a pistil as outlined by Kosanke<sup>14</sup> describes a pistil as a dense symmetrical pattern of stars within a break and implies that a pistil spreads no more than 1/3 the size of the break, with anything larger being a petal. Petals are further described as concentric spherical layers but also include the outermost layer of the break (anything smaller than 1/3 of the break being a pistil).  
  
A double-pistil chrysanthemum (describing only the two inner cores) is therefore equivalent in concept to a double-petal chrysanthemum with a pistil (describing the two outer layers and an inner core).  
  
Whilst the term double-pistil, may perhaps be incorrect according to Western terminology, this term corresponds with the Japanese concept and is used in this text to maintain a Japanese sense.
- 11 Ryogoku Fireworks Association, Yanagibashi, Tokyo.
- 12 The executive Committee for the Sumida River Fireworks Display, “Fireworks/Down Town/Sumida River”, 1983.
- 13 M. Watanabe, “A Study on the Recording Method for Fireworks Display”, Master’s Thesis, School of Fireworks, Ashikaga Institute of Technology, 2008.
- 14 K. L. Kosanke, B. J. Kosanke and E. Contestabile, *The Illustrated Dictionary of Pyrotechnics (Pyrotechnic Reference Series No.1)*, Journal of Pyrotechnics Inc. 1st edn, March 1995.