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The Use of Lenses with Controllable Bokeh Function for Macro Photography of Objects Similar to The Background

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ABSTRACT

The article discusses various options for using portrait lenses with a controllable bokeh function for macro photography in difficult shooting conditions when the shooting objects and minor background objects are at the same distance from the camera and have similar colours. The article considers different approaches to adapting portrait lenses with a controllable bokeh function for macro photography. Test shots were taken to verify the applicability of these lenses for macro photography. Positive and negative aspects are defined, and brief conclusions are drawn on the best ways of using photo lenses with a controllable bokeh function as a new tool for macro photography in complex conditions of shooting objects similar to the background.

Keywords: bokeh, macro photography, lens, macro lens, close-up lens, reverse macro adapter, reversing ring, coupling ring.

1. Introduction

Art of photography is one of the most multifaceted forms of fine arts, which includes many genres and directions. Macro photography can legitimately be called one of the most interesting genres of photography.

Macro photography (from Greek μακρός - 'big', 'large', - and photography) is a type of filming and photographing, when pictured objects are filmed at a scale of 1:1 or larger[1].

The appeal of macro photography is that this genre allows us to see the imperceptible, and often inaccessible to the human eye. The unexplored world of nature's microcosm, astonishing in its beauty and diversity.

Basically, macro photography can be divided into two categories: macro photography for scientific purposes and macro photography for artistic purposes.

When shooting macro photography for scientific purposes, the main requirement is to shoot with maximum image quality and detail, as well as the minimum possible image distortion (fig. 1).

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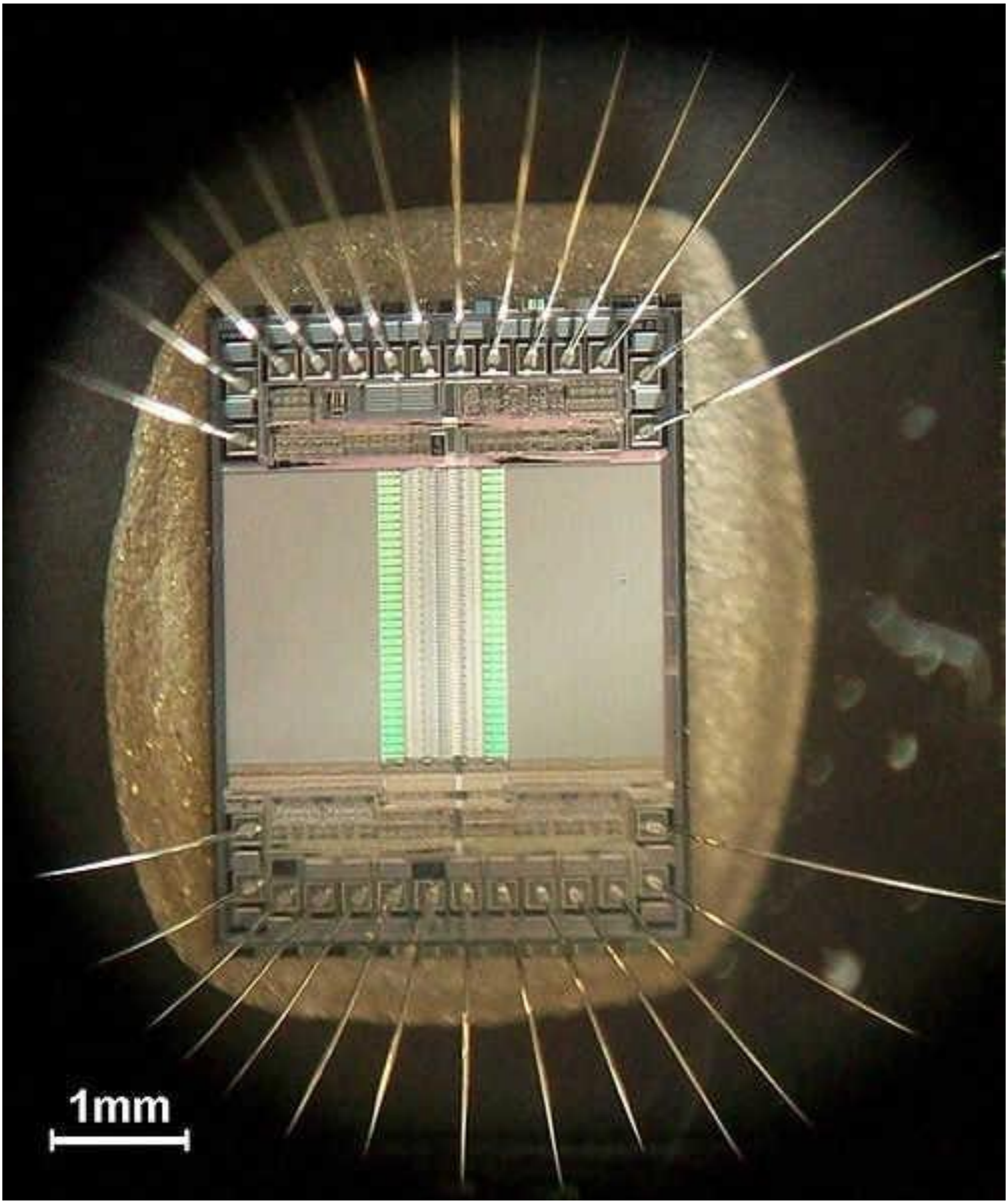


Figure 1. Example of macro photography for scientific purposes (macrophotograph of a microcircuit crystal)[2].

When doing artistic macro photography, the photographer is less constrained by technical criteria for the picture. The main rule of artistic macro photography is to express fully the photographer's artistic idea. At the same time, often most of the objects in the frame may be out of the zone of sharp focus (fig. 2).

Figure 2. Example of artistic macro photography [3].

2. Background and theoretical framework

Like any other type of photography, macro photography obeys the general basic rules of photography. There are no secondary elements in photography. Any photography, including macro photography, contains two main elements - the main object (there can be several) and other objects, called background.

Backgrounds can both beautify and hopelessly ruin a photo. It is important that the background does not compete with the main object, but harmoniously complements it.

The importance of background in art photography has been discussed in almost every photographer's guidebook for many decades. For example, the book “25 Lessons in Photography”, published in 1961, states “... unattractive will be a shot in which the main object is lost, located too far away, or a shot overloaded with secondary objects, among which eyes do not immediately find the main thing ... ”[4].

Certainly, the final result of photography depends largely on the capabilities of the camera, lens and other equipment used with the lens being the most important component of macro photography.

The small size of the objects to be shot and the short shooting distances are the reason why manufacturers of optical equipment have designed and produced special lenses, better known as ‘macro lenses’, intended specifically for macro photography.

The majority of macro lens can provide 1:1 magnification. Some of the lower-end ones will produce a 1:2 magnification, which you really shouldn’t go beyond[5].

On the other side of the spectrum, some macro lenses provide up to 5:1 magnification, a significant boost to how close you can get.

An important feature of all macro lenses is the minimum depth of field (DOF).

Most macro lenses are designed for use in, among other things, macro photography for scientific purposes. These lenses provide the best possible image quality, with minimal distortion throughout the entire field of shot. But in some cases, this aspect can be a negative factor.

Let's consider a macro shot of an object (for example, an insect) located at some distance from minor objects (fig. 3). An artificial fishing fly of approximately 10 mm in length is used as the insect. Artificial moss is used as a background.

Figure 3. The object of the macro photo is at a some distance from other objects.

In this case, the background will be blurred because of the small value of DOF, and the main object will be the centre of the frame (fig. 4).

Figure 4. Macro shot of an object at a distance from minor objects. Macrolens "Volna-9", lens aperture 5.6.

Things are more complicated when the main object and minor objects are at the same distance from the camera (fig. 5). For example, that insect that sits on the tree's bark or a small fungus growing between fallen leaves.

Figure 5. The shooting object and minor objects are at the same distance from the camera.

If the color of the shooting object is similar to the colors of minor objects, it will be difficult to find the main object in the macro photo (fig. 6).

Figure 6. Macro shooting of the shooting object and minor objects that are located at the equal distance from the camera and have similar colors. Macrolens "Volna-9", lens aperture 5.6.

In such cases, masters of macrophotography use various technical methods. There are many such techniques. For example, when macro photography is processed in specialized software, the image of all background objects is converted into shades of gray, whereafter the main object of the photograph stands out sharply against the background of other objects because it is the only colored item (fig. 7).

Figure 7. Highlighting the object of a macro shot with colour[6].

If the illumination level of the scene you are shooting is low, the shooting object can be additionally illuminated with a spot light source, which will dramatically highlight it against the general background of dark surrounding objects (fig. 8).

Figure 8. Highlighting the object of a macro shot with spot lighting[7].

3. Methodology

This article considers one more technical method of macro photography of objects located at the same distance from the camera and having similar colors - macro photography using lenses with the possibility of altering the character of the pattern in the blur zone (bokeh). An information search revealed that this technique had not been previously mentioned in the available sources.

In portrait, landscape and other genres of photography, lenses with a controllable bokeh function are known and widely used. Depending on the shooting conditions, the bokeh variation can be either in the form of "Swirly bokeh" (fig. 9) or in the form of rays diverging from the center of the frame (fig. 10).

Figure 9. Swirly bokeh

Figure 10. Bokeh Radial Blur

Many people know and associate this type of bokeh with the famous Helios lenses (Helios 40-2 85mm f/1.5, Helios 44-2 58mm f/2.0, Helios 44-3 58mm f/2.0, etc.). These the most popular lenses, previously produced in the USSR, are simple, reliable and inexpensive and provide an excellent image. However, these lenses do not have the ability to change the "swirled" character of the pattern in the blur zone (fig. 11).

Figure 11. Swirly bokeh of lens Helios 44-3 58mm f/2.0

But there are lenses such as Selena 58mm f/1.9, Selena 85mm f/2.2, New Petzval 85mm f/2.2, Monolens Petzval 104mm f/3.0 Tilt-Swirl IRIS, which allow you to change the "swirled" nature of the pattern in the blur zone (fig. 12). These and similar lenses are designed according to a scheme devised by the famous optician Joseph Petzval in 1840.

Figure 12. Adjusting of Swirly bokeh

These lenses make it possible to highlight the shooting object by making it the only clearly shown object in the photo, while the contours of other background objects are blurred and swirled slightly around the centre of the photo. This feature imposes a slight restriction on the frame layout: the shooting object needs to be placed in the centre of the photo.

The article considers different approaches to using of the Selena 58mm f/1.9 lens (fig. 13) in macro photography. This is Russian portrait full-frame lens with special option of adjusting the swirly bokeh effect. This lens is produced by one of the leading Russian manufacturers - PJSC Krasnogorsky

Zavod (KMZ Zenit)[8] and in terms of its scheme is a successor of the lens "Lomography New Petzval", previously also produced by the same enterprise.

There are three versions of this lenses: with focal length 58mm f/1.9 for Canon EF, same focal length but for Nikon F and with focal length 85mm f/2.2 for Canon EF.

Figure 13. Selena 1.9/58C - lens with special option of adjusting the swirly bokeh effect.

Basically, this lens is designed for portraits and landscapes and is of little use for macro photography (fig. 14).

Figure 14. Macro shooting with the Selena 58mm f/1.9 lens at the distance as short as possible for the lens. Lens aperture 5.6, bokeh swirling level 7 (maximum).

At the same time, methods have been known for many decades to use lenses not originally designed for macro photography. The most well-known methods are:

- use of extension tubes;
- use of reverse macro adapters;
- use of reversing (coupling) rings;
- use of close-up lenses.

This article examines the applicability of these four methods for adapting the Selena 58mm f/1.9 lens for macro photography.

4. Results

The following equipment was used during test photography:

- camera body Canon EOS 600D - an 18.0 megapixel digital single-lens reflex camera with CMOS APS-C 22.3 × 14.9 mm sensor (1.6x conversion factor);
- Selena 58mm f/1.9 lens;
- Tamron-103A 80-210mm f/3.8-4 lens;
- MC Helios 44-3 lens;
- set of extension tubes;
- reverse macro adapter;
- set of close-up lenses: +1 Diopter; +4 Diopter; +10 Diopter lens;
- tripod for stabilization of camera;
- an artificial fishing fly of approximately 10 mm in length as object and artificial moss as a background.

The photography distance was (on average) from 50 cm (20 in) to 1meter (39 in).

For post image processing has been used free software Paint.NET©.

5. Using of extension tubes

By using extension tubes (fig. 15), it is possible to increase the distance between the lens and the sensor of the camera (fig. 16).

Figure 15. Mounting the Selena 58mm f/1.9 lens to the camera with extension tubes.

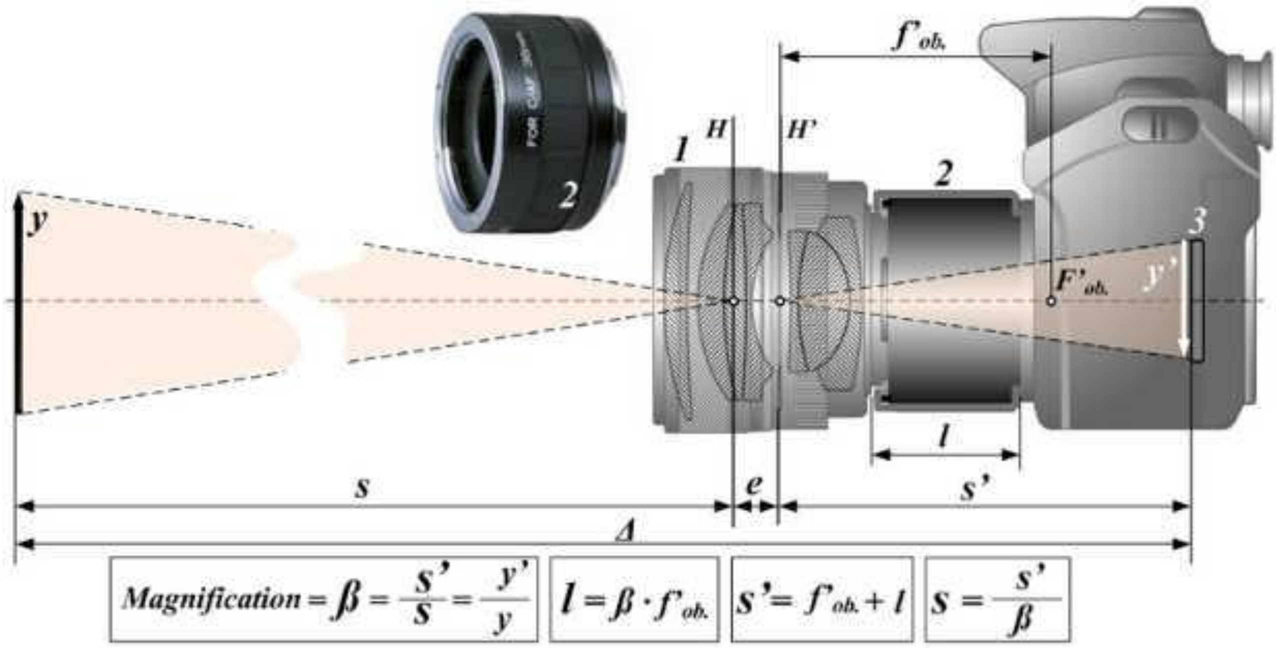


Figure 16. Scheme for using non-specialized lenses for macro photography with the help of extension tubes[9].

Where:

1 - Camera lens;
2 - Extension tube;
3 - Film or sensor;
y - Object height;
y'- Image height;
l - Width of extension tube;
H - First principal plane;
H'- Second principal plane;
e - Distance between principal planes;
s - Object distance;
s'- Image distance;
ß – Magnification;
f'ob. - Camera lens focal length.

The results of the macro test shooting with the Selena 58mm f/1.9 lens and extension tubes are displayed in following picture (fig. 17).

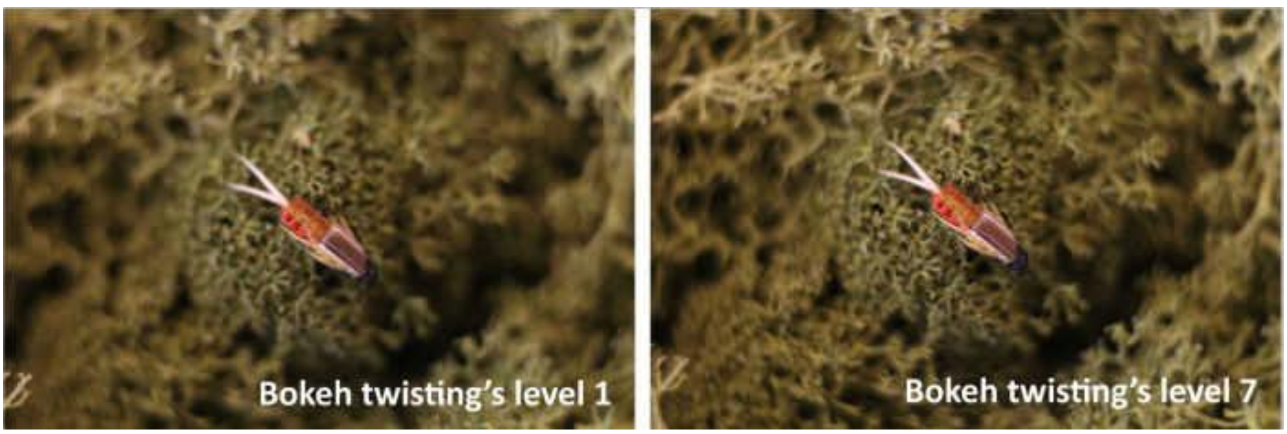


Figure 17. Macro photography with Selena 58mm f/1.9 lens (lens aperture 2.8) and extension tube 21mm.

The test shooting showed good results. The centre of the frame (the location of the shooting object) is rendered with sufficient sharpness, at the same time the peripheral background is blurred. The ability to change the degree of bokeh swirl by turning the adjustment ring of bokeh alteration on the lens has been retained.

6. Using of reverse macro adapters

The second method is to use reverse macro adapters to attach the lens to the camera (fig. 18), with the taking lens facing the film or sensor and the back lens facing the shooting object.

Figure 18. Attaching the Selena 58mm f/1.9 lens to the camera with the reverse macro adapter.

Quite a large magnification can be obtained with this method (fig. 19).

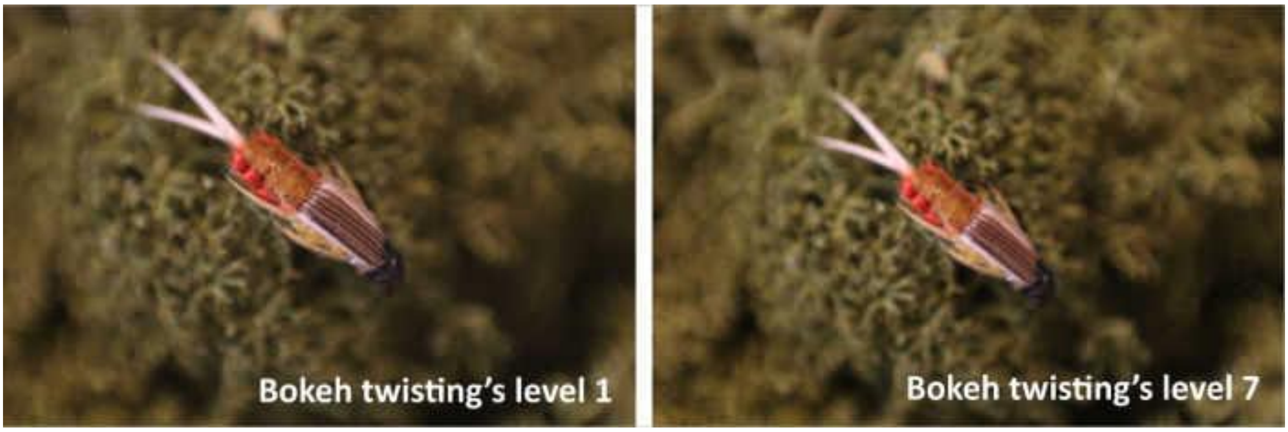


Figure 19. Macro shooting with Selena 58mm f/1.9 lens (lens aperture 2.8) with reverse macro adapter.

Test shooting showed that with the reverse macro adapter, the peripheral background is blurred, but the bokeh swirling effect has disappeared. The centre of the frame (the location of the object) is still rendered with sharpness sufficient for artistic photography.

7. Using of reversing (coupling) rings

The third way is to use reversing (coupling) rings. This method requires the use of two lenses coupled with their front lenses facing each other. To connect two lenses with their external threads for attaching light filters, reversing (coupling) rings with two external threads are used. In doing so, the focal length of the lens mounted closer to the camera should be longer than the focal length of the second lens (fig. 20). The ratio of these focal lengths generally defines the overall magnification of the resulting lens pair.

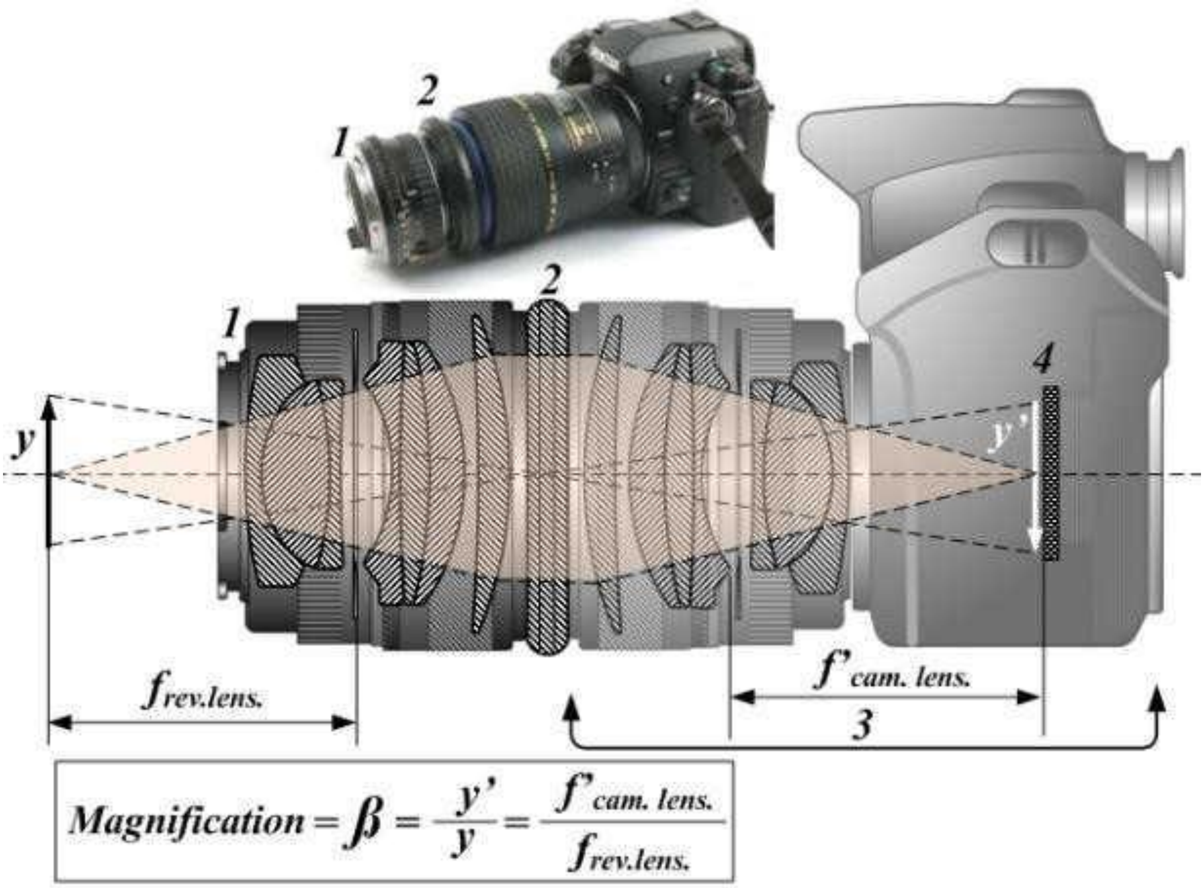


Figure 20. Scheme of using non-specialized lenses with reversing (coupling) rings for macro photography[10].

Where:
1 - Reversed lens
2 - Reversed lens adapter ring.
3 - Camera.
4 - Film or sensor.
y - Image high.
y'- Film or sensor high.
This test shot uses the Tamron-103A 80-210mm f/3.8-4 lens as an additional lens (fig. 21).

Figure 21. Using reversing (coupling) rings to connect Selena 58mm f/1.9 and Tamron-103A 80-210mm f/3.8-4 lenses.

The results of test macro shooting with Selena 58mm f/1.9 and Tamron-103A lenses with different focal lengths connected by reversing (coupling) ring are shown on the images below: focal length of Tamron-103A is 80mm (Fig. 22); focal length of Tamron-103A is 210mm (fig. 23).

Figure 22. Macro shooting with Selena 58mm f/1.9 (lens aperture 2.8) and Tamron-103A (focal length 80mm) lenses connected by a reversing (coupling) ring.

Figure 23. Macro shooting with Selena 58mm f/1.9 (lens aperture 2.8) and Tamron-103A (focal length 210 mm) lenses connected by a reversing (coupling) ring.

Test shooting showed mixed results. At small focal length values of the lens mounted closer to the camera, the bokeh swirling effect is present, but the frame is subject to strong vignetting.

When the focal length of the lens mounted closer to the camera is increased, the overall magnification of the shot also increases, vignetting disappears, but so does the bokeh swirling effect.

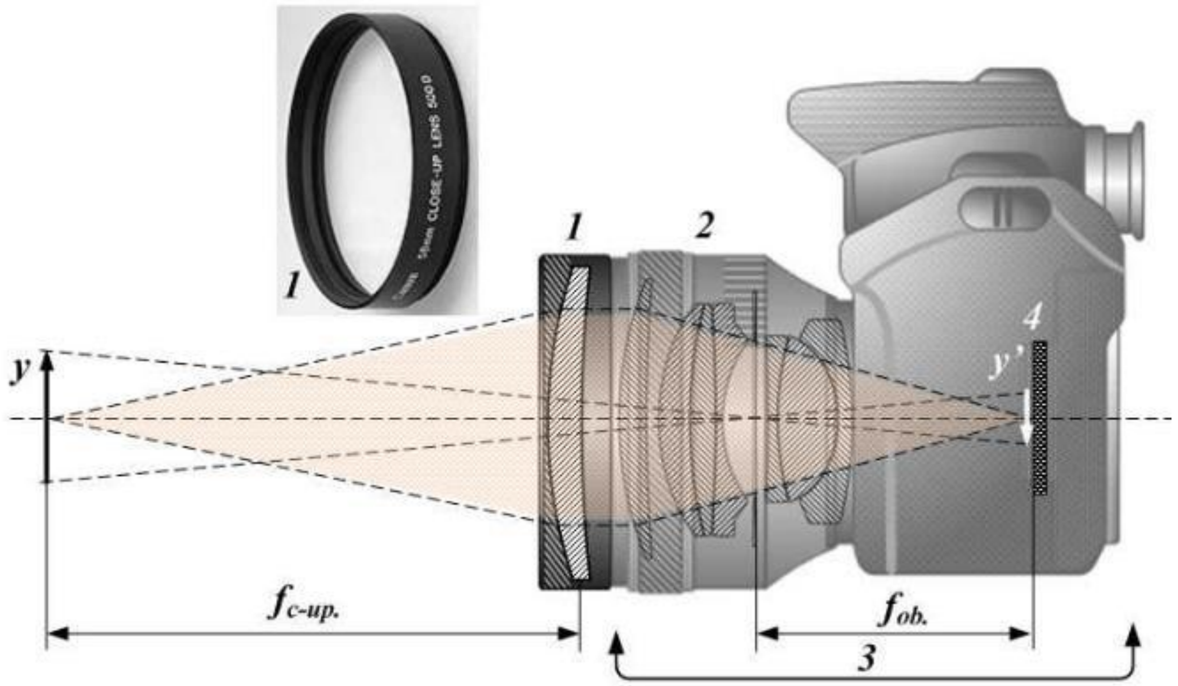
This method also has two other serious disadvantages:

- increased loss of quality of the resulting image due to the large number of lenses (as two lenses are used);

- large size and weight, which reduces usability and increases the risk of damage to the camera's bayonet connection.

8. Using of close-up lenses

The fourth of the most common methods is the use of close-up lenses placed on the front surface of the lens carrier or screwed onto the optical filter threads (fig. 24). Close-up lenses in the +1 to +10 Diopter range are used for macro photography.



$$Magnification = \beta = \frac{y'}{y} = \frac{f_{ob.}}{f_{c\text{-}up.}} = \frac{f_{ob.} \cdot D_{(\text{diopter of c-up lens})}}{1000} \qquad f_{c\text{-}up.} = \frac{f_{ob.}}{\beta}$$

Figure 24. Scheme of using non-specialized lenses with close-up lenses for macro photography[11].

Where:
1 - Close-up lens.
2 - Camera objective lens (set to infinity).
3 - Camera.
4 - Film or CCD plane.
y - Object
y'- Image.

This study includes test macro shooting with a Selena 58mm f/1.9 lens and a set of the following close-up lenses: +1 Diopter lens (fig. 25); +4 Diopter lens (fig. 26); +10 Diopter lens (fig. 27).

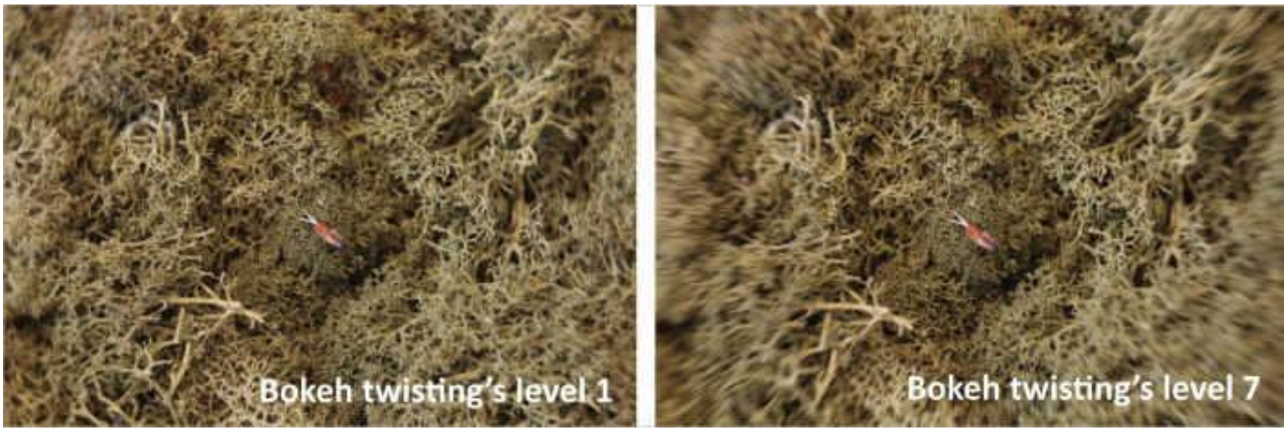


Figure 25. Macro photography with a Selena 58mm f/1.9 lens (lens aperture 2.8) and a +1 Diopter close-up lens.

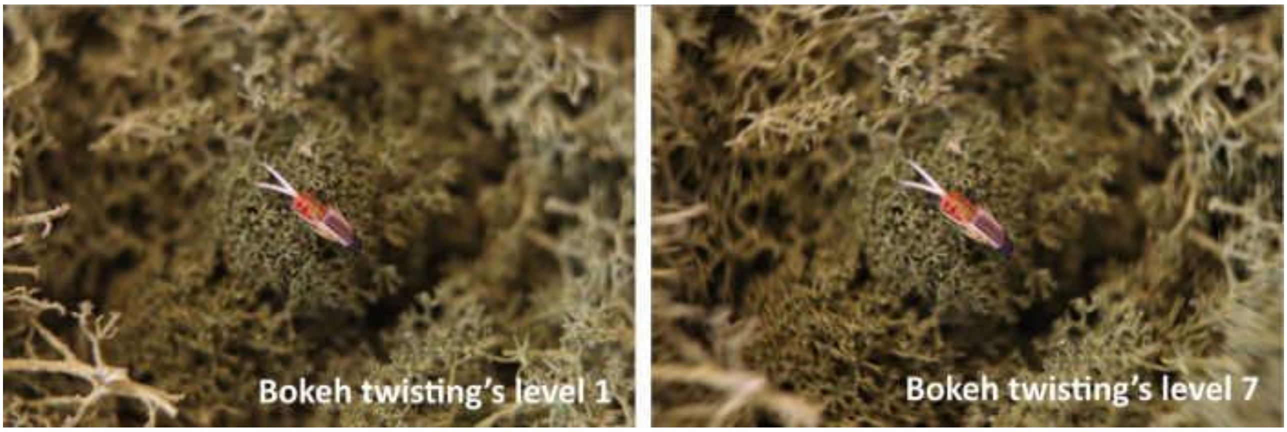


Figure 26. Macro photography with a Selena 58mm f/1.9 lens (lens aperture 2.8) and a +4 Diopter close-up lens.

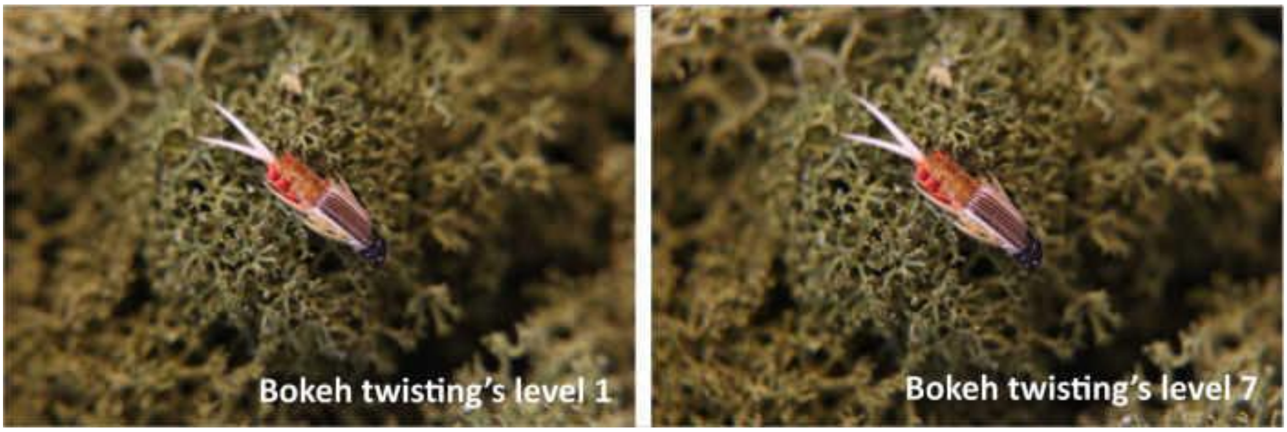


Figure 27. Macro photography with a Selena 58mm f/1.9 lens (lens aperture 5.6) and a +10 Diopter close-up lens.

The test shooting showed that of the four methods considered, the use of close-up lenses gave the best results. The use of close-up lenses of different convergence enables wide variation in the overall magnification of the shot and the level of bokeh blur. In all cases, the centre of the frame where the shooting object is located, is rendered with sufficient sharpness. The ability to alter bokeh by rotating the corresponding adjustment ring on the lens is retained. Depending on the shooting parameters, the bokeh alteration can be either in the form of swirling, or in the form of rays diverging from the center of the frame, or in the form of a combination of both types simultaneously.

9. Discussion

Hence, the following conclusions can be drawn from the test results.

All four of these methods allow you to use portrait lenses with feature of controllable bokeh for macro photography.

When the shooting object and minor objects are at the same distance from the camera and have similar colors, the use of lenses with feature of controllable bokeh can emphasize the shooting object.

Of all considered methods to adapt lenses for macro photography. The best results were achieved by using close up lenses and extension tubes. The background was sufficiently blurred when these methods were used. The shooting object was effectively accentuated, both by blurring the background and by swirling the bokeh.

The use of reversing macro adapters and reversing (coupling) rings for macro shooting with portrait lenses with bokeh altering function is also possible, but only if the resulting effect generally corresponds to the creative intent of the photo.

The restriction of frame layout common for all considered methods is the necessity to display the object in the central part of the photo. The basis for this limitation is the peculiarity of the optical design of lenses with feature of controllable bokeh and is not influenced by the ways in which these lenses are adapted to the purpose of macro photography.

These results of test photography can be briefly summarized in the form of a table (Table 1).

Table 1.

The most well-known methods of adapting portrait lenses with a controllable bokeh function for macro photography.

Method of adapting	Ease of use	Retention of bokeh control	Image quality	Recommended scenarios
Extension tube	Easy	Good	Good	Without restrictions
Reverse macro adapter	Easy	Bad	Good	With restrictions
Reversing (coupling) ring	Difficult (large size and weight of the photo kit)	With restrictions	Medium or bad	With restrictions (only ultra-macro photography)
Close-up lens	Easy	Good	Good	Without restrictions

Based on this table, we can conclude that photographers have a wide range of methods of adapting portrait lenses with a controllable bokeh function for macro photography. Each of the methods has its own strengths and weaknesses, depending on the photographic equipment used and the shooting conditions.

These conclusions are also true with other bokeh-swirling lenses such as the MC Helios 44-3 58mm f/2.0 (fig. 28). This lens is based on the Carl Zeiss Jena Biotar® optical scheme and does not alter the bokeh as much as the Selena 58mm f/1.9 and other lenses based on the scheme developed by Josef Petzval. In addition, the degree of bokeh variation in this lens is unaltered, as it is not a special option but a side feature of the Carl Zeiss Jena Biotar® optical scheme. A test macro shot with the MC Helios 44-3 58mm f/2.0 lens is shown below (fig. 29).

Figure 28. MC Helios 44-3 2/58. Lens with swirly bokeh effect.

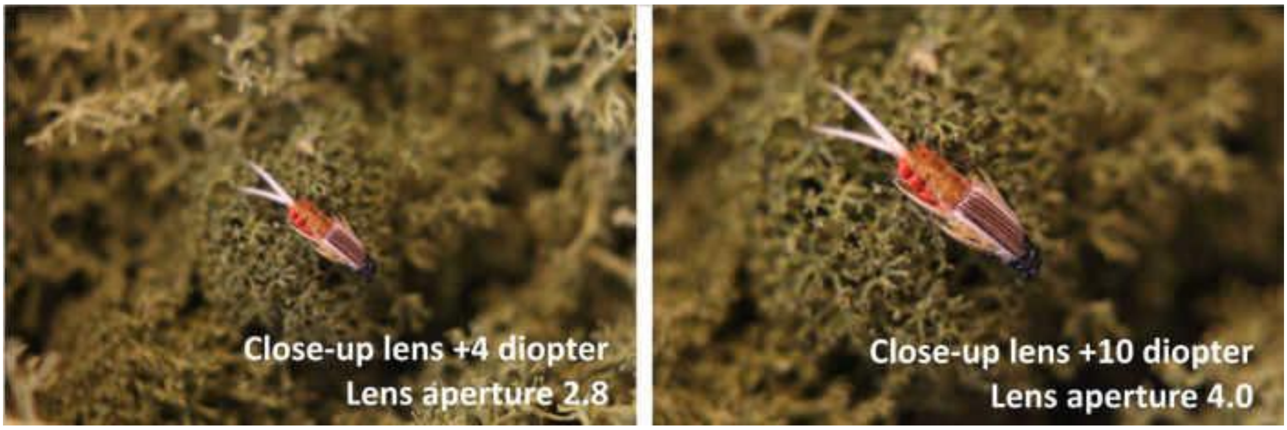


Figure 29. Macro shooting with MC Helios 44-3 lens and +1 and +10 diopter close-up lenses.

10. Conclusion

The results of macro photography presented in this article have thus proved that the use of portrait lenses with bokeh changing capability allows the photographer to take macro shots in difficult conditions when the shooting objects and the external objects are at the same distance from the camera and have similar colours. The ways of adapting portrait lenses to macro photography purposes are quite simple.

In general, this is evidence that modern photo optics is a powerful tool in the hands of a photographer, and the competent use and combination of optical features of photographic equipment allows not only to perform photography in difficult conditions, but also to achieve good artistic results.

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