

Maria Belodubrovskaya
Collegium 2007

Understanding the Magic: Special Effects in Ladislav Starewitch's *L'Horloge magique*

Ladislav Starewitch is one of those cinemagicians whose name deserves to stand in film history beside those of [Georges] Méliès, Emil Cohl, and [Walt] Disney.

Charles Ford¹

Like film historian Charles Ford, nearly every commentator who writes about Ladislav Starewitch calls him a cinemagician and a great cinematic pioneer. What they typically refer to is Starewitch's role in developing the stop-motion puppet animation film. Although the technique of animating three-dimensional objects through freeze-frame cinematography was invented no later than 1897, from 1910 to the 1930s Starewitch was indeed its most prolific and sophisticated practitioner.² During this time he created over forty narrative puppet films that struck the viewer by their fantastic effects. However, Starewitch's contribution to film history is not limited to his role as an early stop-motion animator. His artistic practice also involved persistent innovation with special-effects cinematography. Several of his animated films included shots combining not only puppets with miniature sets, but also puppets with live-action footage, puppets with still images, and even conventional live-action with animated live-action.³ In fact, it is for his special effects as much as for his puppetry that he deserves a reputation as a "cinemagician" and a pioneer.

The role of Starewitch as a special-effects innovator has hardly been acknowledged. When commentators mention the technical sophistication of his films, they rarely elaborate. Fellow animator Simon Pummell is aware that "Starewitch never lets himself off the technical hook" but provides only one example: a matte shot in *Fetich Mascotte* (*The Mascot*, 1933).⁴ In his tribute to the artist, Starewitch's Russian producer, Alexander Khanzhonkov, mentions cinematographic innovation but only in the context of Starewitch's live-action features, the making of which Khanzhonkov witnessed. He writes: "Starewitch's contribution to the development of methods of trick cinematography was not insignificant, and his achievements in cinematographic technique deserve their own study. For myself I can say that he successfully used multiple exposures and the technique of filming against black velvet [to obtain footage of actors against an empty background], and he widely used a mobile camera."⁵

One reason that little is known about Starewitch's cinematographic techniques is perhaps that he guarded his secrets. On one occasion, when asked to demonstrate his methods during the making of *Strekoza i muravei* (*The Dragonfly and the Ant*, 1913), Starewitch apparently went "suddenly silent, then looked at [his interlocutor] fiercely and said: 'I can neither tell you nor show anything more. It is a secret. Go and see my film [...], it will soon be finished.'"⁶ Whatever the logic behind this reported attitude—the knowledge that his techniques were unique or, more likely, the desire to preserve the impression of amazement that his films unfailingly generated—today we have a chance to learn more about Starewitch's secrets, thanks to invaluable efforts such as the Starewitch retrospective at the 2007 Le Giornate del Cinema Muto and restoration work on Starewitch's films by Léona Béatrice Martin Starewitch.

In this essay I discuss the techniques of special-effects cinematography in Starewitch's *L'Horloge magique* (*The Magic Clock*, 1928). First, I explore the special effects that Starewitch had used up to 1928. Second, I discuss his innovative work with them in *L'Horloge magique*.

Finally, I compare special effects in this film to its most celebrated contemporary counterpart, Merian C. Cooper and Ernest B. Schoedsack's *King Kong* (1933). I argue that Starewitch's work ranks among, and perhaps above, some of the most sophisticated achievements of his generation of special-effects artists and suggest that further attention to his cinematographic work may bring us closer to a comprehensive appreciation for his art.

L'Horloge magique was not the first animation film in which Starewitch used special effects. As early as 1912, Starewitch included in his *Mest' kinematograficheskogo operatora* (*The Cameraman's Revenge*) a scene in which his characters, Mr. and Mrs. Beetle, watch a movie at an outdoor movie theater. The movie, called *The Adulterous Husband*, is a "documentary" about Mr. Beetle's affair, which the Grasshopper, the cameraman, has caught on camera earlier in the film to punish Mr. Beetle for stealing his mistress, the Dragonfly. This scene is presented in a composite shot combining the "film within a film," projected upon the miniature screen of the movie-theater set, and the set itself.⁷

The impression that an actual live projection inside the set was filmed to create this scene is extremely strong. The three-dimensional miniature screen is turned at approximately a thirty-degree angle to the surface of the frame. The footage on the miniature screen is perfectly aligned with its surface, so that it looks as if the footage itself is projected at a thirty-degree angle. (This rules out the possibility that rear projection was used to create this scene, as a rear-projected image would have been aligned with the surface of the frame.)⁸ The footage wiggles slightly, mimicking the way actual projection looked during the 1910s. Throughout most of the show the audience of beetles is completely still, further simulating the impression that the scene was shot live rather than animated. In addition, the heads of Mr. and Mrs. Beetle seated in the first row appear to cast shadows on the lower portion of the screen as if blocking the light from an actual projector at the back of the theater. How was this remarkable scene created?

I would suggest that Starewitch made stills from the footage we see earlier in the film and then animated these stills by placing them sequentially shot by shot upon the miniature screen. Such stills would have been easy enough to produce. The beetle characters that Starewitch was working with at the time were about three inches tall. This means that the stills needed to be a workable five-by-seven inches in size. No additional filming had to be done to produce the stills. *The Adulterous Husband* features the same footage we see earlier in the film. Although it is supposed to contain the footage from the cameraman's camera, what we see in fact are the shots complete with the camera and the cameraman. Moreover, the actions of characters in both the film itself and *The Adulterous Husband* are exactly the same. Finally, the fact that the figures of the Beetles seated in front of the miniature screen overlap with it confirms that the images on the screen had to be physically inserted into the set,⁹ as any kind of a traveling-matte technique—conceivable but not yet invented in 1912—would not have allowed for such seamless overlapping.¹⁰

By 1920 Starewitch uses matte shots to create special effects. In his *Dans les Griffes de l'araignée* (*In the Spider's Grip*, 1920), he designs a scene in which the Moth, a fashionable actress from Paris, tells the Fly, her country hostess, about the delights of the city. The characters, seated on a flower, are featured in an iris frame left. Frame right, towards the top of the frame, in another iris, we see several successive images of Paris. The center and lower right of the frame present a large image of the Moon with some clouds against the black sky. It is impossible to combine all three elements of this scene in a single exposure, because to accomplish this one would have to suspend both the characters and the pictures of Paris in the air

in front of the camera. More likely the images were created through sequential exposure of different parts of the image. First Starewitch shot the characters of the Moth and the Fly through a circular mask (a matte) mounted on the left in front of the camera. Then he exposed the film again, now masking the area where the characters used to be and using another circular mask (a counter-matte) to film the images of Paris. The static (probably painted) image of the Moon could have been exposed at the same time: as a matte necessarily leaves the rest of the frame dark, it is easy to place another static image within the space not taken up by the matte as long as its contours are dark enough to blend in with the edges of the matte.

In the late 1920s Starewitch continues to work with matte shots and starts experimenting with rear projection—now to combine live-action with puppet animation. In *La Reine des papillons* (*The Queen of the Butterflies*, 1927), a little girl (Starewitch's daughter Jeanne (Nina Star)) saves the queen of the butterflies and is rewarded with a journey to the fairyland. In some scenes set in the fairyland, Nina is played by a puppet. However, there are several moments where live footage of Nina is combined with animation in the same shot. For instance, there is a segment in which the footage of Nina in a medium shot is presented side-by-side with a close view of an insect puppet. This was accomplished through split-screen cinematography, where each side of the frame (Nina's and the puppet's) was exposed sequentially while the other was masked. A visible line in the middle of the frame confirms this. In another instance, Starewitch combines live footage of Nina in the background and a puppet of a minstrel in the foreground. Rear projection was used to accomplish this composite shot: the image of Nina occupies the entire background of the frame and the quality of the background image is relatively poor.¹¹

Neither one of these two composite shots produces a narratively convincing encounter between Nina and the puppets. Nina does not interact with the puppets, and her space in the frame is visibly different from their space. In the two films that followed *La Reine des papillons* in 1928, *La Petite Parade* (*The Little Parade*) and *L'Horloge magique*, Starewitch designed special effects that allowed for complete narrative integration of live-action with animation.

In *La Petite Parade*, Starewitch again combines live footage of Nina's performance, presented through rear projection, with puppets. Here Nina's action is framed as an actual stage performance that her character, the ballerina, otherwise represented by a puppet in the film, performs for the nightly audience of toys. We see most of Nina's performance through conventional crosscutting between the audience and Nina, each featured in their own separate shots. However, there are moments in the performance scene when the audience and Nina are combined in one shot. For instance, at the beginning of the scene, we see a well lit miniature set with the toy characters interacting before a stage. Then the lights start to dim, and the curtain on the background stage at frame center opens. Behind the curtain there appears Nina, who starts dancing.

It is clear that Nina's performance is projected from behind the set upon a miniature screen that formed the perpendicular opening of the stage. The rear-projected footage in the composite shots looks very bleached out, which is especially noticeable in comparison with the crosscut sections where this same footage is perfectly contrasted. There are at least three reasons why the image looked this way, given that it was produced in the 1920s. First, rephotography of a rear-projected image always reduced the contrast of the original image because of loss in image resolution. Second, the bright light used in the rear projector necessarily overemphasized the light areas of the image. Third, in order to make the rest of frame visible, the cinematographer may have been forced to overexpose it, making the projector-lit part brighter. All of these drawbacks betray the composite nature of the shot.

The drawbacks of rear projection are important because at the end of 1920s special-effects artists in all major film-producing countries worked to overcome them by developing new approaches to composite cinematography. Starewitch was no exception, and in his *L'Horloge magique* he offered some very impressive solutions. In fact, I would argue that this film presents the most complicated and polished special effects that Starewitch had accomplished to date.

L'Horloge magique is composed of two parts. The first part deals with the making and operation of a magic clock, assisted by a little girl (Nina). The second part, "The Enchanted Forest," involves a dream experienced by Nina, where she enters the magic world of the clock, apparently dies, and is resurrected as a princess. With the exception of two shots with superimposed foreground columns in the first part, most of the special effects in the film are reserved for the second part. For instance, it is here that we see two instances of composite shots combining foreground action and rear projection, both of which are vast improvements over the sequences I described from *La Petite Parade*.

When Nina wakes up as a princess, she follows a flower on a walk through the magic kingdom. At several moments during this walk, the live footage of Nina appears in the background of shots featuring the animated flower in the foreground. What is remarkable about these shots is that they come very close to producing a convincing impression that Nina and the flower share the same space. This impression is achieved through the distinct choice of lighting that accompanies both components of these composite shots.

The live-action footage of Nina is filmed in such a way that Nina receives very little light, so that in some of the shots she appears as a dark silhouette upon the lighter background of the sky. When an image as dark as this is rear-projected upon the final scene, its brightness is severely reduced. (This effect is probably also enhanced by filtering either the rear-projection screen or the camera lens.) At the same time, the lighting of the foreground featuring the flower-guide and some rocks and plants is limited to one very low-intensity source. All we see are black silhouettes with slight lighting highlights. The rear-projection screen is also framed by the dark contours of the miniature set, creating the impression that Nina is about to enter a dark alcove now occupied by the flower. Narratively, these shots appear to be somewhat discontinuous, as the overall action occurs in broad daylight and these shots look as dark as night.¹² Nevertheless, they work beautifully as special effects. Although the resolution and contrast of the original live-action footage are still sacrificed, as is unavoidable with rear projection, the visible discrepancy between the foreground and the background in the composite images is successfully reduced by this effective lighting design.

The second instance of a masterful combination of animated action with rear projection involves the scenes where the puppet character of Ondin, the water spirit, jumps in and out of rear-projected water. What we see is a tiny section of the water's edge, where the water is heavily shaded by plants and the bank sports a busy collection of leaves and flowers. These images of the water's edge are similar to the ones described just above in that the rear-projected image is framed by the miniature set and occupies only about one-half of the frame. In addition, the color and lighting designs of both the animated and the rear-projected segments match visually: both feature highly contrasted and evenly distributed blocks of light and dark. All of this helps the rear-projected image to easily merge with the animated foreground. However, what makes the components of the shots look virtually seamless is the perfect coordination of the background image with the actions of the puppet. Every time Ondin seems to jump in or out of the water—in fact, he jumps up and out of the frame or appears on the set from behind its edge—

the background image features ripples that would realistically appear if someone jumped in or out of the water. That is, Ondin seems to be entering the rear-projected image!

These shots are done so skillfully that it is hard to believe that they are composites, although they would be impossible otherwise. There is no doubt that the images of water are rear-projected. The images unmistakably feature real water, and it is impossible to animate real water shot by shot at the same time as one animates puppets. Additional confirmation is provided by the image of the same water, which is included on its own during a crosscut section between Ondin underwater and the surface. As compared to this image, the background images in the composite shots lack deep blacks and are less sharp, thus signaling that rephotography was involved. Finally, it made sense to use rear projection. It could easily allow Starewitch to coordinate the background image as precisely as he did, as rear projection provides one with the chance to run the preexisting footage back and forth as much as one needs until the matching action is found.

These special effects represent only one subset in the collection of spectacular special effects that Starewitch designed for *L'Horloge magique*. The other subset involves combining animated live-action with animation or with live-action without the use of rear projection.

During her initial entry in the enchanted forest, Nina haplessly steps on a flower, thus attracting the attention of Sylph, the air spirit, and other forest creatures, who apparently make her shrink in size. The diminished Nina sees a forest spirit; it scares Nina, and she runs away. In the next scene Nina, still tiny, runs into a pair of forest creatures, gets frightened, and again makes her escape. Nina's shrinking in the first scene is a special effect in itself, produced as it is by printing successively smaller images of Nina in the laboratory. One can tell that the images were indeed photographically reduced rather than just reproduced from images of Nina filmed at different distances. One part of the effect of Nina's diminution is produced by the very same image that gets progressively smaller and smaller: in it Nina's position, hair, and the shadows on her gown remain precisely the same. However, Starewitch complicates the diminution effect even further by making Nina and the animated puppet directly respond to each other within the same composite shot. In the second of these two scenes, the composite elements are complicated yet again, as Nina interacts with two puppets instead of one and seems to share their three-dimensional set.

What makes these two scenes remarkable is not only that they involve a diminished and animated live image of Nina—let me call it animated live-action—but also that live footage of Nina appears at the same time in front of the background *and* behind the animated action in the foreground. In the first scene there is a moment in which the puppet steps in front of Nina, covering up a portion of her image with his arm. At the beginning of the second scene, Nina seems to be placed behind the puppets, which look slightly back at her. However, at the end of the scene, Nina's image is visible in front of one of the puppet's legs.

The quality of Nina's image as opposed to the background image rules out that rear projection was used to create these composite shots. The backgrounds in the two scenes portray forest landscapes—large trees and small bushes, respectively—located at a distance from the characters. The background of the first scene is probably a painting, as it looks diffused and somewhat artificial. The background of the second scene appears to be an out-of-focus photograph. In comparison with these backdrops, which clearly suggest depth and a variety of hues, Nina's image is flat, contains only whites and light grays, and lacks sharpness without being out of focus. This is particularly noticeable as compared to the footage of Nina included in the crosscut sections of the two scenes. Here Nina's image is very sharp and perfectly

contrasted. Although there are hardly any halos, Nina's images bleed somewhat: their contours change slightly from image to image and at times dissolve into the background. All of this suggests not only that Nina's image has been rephotographed more than once, which would have been done already to produce the diminished Nina, but that rephotography or reprinting has also been used to combine Nina with the rest of the scene. That is, it suggests that Starewitch used some kind of a traveling-matte technique to create these composite shots.

In the 1920s, a traveling-matte process involved creating a dark matte of the detail to be inserted in the background scene. First, this dark matte was photographed or printed against the background scene to create a negative image of the background but leave the portion masked by the matte unexposed. Second, that same strip of film was photographed again, now with the light image of the detail placed in front of it. This exposed the previously unexposed portion, and the composite image was produced. The matte was created by either using the negative of the image of the detail filmed against a pitch-black background (provided the detail was light enough for its negative to be able to block light and surrounding background was dark enough to produce transparent film) or by drawing a set of transparencies with the dark mask of the detail that was then transferred onto a filmstrip.

This process allowed special-effects artists to place an actor in front of any background. Typically, when this was achieved, nothing else was required. Starewitch, however, went further. He also wanted to build his images in such a way that his puppets appeared in front of the matted-in detail (Nina). Although this additional manipulation required at least double the time, testing, and precision, he could accomplish it in one of two ways. He could either create additional traveling mattes, now with the puppets matted over the images of Nina, or he could produce complex initial mattes of Nina that already incorporated the areas that needed to later allow for the puppets.

Whatever the exact process used, the resulting special effects produced by Starewitch here are extraordinary. Nina seems to effortlessly move within the space of the animated set. Although her image is somewhat bleak and flat, she is clearly discernible from the set's background. At the same time, Nina's image looks very convincing within the animated space, as we can clearly see her complicated body movements, and the play of light and shadow on her tiny face and gown is very legible.

In the following section of *L'Horloge magique*, Starewitch expands on the traveling-matte technique to produce even more spectacular results later in the film. This time he uses composite cinematography to combine not Nina's live performance and puppetry, but the tiny animated figure of Nina and live footage of an actor's hand. Moreover, here the composite elements not only share the frame and overlap, but also interact intensely with each other.

During the crosscutting that opens the first scene in the section, Nina, in a medium shot, climbs from behind a rock. She sees the man approaching her, screams, and hides. The man reaches with his hand towards the camera, and in the next shot we see his (left) hand in a relatively long shot reaching from behind the foreground rocks, lifting Nina from behind a small rock in the middleground center and setting her on top of that rock. The hand proceeds to tap Nina on top of her head, to tickle her body repeatedly on the side, and finally to pick her up by the waist with two fingers and to take her out of the frame. In the second scene the man shakes Nina in both hands and then opens his (right) hand to see what has happened to her. On his hand we see Nina, who kicks her legs, turns over, and eventually gets up, only to fall to her death through his fingers. Through all of this action Nina, who is the size of the hand's thumb, is vigorously moving her arms and body to fight off the hand's approaches.

The composite shots used in this section are even more complicated than the ones portraying Nina's encounter with the forest creatures, as both elements in the shots were initially filmed live and both make complex movements. As before, the differences between the images of Nina and the images of the hand confirm that traveling mattes were used. Although the hand fully matches the color and focus schemes of the rocks behind it (both display a full range of tones from white to black with grays predominating), Nina's image is white, flat, not contrasted, and bleeds slightly. What is puzzling about these composite shots, however, is that the hand does not move as smoothly as it might have if live footage of it was used without any manipulation. Instead, its movements are jerky, as if it was filmed either at slow speeds or though stop-motion. Although I can only guess as to why this might be the case, one fact provides a possible clue: both the hand and Nina move during both scenes, but only the hand gets blurry. The reason for this is probably that out of all the live footage of Nina that was recorded, only clearly discernible images were used to create composite shots, as blurry images do not produce the clear contours required for successful traveling mattes. From this it follows that a number of frames of Nina's footage turned out to be unusable and had to be cut. Because the hand's motions had to last for as many frames as Nina's motions, a number of images might have been also cut out from the footage of the hand. The reason that the jerkiness is more noticeable with the hand than with Nina is because the hand is a lot larger in the frame and because its motions are a lot smoother to begin with.

Despite the slight jerkiness of the hand's image, Nina's struggles with the hand look exceptionally convincing. This is because the hand's and Nina's actions are meticulously coordinated, as if Nina is indeed responding to the hand. Moreover, during several moments Nina's body is positioned behind the hand's thumb or index finger but in front of the rest of the fingers. Most amazingly, the hand's index finger casts a shadow on Nina's gown whenever it is close enough to her to do so realistically, and Nina's contours in turn cast shadows on the back of the set. One would think that this could only have been possible if the actor was literally holding the puppet of Nina in his hand. Indeed, later in the film, and even perhaps at the very end of both scenes described here, Starewitch substitutes a Nina puppet for Nina. However, there is no doubt that what we see for most of the duration of these remarkable scenes is indeed live footage of Nina. Thus, the shadows must have either been added through additional matte work or by a careful coordination of objects placed opposite the light outside the frame.

It is hard to overvalue Starewitch's sophistication as a special-effects artist. As I hope to have shown, all one needs to do is look closely at what Starewitch is doing in his films. However, one other way to appreciate his innovations is to compare them to the work of his contemporaries. Both rear projection and traveling mattes were used by America's special effects artist Willis O'Brien in the making of *King Kong* (1933), the film that to this day is recognized as the most accomplished achievement of its era in the field of special effects. *King Kong* provides for a particularly nice reference point to Starewitch's work because it contains composite shots combining live action of characters, and in particular Ann, the beauty, with stop-motion animation of the giant gorilla Kong, the beast.

Although the film features extremely complicated special effects and its achievements are many and undeniable, when it tries to do exactly what Starewitch did in *L'Horloge magique* five years earlier, it fails to surpass Starewitch's finesse. Although live actors in foreground sets are often portrayed in front of rear-projected spaces, they never convincingly enter them, as Ondin enters the water in the scene I discuss above. The elements that comprise the composite shots

either look too different or feature a clearly discernible dividing line. When a rear-projected live actor interacts with an animated character in the foreground set, the two never respond to each other in the perfectly coordinated way that Starewitch's characters do in *L'Horloge magique*: their responses are appropriate but approximate. For instance, when Ann is featured in a tiny cave on the side of the image of fighting Kong, she appears to be witnessing the fight and responds to it by acting scared and agitated.¹³ However, as opposed to the way Nina responds to forest creatures in Starewitch's scenes, Ann's movements do not precisely reflect upon the progression of the fight. As for the quality of the rear-projected images themselves, with the exception of one scene where heavy diffusion on the set blends it with the background, the rear-projected backgrounds in *King Kong* tend to look bleak and flat.

King Kong also includes many scenes in which traveling mattes are used to combine live actors with animated characters. However, only rarely do the animated characters interact directly with live-action characters in composite shots the way the giant hand handled Nina in *L'Horloge magique*. In fact, almost every time that the animated animals hold humans in their hands or mouths, puppets are substituted for actors.¹⁴ There are two exceptions. During Ann's initial encounter with Kong, there is a moment when he lifts her up in the air, and we actually see a live image of the actress in Kong's hand. This moment flashes past extremely quickly, which may be related to the fact that the image of Ann does not merge easily with the image of Kong. Ann's image radiates intensely, which is probably the result of overexposure that was necessary to create a workable traveling matte. And it bleeds into the surrounding image, making the composite shot unconvincing. Late in the film there is another scene in which the animated Kong holds Ann in his hand and touches her with his fingers. Just like Nina, live-acting Ann appears to be both in front of Kong hand and behind his fingers. Although the image is very impressive, one can see that it is a composite. Ann's part of the image lacks contrast in comparison with Kong's image, and there is a clear dividing line where the animated image of Kong's body meets the rear-projected image of Kong's hand holding Ann.¹⁵

It would certainly be impossible to argue that *King Kong* is a lesser achievement than *L'Horloge magique*. Overall it accomplishes incomparably more in terms of special effects than Starewitch's film. However, when O'Brien and Starewitch are trying to do the same—to convincingly show a direct interaction between live-action and animated action—Starewitch seems to achieve a more seamless result. This achievement becomes even more significant if we remember that as opposed to O'Brien, who worked with a team of experienced special-effects experts at a major studio (RKO) and had the best available technology at his disposal, Starewitch planned and realized his special effects entirely with the help of only one assistant, his daughter Irène, and at a home-based artisanal studio in rural France.

All the special-effects techniques I have discussed here—stills replacement,¹⁶ matte work, rear projection, and traveling mattes—are extremely time-consuming and difficult to implement. It is almost inevitable that the rear-projected background would end up looking visibly different from whatever foreground the artist films in front of it. Traveling mattes are exceptionally difficult to align precisely, and the slightest miscalculation or technological imperfection makes them appear mismatched.¹⁷ All were subject to intense innovation from the 1910s on. I have argued that Starewitch was at the forefront of this innovation from the very beginning. Moreover, in the 1920s he perfected these techniques entirely on his own, without the immediate benefit of the latest technological developments of his contemporaries.¹⁸ In this context, he was able to produce extraordinary special effects in both their design and execution,

and his special effects certainly rivaled and perhaps surpassed some achievements of his most celebrated counterparts. I suspect that Starewitch's work harbors further insights into his pioneering achievements in cinematography. The study of his films may not only lead us to a more comprehensive appreciation of the art behind his magic, but may also help us learn more about the artisanal mode of film production during the silent era.

¹ Quoted in Pilling, Jayne, ed. *Starewicz, 1882-1965*. Edinburgh: 37th Edinburgh International Film Festival, 1983, p. 5.

² On the history of stop-motion animation, see, e.g., Rickitt, Richard. *Special Effects: the History and Technique*. New York: Billboard Books, 2007, ch. 4.

³ Along with animation films, Starewitch also made at least twenty live-action features, on which he acted primarily as a cameraman, but also as a director, scriptwriter, set designer, and actor.

⁴ Pummell, Simon, "Of Rats and Men," *Sight and Sound* (May 1995), p. 61.

⁵ Khanzhonkov, Aleksandr. "Pervyi mul'tiplikator" [The First Animator]. *Iz istorii kino*, vol. 7. Moscow: Iskusstvo, 1968. Vladimir Antropov also mentions, in connection with one of Starewitch's live-action films, that Starewitch employed techniques previously unknown to Russian cinema: "tenfold exposure, rapid shooting, and distorted optics" (Antropov, Vladimir. "Wladyslaw Aleksandrowicz Starewicz." Tsivian, Yuri, and Paolo Cherchi Usai, eds. *Silent Witnesses: Russian Films, 1908-1919*. Pordenone: Le Giornate del Cinema Muto, 1989, p. 587).

⁶ Quoted in Tsivian, et al., p. 202.

⁷ In this essay I use the term "composite shot" to indicate any shot that involves rephotography of previously photographed or masked material to combine two or more images into one.

⁸ Rear projection was first used in 1913 and so was presumably conceivable a year earlier.

⁹ The miniature screen is actually fitted with tiny supports that seem designed to hold the stills in place.

¹⁰ The earliest traveling-matte process was invented by Frank D. William in 1916.

¹¹ Rear projection of backgrounds is also featured in *Le Rat de ville et le rat des champs* (*The Town Rat and the Country Rat*, 1926).

¹² It is possible that when originally projected in the 1928 these images did not look this dark.

¹³ The image of Ann is rear projected upon a small screen mounted in the set using a process developed for *King Kong*. It could be argued, however, that Starewitch anticipates this idea in his rear-projected stage opening in *La Reine des papillons*.

¹⁴ Every time we see Ann in a closer shot inside of Kong's hand, the giant hand is part of the set rather than animated.

¹⁵ For more on special effects in *King Kong* see, e.g., Morton, Ray. *King Kong: The History of a Movie Icon from Fay Wray to Peter Jackson*. New York: Applause Theatre & Cinema Books, 2005, ch. 2; Rickitt, pp., 182-6.

¹⁶ I use the term "replacement" here in parallel with the term "replacement animation" used in animation literature, which designates a type of stop-motion animation where the puppet is replaced rather than moved between the frames.

¹⁷ On the development and complications of both processes see, e.g., Fielding, Raymond. *The Technique of Special Effects Cinematography*. Oxford: Focal Press, 1985, chs. 8 and 10.

¹⁸ For instance, major breakthroughs in rear-projection screens and optical printing were made during the making of *King Kong*, and Starewitch certainly could not have immediately benefited from them.