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Article

What Happens if Someone Doesn't Clean Male Masturbator? A Study Based on in Vitro Microbial Culture

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Abstract: The study investigated hygiene issues associated with the lack of cleaning in male masturbators through in vitro microbial culture. The experiment used 24 masturbators simulating human use scenarios, with pig semen serving as a potential microbial culture medium. The results showed that in YPD media, the colony-forming units (CFU) of the no-clean group increased from 11,600 ± 1249 mL^{-1} at 0 hours to 41,000 ± 8641 mL^{-1} at 48 hours, representing a 3.53-fold increase. In PDA media, the fungal colony area of the water-cleaned group at 48 hours was 328.01 ± 144.00 mm^2, while the special cleaning fluid group exhibited only 14.12 ± 3.55 mm^2. The special cleaning fluid achieved a 97.8% inhibition effect on fungi (PDA media, 48 hours) and a 90.6% cleaning effect on bacteria (BPA media, 48 hours). These findings suggest that the use of GXP special cleaning fluid significantly reduces the risk of microbial growth, ensuring improved hygiene and safety.

Keywords: male masturbator; microbial culture; sex toy hygiene

1. Introduction

Sexual needs, as a core aspect of human life, are gaining greater recognition, with masturbators becoming increasingly popular [1,2]. The purchase and use of sex toys is a growing phenomenon for enhancing pleasure in many countries [3]. In a questionnaire survey of 2743 Chinese adult men reported by Wang et al., 81.1% of the men had masturbating experience [4]. Not only masturbation with bare hands, but also the use of masturbation cup is becoming more common. In order to meet different sexual needs, various types of masturbation cups such as electric, disposable, and exotic-shaped have been derived. Especially after the Covid-19 pandemic, more people use sex toys due to affected sexual activities during the lockdown [5]. Arafat et al. reported that in 2020, the sales of sex-related products doubled in Germany, Denmark, and the United Kingdom [6]. At the same time, sex-related production made in China increased by more than 50%. In China, the main consumer group of sex toys is young people while older youth are gradually replacing the main position. Among the core consumers, 21% were aged 18-25 and 24% were aged 31-35 [7]. In addition, among consumers who purchased high-end adult products, 33% had a bachelor's degree while 15% had a master's or higher degree. Consumers with higher education tend to be more accepting of sex toys and have greater expectations for the quality of sex life [8].

However, although more and more researchers have begun to study masturbation cups, such as their potential medical functions for erectile dysfunction and improvement of sexual behavior duration for normal people [9,10]. The current hygiene issues are still mainly focused on women sex toys [11]. For example, Wood et al. reported that women

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who shared sex toys were more likely to report having been diagnosed with bacterial vaginosis and candidal infection, compared with who did not share [12]. Collar et al. reported in a cross-sectional survey of 800 women that 31.8% of the women shared sex toys with sexual partners, but only 14% of the women often used condoms when sharing [13]. Therefore, this study will focus on male masturbation cup, and explore the impact of different cleaning times on the potential hygiene issues of masturbation cup through in vitro microbial culture.

2. Methods

2.1. Study Protocol

In this experiment, 24 removable channels of electric masturbators were used for microbial culture. In order to simulate the situation of humans using masturbators, we used a silicone simulated penis (height 13cm/Φ 3.5 cm) with a bag of lubricant to simulate the reciprocating thrusting movement. In addition, in order to simulate the function of semen as a potential liquid culture medium for microorganisms, we purchased fresh pig semen, which was not diluted by diluent with bactericidal ingredients. After completing the simulation of thrusting movements, the semen was manually injected into the masturbators. The main outcome measure of the experiment is the colony forming units (CFU) in different media under different placement durations and cleaning conditions after the use of the masturbators as shown in Figure 1. An orthogonal experimental design was used, and two factors were set: cleaning method (no clean, clean by water, clean by special fluid) and washing after placement for n hours (n = 0, 6, 12, 24, 48h), forming a total of 15 orthogonal combinations.

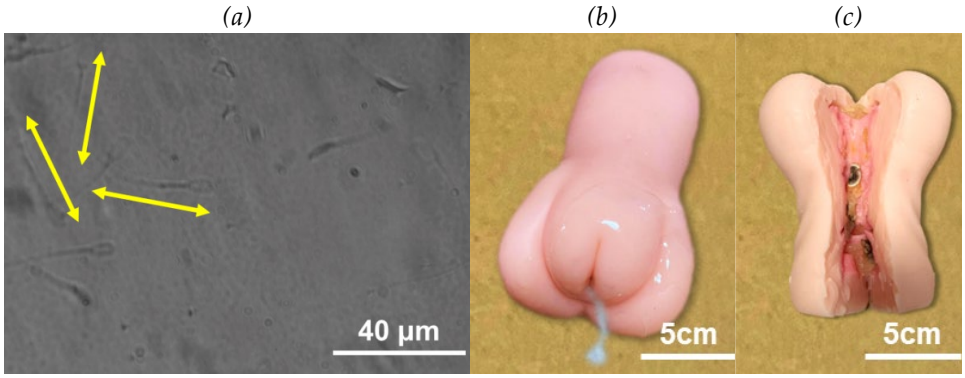

Figure 1. (a) The appearance of pig sperm under 600 times magnification and the Schematic diagram of (b) masturbation cup injection and (c) masturbation cup with microbial culture.

2.2. Media

The media used were YPD (Yeast Peptone Dextrose: 1.4×10^{-2} g·L^{-1} yeast extract, 1.0×10^{-2} g·L^{-1} peptone, 2.0×10^{-2} g·L^{-1} glucose, and 1.4×10^{-2} g·L^{-1} agar, pH = 6.0), PDA (Potato Dextrose Agar: 5.0×10^{-3} g·L^{-1} potato starch, 2.0×10^{-2} g·L^{-1} glucose, 1.5×10^{-2} g·L^{-1} agar, and 1.0×10^{-4} g·L^{-1} chloramphenicol, pH = 6.0), and BPA (Beef Extract Peptone Agar: 1.0×10^{-2} g·L^{-1} peptone, 3.0×10^{-3} g·L^{-1} beef extract, 5.0×10^{-3} g·L^{-1} NaCl, and 1.5×10^{-2} g·L^{-1} agar). YPD medium was used for culturing yeast, PDA for fungi, and BPA for bacteria. All culture media were sterilized by autoclaving at 121 °C for 15 minutes and used within one week of preparation.

2.3. Cultivations

To prepare serial dilutions, 10 mL of sterile water was added to the masturbation cup and mixed thoroughly to yield Solution A. Then, a 1 mL aliquot of Solution A was transferred into 9 mL of sterile water to obtain Solution B (10^{-2} dilution). Subsequently, 1 mL of Solution B was further diluted with 9 mL of sterile water to produce Solution C (10^{-4} dilution). A 0.5 mL aliquot of Solution C was spread onto four types of culture media, each in

triplicate. After inoculation, all media were sealed, labeled, and incubated under appropriate conditions. YPD and BPA media were incubated at 35 °C for 48 hours, while PDA media were incubated at 25 °C for 72 hours. After incubation, colony morphology and other characteristics were observed. The bacterial suspension was quantified using the dilution plate colony counting method, and the number of colony-forming units per milliliter (N) was calculated using the following equation.

$$N=\frac{\sum C}{(n_1+0.1n_2)d}$$

Where N is the number of colony forming units per milliliter (CFU/mL), $\sum C$ is the total number of colonies counted on all plates, n_1 is the number of plates counted at the first dilution; n_2 is the number of plates counted at the second dilution, d is the dilution factor.

2.4. Device Information

The GXP Ailo Mecha Girl is a non-through-type male electric masturbator, from Glowing X Palpitation (GXP) Goudou Kaisha, measuring 205 mm in length, 104 mm in width, and weighing 630 ± 10 g, featuring intercourse simulation functions, with a vaginal depth of 138 mm. The outer shell is made of ABS (Acrylonitrile Butadiene Styrene) material, while the inner virtual vagina is made of TPE (thermoplastic elastomer) material, as shown in Figure 2a and Figure 3. The Sage Lubricant is a low-viscosity, water-based lubricant designed to simulate natural vaginal secretions, with a net weight of 5.3 ± 0.1 g (8 mL) in a single bag. The main components of the cleaning agent (GXP masturbator special cleaning fluid) are propylene glycol solution with 1.6 ± 0.16 ppm Ag+ cations added, resulting in a potential bactericidal effect. as shown in Figure 2b and Figure 2c.

Figure 2. The schematic diagram of GXP Ailo Mecha Girl electric masturbator and accessories: (a) outer packaging and (b) sage lubricant (c) GXP masturbator special cleaning fluid.

Figure 3. The product images of GXP Ailo Mecha Girl electric masturbator (a) physical model, (b) perspective and (c) parallel simulated vagina design.

3. Results and Discussion

The colony-forming units per milliliter (CFU/mL) of YPD and BPA media under different cleaning methods and placement times are shown in Figure 4, Table 1, and Table 2. In YPD media, the CFU values of the non-cleaned group (NC group), where the male masturbation cup was left for *n* hours post-use without cleaning, were significantly higher than those of the other two groups: the water-cleaned group (CW group) and the fluid-cleaned group (CF group). The CFU values of all three groups increased progressively over time. For instance, from *n* = 0–48 h, the CFU values in the NC group rose from 11,600 ± 1249 mL^{-1} to 41,000 ± 8641 mL^{-1}, representing a 3.53-fold increase.

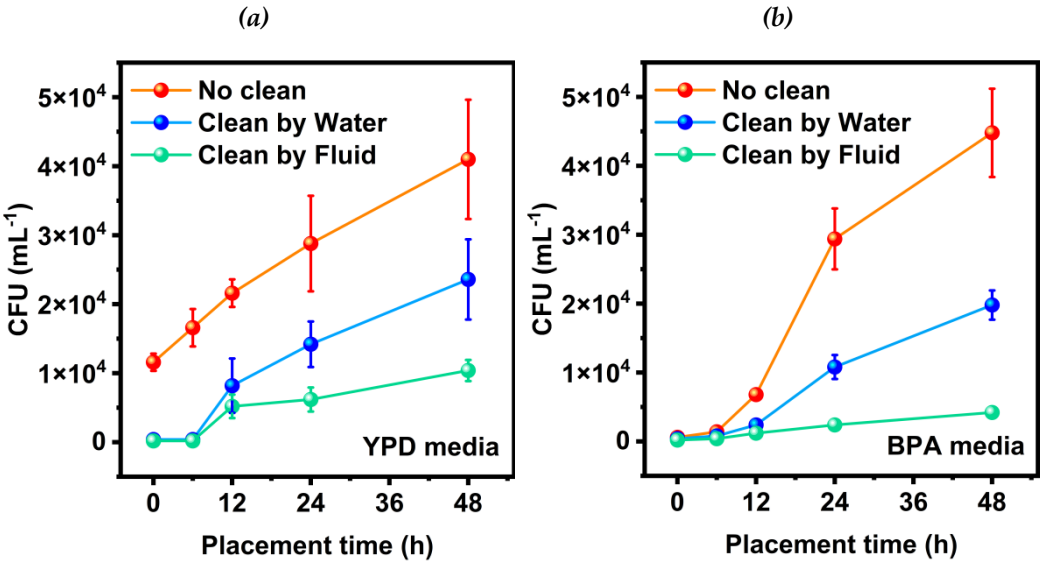

Figure 4. The CFU/mL of (a) YPD and (b) BPA media under different conditions. Some error bars are smaller than the radius of scatter points.

Table 1. The CFU/mL of YPD media under different conditions.

Method Time	Unclean	Clean by water	Clean by fluid
0	11600 ± 1249	400 ± 200	200 ± 200
6	16600 ± 2705	1200 ± 346	200 ± 200
12	21600 ± 2000	8200 ± 3667	5200 ± 1700
24	28800 ± 6919	14000 ± 3304	6400 ± 1743
48	41000 ± 8641	23600 ± 5810	10400 ± 529

Table 2. The CFU/mL of BPA media under different conditions.

Method Time	Unclean	Clean by water	Clean by fluid
0	600 ± 200	400 ± 200	200 ± 200
6	800 ± 115	800 ± 200	400 ± 115
12	6800 ± 692	2400 ± 400	1200 ± 305
24	29400 ± 4422	10800 ± 1743	2400 ± 305
48	44800 ± 6409	19800 ± 2116	420021

Overall, the CFU values of the CW group exhibited a notable difference compared to the CF group, particularly after the placement time exceeded 6 hours. At *n* = 12 h, the CFU values were 8200 ± 3667 mL^{-1} for the CW group and 5,200 ± 1,700 mL^{-1} for the CF group. In BPA media, the overall trend of CFU value changes across the groups was generally consistent with that observed in the YPD medium. However, the residual bacterial load after cleaning with the fluid was significantly lower than that after cleaning with water.

For example, the CFU value of the CW group (10,800 ± 1743 mL^{-1}) was 4.5 times higher than that of the CF group (2400 ± 305 mL^{-1}) at n = 24 h, whereas this ratio was only 2.2 in YPD media.

For clearer visualization, the photos of YPD and BPA media at n = 12 h are shown in Figure 5a-f. Additionally, images of different bacteria, including *Escherichia coli*, *Bacillus cereus*, and *Corynebacterium*, with Gram staining, are shown in Figure 5g-i.

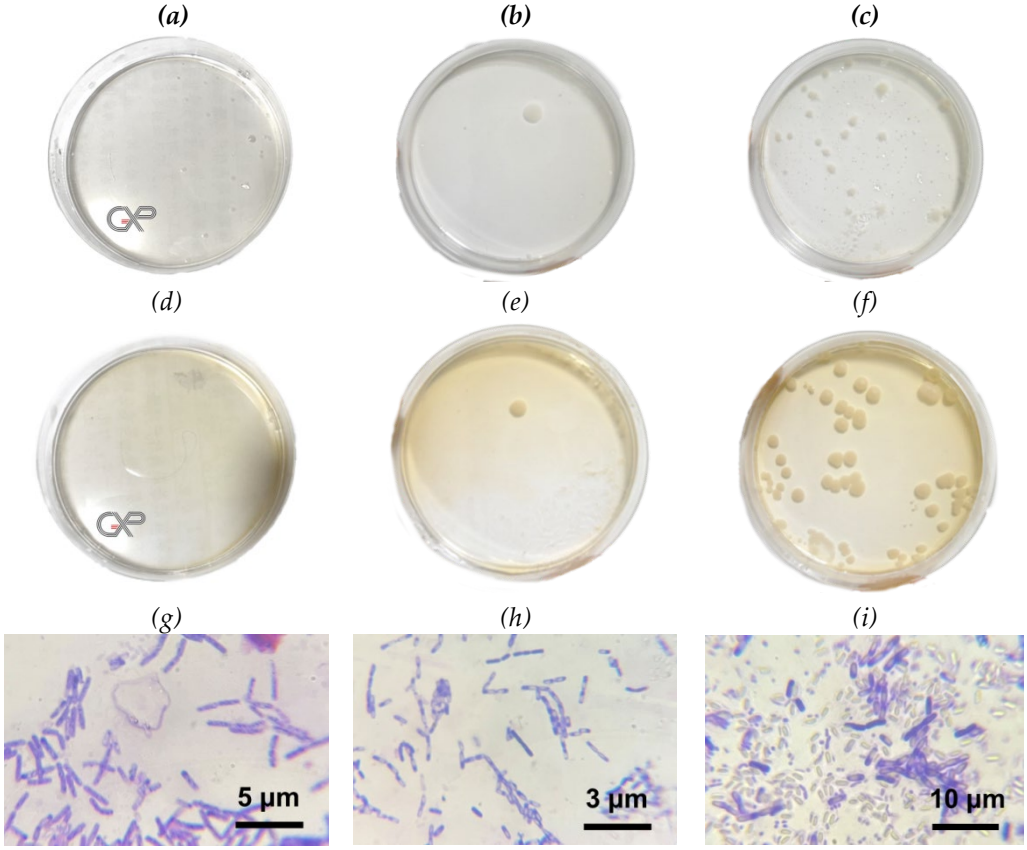

Figure 5. The photos of (a-c) BPA media, (d-f) YPD media when n = 12 h and different bacteria under 1500 times magnification with gram staining: (g) Escherichia coli (h) Bacillus cereus (i) Corynebacterium.

Analysis of variance (ANOVA) conducted on the orthogonal experimental data for both YPD and BPA media revealed that both the cleaning method and placement time had highly significant effects on the CFU values in both media, as shown in Table 3. In YPD media, the F-value for different cleaning methods was 33.681, with a P-value of 0.00013 ($P << 0.05$), and the F-critical value (F_{arr}) was 4.459 ($F > F_{arr}$). For different placement times, the F-value was 14.156, with a P-value of 0.001 ($P < 0.05$), and the F_{arr} was 3.838 ($F > F_{arr}$). In BPA media, the F-value for different cleaning methods was 6.110, with a P-value of 0.025 ($P < 0.05$), and the F_{arr} was 4.459 ($F > F_{arr}$). For different placement times, the F-value was 8.226, with a P-value of 0.006 ($P < 0.05$), and the F_{arr} was 3.838 ($F > F_{arr}$).

Table 3. The analysis of variance conducted on the orthogonal experimental data for YPD and BPA media.

Source of Variation	F	F crit	P-value
In YPD media			
Cleaning method	33.681	4.459	0.000***
Placement time	14.156	3.838	0.001***
In BPA media			
Cleaning method	6.110	4.459	0.025*

Placement time	8.226	3.838	0.006**

*: $p < 0.05$ (statistically significant), **: $p < 0.01$ (highly significant), ***: $p < 0.001$ (very highly significant).

Since PDA medium does not have a screening effect on fungal species, multiple fungal colonies may grow simultaneously in one medium. Therefore, fungal growth is measured by calculating the colony area (including hyphae). In general, the fungal colony area of the NC and CW groups gradually increased with the increase in placement time. For example, from n = 0 to 48 hours, the fungal colony area of the CW group increased from 26.57 ± 13.73 mm² to 328.01 ± 144.00 mm². However, the fungal colony area of the CF group was almost zero, except for the area of 14.12 ± 3.55 mm² at n = 48 hours. This indicated that the cleaning fluid could effectively inhibit fungal growth, as shown in Table 4 and Figure 6a. The orthogonal experimental data for PDA medium were subjected to variance analysis, and the results showed that cleaning methods had a very significant effect on the fungal area value. The P-value between different cleaning methods was 0.00017 ($P << 0.05$), while the P-value between different placement times was 0.007 ($P < 0.05$). Figure 6b-d shows images of the PDA culture medium at n = 48 hours, where the white circular colonies are a type of mold and the pink colonies are yeast. The images after 1500x magnification are shown in Figure 6e-f.

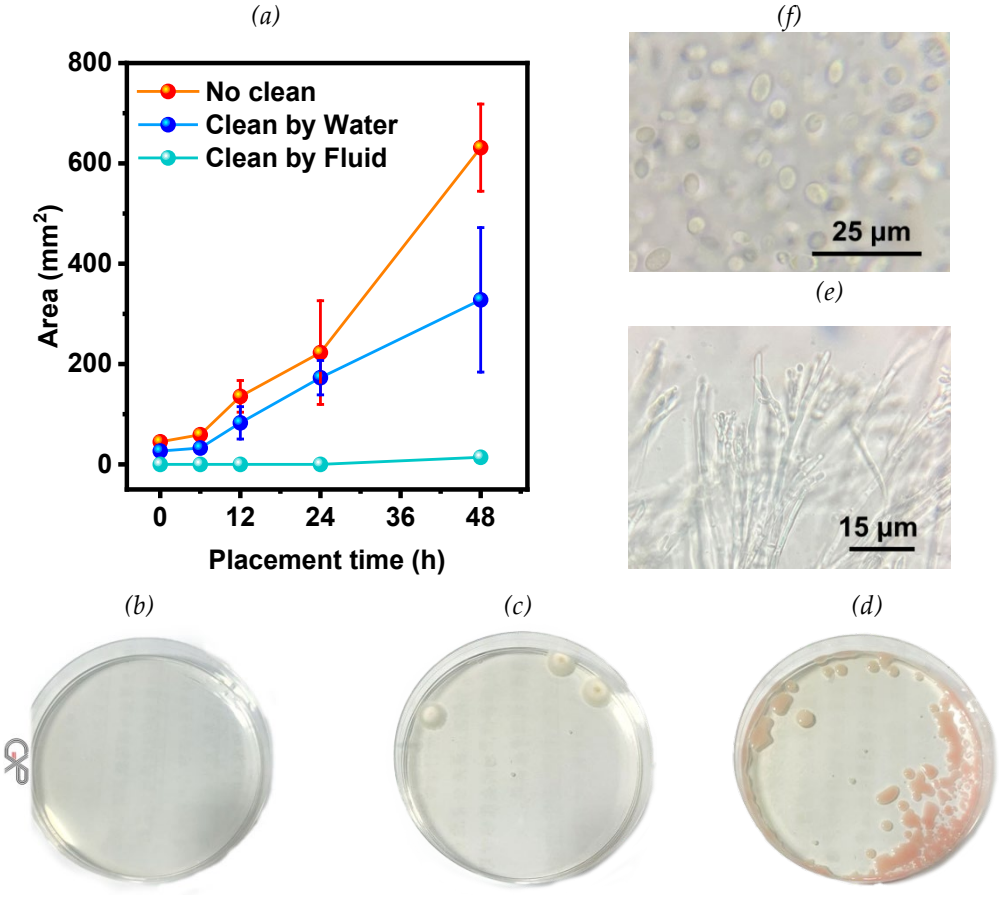

Figure 6. (a) The CFU/mL of PDA media under different conditions. (b-d) The photos of PDA media when n = 48 h and different fungi under 1500 times magnification with gram staining: (e) mold and (f) yeast. Some error bars are smaller than the radius of scatter points.

Table 4. The fungal colony area (mm2) under different conditions.

Method / Time	Unclean	Clean by water	Clean by fluid
0	44.93 ± 5.85	26.57 ± 13.73	0
6	59.07 ± 15.35	32.61 ± 17.15	0

12	135.54 ± 31.56	82.76 ± 32.24	0
24	222.84 ± 103.41	172.80 ± 34.15	0
48	631.29 ± 86.89	328.01 ± 144.00	14.12 ± 3.55

For in vitro microbial culture experiments, the cleaning effect E with a certain placement time can be defined as:

$$E=1-\frac{\text{CFU/Area of CW or CF}}{\text{CFU/Area of NC}}$$

The cleaning effect of the special fluid in YPD medium (ECF = 74.6%, n = 48 hours) is not significantly enhanced compared to its effects in the other two culture media (ECF = 90.6% in BPA, 97.8% in PDA, n = 48 hours). This may be due to the fact that Bacillus species can form spores, which are highly resistant to chemicals like ethylene glycol and dehydration [14]. Additionally, the nutrient-rich, porous TPE surface of the masturbator makes it easier for bacteria to form biofilms [15]. The near-complete cleaning effect on fungi may be attributed to the fact that PDA medium contains chloramphenicol, which inhibits bacterial growth [16], and the chitin component in yeast cell walls and the ergosterol in their membranes have lower tolerance to organic polar solvents compared to the peptidoglycan structure found in bacteria [17,18]. Specifically, the hydrophobic nature of chitin makes it more sensitive to polar solvents like ethylene glycol, which can cause it to dissolve or break down.

4. Conclusion

This study demonstrated that both the cleaning method and the placement duration following use significantly affect the microbial load present in a male masturbation cup. Across both YPD and BPA media, the absence of cleaning (NC group) resulted in the highest CFU/mL values, with microbial populations increasing markedly over time. Cleaning with water (CW group) showed moderate effectiveness in reducing microbial growth, whereas cleaning with the specialized fluid (CF group) consistently resulted in the lowest bacterial counts, especially after prolonged exposure. Notably, the CFU difference between CW and CF groups became more pronounced as the placement time extended beyond 6 hours, indicating the time-sensitive nature of microbial proliferation. ANOVA results confirmed the statistically significant impact of both cleaning method and placement time on bacterial growth. These findings emphasize the importance of timely and effective cleaning practices—particularly using antimicrobial agents—in minimizing microbial contamination in reusable personal health devices.

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Abbreviation:

YPD	Yeast Peptone Dextrose
PDA	Potato Dextrose Agar
BPA	Beef extract Peptone Agar
ABS	Acrylonitrile Butadiene Styrene
TPE	Thermoplastic Elastomer
CFU	Colony Forming Units

NC	Non-cleaning
CW	Clean by Water
CF	Clean by Fluid

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