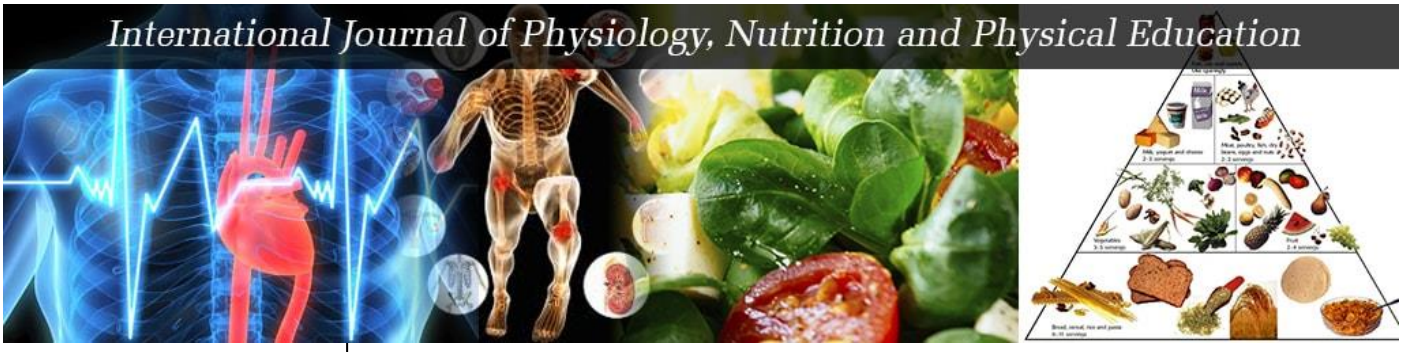

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Sexual dimorphism in the fluorosis among the rural people of Bankura District of India

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Abstract
Fluorosis has become one of the most serious public health problems in India. A cross sectional study was carried out in the endemic fluorosis areas of Bankura District of India to find out the sexual dimorphism in prevalence of dental and skeletal fluorosis and also find its association with urinary fluoride level. In the present study, the prevalence of dental and skeletal fluorosis was 77.78% and 11.11% respectively and the urinary fluoride level was 1.37±1.09 mg/l. It was noted that females (83.72%) were about two times more prone to dental fluorosis than males (68.97%) with OR=2.314 and RR=1.469. Similar finding was observed in skeletal fluorosis also, where females (13.95%) were more prone to become skeletal fluorosis than males (6.90%) with OR=2.189 and RR=1.297. This study showed that more than three fourth of the participants were suffering from dental fluorosis and this situation was very serious among the females in this locality.

Keywords: Dental fluorosis, skeletal fluorosis, urinary fluoride level

Introduction
Fluorine is thirteen most abundant elements available in the earth crust (natural surface and ground waters) and twenty fourth most abundant elements in the universe [1]. It has potential impact on the human health with both beneficial and harmful [2]. The consumption of low concentrations of fluoride can improve the dental health [3]. But, prolonged exposure to high level of fluoride can drastically affect the human health and produce dental and skeletal fluorosis [4]. It can affect the non-skeletal organs in the body including kidney, liver, and brain and also responsible for growth retardation, changes in DNA structure and reduced intelligence [2, 5-9].
The recent report indicated that it affects nearly 200 million people from 25 countries [10]. India and China are the worst affected countries in endemic fluorosis in the World [11]. Short et al. first reported endemic fluorosis from India in 1937 [12]. Presently, more than sixty million people are affected by fluorosis living in nearly two hundred thirty districts of nineteen states of India [13, 14]. Seven districts of West Bengal in India are affected by endemic fluorosis. These districts are Bankura, Bardhaman, Birbhum, Malda, North Dinajpur, Purulia, and South Dinajpur [15]. In Bankura District seventeen blocks are affected with endemic fluorosis and only five blocks were unaffected till now [16]. But, only a few studies have been reported dental and skeletal fluorosis in this region till now. In this purview this present study was conducted to find out the sexual dimorphism in prevalence of dental and skeletal fluorosis and also find its association with urinary fluoride level.

Methodology
Area of study: The study was conducted in the Simlapal block (22°55′22″N 87°04′24″E; area: 310.15 km^2) of Bankura District. The maximum fluoride concentration in the water of tube well was reported as 12.69 ppm from this area.

Participants: A total of 72 participants were random selected for the study, out of which 29 participants were males and 43 participants were females. The inclusion criteria of this study were (i) the probable participants were the inhabitants of study area and (ii) taking drinking water from the same source for last five years.

The people with occupational migration or changing the source of collection of drinking water were excluded from this study. Written consent was taken from each of the participants before conduction of the study. In case of minor participants written consent was taken from their legal guardians. The permission was taken from the authority before the study.

Study duration: The study was carried out over a period of three months, October 2017 to December 2017.

Identification of dental and skeletal fluorosis: Criteria for Dean's classification system for dental fluorosis was used to identify the possible presence of fluorosis [17]. The skeletal fluorosis was determined using the criteria given by Teotia, Teotia and Singh in 2004 [18].

Determination of urinary fluoride level: Total solubilized fluoride is determined using a fluoride ion- selective electrode (ISE) capable of being calibrated. Analysis was performed under standardized operating procedures. The precision and accuracy of the fluoride analyses, including quality control measures monitored. The limit of detection (LoD) for urinary fluoride was 20 µg/l.

Statistical analysis: This was performed using the Statistical Package for the Social Science (SPSS) version 17.

Results

Descriptive statistics of the different parameters is presented in table 1. This study clearly indicated that 77.78% of the participants were suffering from dental fluorosis as per the criteria for Dean's classification system for dental fluorosis. While categorize the participants according to the severity of dental fluorosis it was noted that no case of severe dental fluorosis was observed. The percentage of questionable, very mild, mild and moderate level of dental fluorosis in this study was 22.22%, 33.33%, 11.11% and 11.11% respectively. While studying the skeletal fluorosis in this study, it was noted that 11.11% of the participants were suffering from jenu varam and no case of jenu vulgum the severe degree of skeletal fluorosis was observed. The urinary fluoride level among the participants was 1.37±1.09 mg/l. 45.83% of the participants were suffering from upper fluoride level.

Sexual dimorphism in the prevalence of dental and skeletal fluorosis is presented in table 2. This study indicated that 83.72% of the female and 68.97% of the male participants had dental fluorosis. While the prevalence of skeletal fluorosis of the male and female participants were 6.90% and 13.95% respectively. This indicated that female participants were nearly two times more prone to become affected by dental or skeletal fluorosis then the male participants.

Effect of sexual dimorphism in the severity of dental fluorosis according to the criteria for Dean's classification system is presented in fig 1. The prevalence different grades of dental fluorosis among the females *viz*. questionable, very mild, mild and moderate were 23.26%, 34.88%, 13.95% and 11.63% respectively. And in case of males this prevalence were 20.69%, 31.03%, 6.90% and 10.34% respectively. Though there was no statistical significant difference (χ^2=2.627; P>0.05) was observed among the male and female participants in the prevalence dental fluorosis, but it was clearly noted that male participants were less likely (10.34%) to be affected by moderate degree of dental fluorosis than the female participants (11.63%) and it was also noted that male participants (31.03%) had greater chance of being in normal grade than the female participants (16.28%).

Effect of sexual dimorphism in the severity of skeletal fluorosis is presented in fig 2. This indicated that prevalence of Jenu varam among female and male were 13.95% and 6.90% respectively and no case of Jenu vulgum was noted. While considering the total participants the prevalence of Jenu varam was 11.11%. Statistically no significant difference (χ^2=0.873; P>0.05) was observed among the male and female participants, but female were more prone to be affected with skeletal fluorosis.

Urinary fluoride level of the participants is presented in fig 3. This study showed that the urinary fluoride level was lower among the female participants (1.35±1.09 mg/l) than the male participants (1.40±1.10 mg/l). Interestingly, the urinary fluoride level was much higher among the participants with dental fluorosis (1.40±1.17 mg/l) than the non-dental fluorosis participants (1.27±0.78 mg/l).

Effect of age on the urinary fluoride level and the prevalence of fluorosis is presented in fig 4. The urinary fluoride level of five age groups in this study *viz.* <20 years, 20-29 years, 30-39 years, 40-49 years and >49 years were 1.31±1.05 mg/l, 1.40±0.98 mg/l, 0.71±0.47 mg/l, 1.76±1.33 mg/l, and 1.51±1.34 mg/l respectively. The prevalence of dental fluorosis in the said age group was 75.00%, 76.19%, 77.78%, 78.57%, and 87.50% respectively. While, in case of skeletal fluorosis this was 5.00%, 4.76%, 0.00%, 14.29% and 50.00% respectively. Interestingly, the prevalence of dental fluorosis was increasing linearly with age, while the prevalence of skeletal fluorosis showed a different pattern in this study. The very low and very high of prevalence of skeletal fluorosis at the age of 30-39 years and >49 years may be due to very low number of participants in this age group i.e., 9 in 30-39 years and 8 in >49 years.

Distribution of urinary fluoride level according to age and prevalence of dental fluorosis is presented in Fig 5. It was observed that upper level of urinary fluoride was observed 45.83% of participants and among the said age group it was noted as 40.00%, 47.62%, 11.11%, 71.43%, and 50.00% respectively. While studying the relationship between severity of dental fluorosis and urinary fluoride level, it was noted that upper level of urinary fluoride were 50.00%, 37.50%, 45.83%, 37.50%, and 62.50% in normal, questionable, very mild, mild and moderate level of dental fluorosis respectively.

Distribution of urinary fluoride level according to age and prevalence of skeletal fluorosis is presented in Fig 6. Upper level of urinary fluoride level was observed among 37.50% of the participants those who were suffering from jenu varam.

Discussion

In the present study, we observed a very prevalence of dental fluorosis (77.78%) and skeletal fluorosis (11.11%) among the rural people living the fluorosis endemic zones of Bankura District (Table-1). In a similar study Nirgude et al. found that the dental fluorosis was present in 30.6% and skeletal fluorosis was 24.9% among participants [19]. Our study suggests highest prevalence of very mild fluorosis (33.33%) among participants (Table 1). A study conducted in 2017 among adolescent students in Kolar district of Andra Pradesh showed an increase prevalence of moderate or severe fluorosis (>50%) according to Dean's Fluorosis Index when compared with other categories [20].

Dental fluorosis as per Dean's Index was observed 83.72% in females and 68.97% in males respectively. For skeletal fluorosis prevalence was observed 13.95% in females and

6.90% in males (Table 2). But based on the grading of intensity of dental fluorosis most of the females had very mild fluorosis followed by mild and then moderate. On the other hand most of the males suffered from very mild fluorosis followed by moderate and then relatively less mild form of fluorosis (fig 1). Thus our study suggests that gender was associated with dental fluorosis and skeletal fluorosis, and females had a more than two times (OR=2.514) treated risk of developing fluorosis (Table 2). Similar research was obtained by Rigo et al. with Odd ratio 1.55 in Brazil [21]. More prevalence of in females may probably due to their sufferings from low calcium (Ca++) intake and deficiency of vitamin C. Susheela et al. found that development of skeletal fluorosis can be due to consumption of fluoride together with other factors such as low intake and body reserve of calcium and vitamin C [22].

The prevalence of dental fluorosis in early age (<20 years) is an expression of higher exposure to fluoride and it is fairly important since it affects permanent teeth. Intake of more volume of water during growing stage may result in fluorosis among adolescent since most of the ingested minerals are absorbed by the body during growing stage [23].

In the present study, we noted that people who were above 40 years of ages had more skeletal fluorosis, while the prevalence of skeletal fluorosis is less in below 30 years of ages. This finding of the present study is substantiated by Nirgude et al., they reported that prevalence of skeletal fluorosis increases with increased age [19]. Xiang et al. showed skeletal fluorosis increases with age [24]. This striking finding might be due to decrease in renal fluoride excretion in this physically active working class as increase in physical activity and exercise. There is reduction of renal blood flow and glomerular filtration rate and increase reabsorption of fluorine from renal tubules, and hence urinary fluoride level is decreased [25]. There are several reports that observed decline in renal clearance of fluorine with increasing physical activity and or exercise intensity which needs to be investigated in a large trial [26]. Absorption of flurode is regulated by the diet as well. The population (>40 years of age) having more of vegetables in food is expected to excrete more of fluoride in urine compared to those (<40 years) who consume more meat [27]. Long term diet induced changes in urinary pH could influence the fluoride level in urine. Vegetable have alkaline urine which promotes more fluoride excretion through urine that is seen in the older ages individuals in the present study. In contrary protein rich diet acidifies urine that promotes retention of fluoride in body and less amount is excreted in urine resulting less amount of urinary fluoride level in young and middle aged people in the present study increasing the risk of dental fluorosis in this group. In the present study urinary fluoride concentration ranges in female from 0.13-4.81µg/l with mean 1.34±1.08 µg/l and in male from 0.17-4.62 µg/l with mean 1.40±1.08 µg/l (Fig 2). Low concentration of urinary fluoride level in females may be attributed to relatively less consumption of drinking water and foods compared to males. Unlike observation of higher fluorine level in urine have been more in other studies too ascribing the reason to additional intake of bioactive fluoride through food [28]. Thus the findings of the present study are in close agreement with the results found in previous studies to provide a robust estimate of the variability of the effect of fluoride exposure in gender and different age groups.

Table 1: Descriptive statistics of the different parameters

Parameters	N (%)
Age (years)	
<20	20 (27.78)
20-29	21 (29.17)
30-39	9 (12.50)
40-49	14 (19.44)
>49	8 (11.11)
Sex	
Female	43 (59.72)
Male	29 (40.28)
Dental Fluorosis	
Normal	16 (22.22)
Questionable	16 (22.22)
Very Mild	24 (33.33)
Mild	8 (11.11)
Moderate	8 (11.11)
Severe	0 (0)
Skeletal Fluorosis	
Normal	64 (88.89)
Jenu Varam	8 (11.11)
Jenu Vulgum	0 (0)
Urinary F Level	
Upper	33 (45.83)
Normal	39 (54.17)

Table 2: Sexual dimorphism in the prevalence of dental and skeletal fluorosis

Fluorosis	Female (N=43)	Male (N=29)	χ^2 test	OR	RR
Dental Fluorosis					
Present	36 (83.72)	20 (68.97)	χ^2=2.182; P>0.05	OR=2.314 (0.748–7.156)	RR =1.469 (0.815–2.648)
Absent	7 (16.28)	9 (31.03)			
Skeletal Fluorosis					
Jenu Varam	6 (13.95)	2 (6.90)	χ^2=0.873; P>0.05	OR=2.189 (0.410–11.693)	RR =1.297 (0.826–2.038)
Normal	37 (86.05)	27 (93.10)			

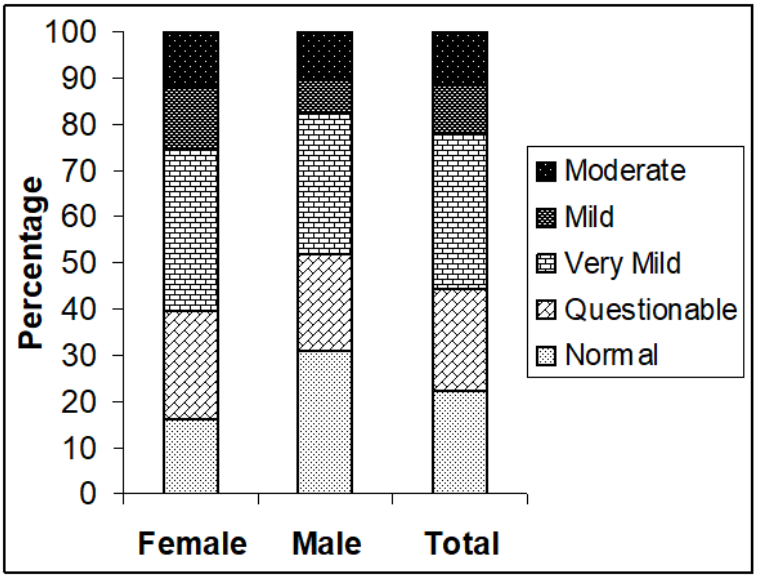

Fig 1: Effect of sexual dimorphism in the severity of dental fluorosis according to the criteria for Dean's classification system

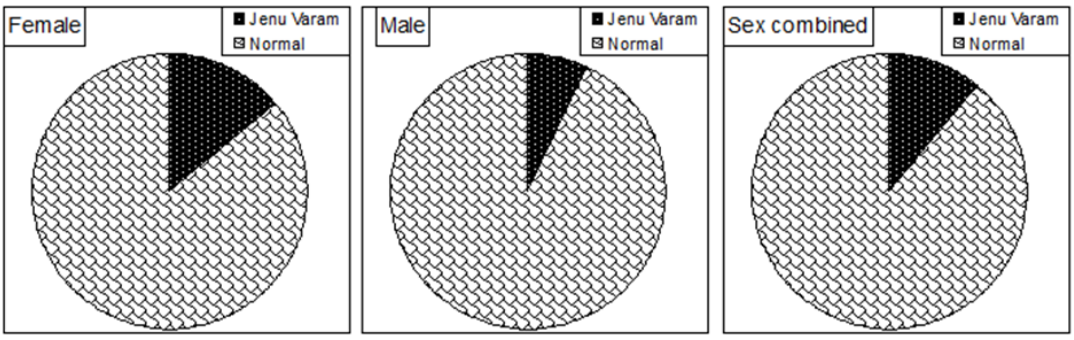

Fig 2: Effect of sexual dimorphism in the severity of skeletal fluorosis

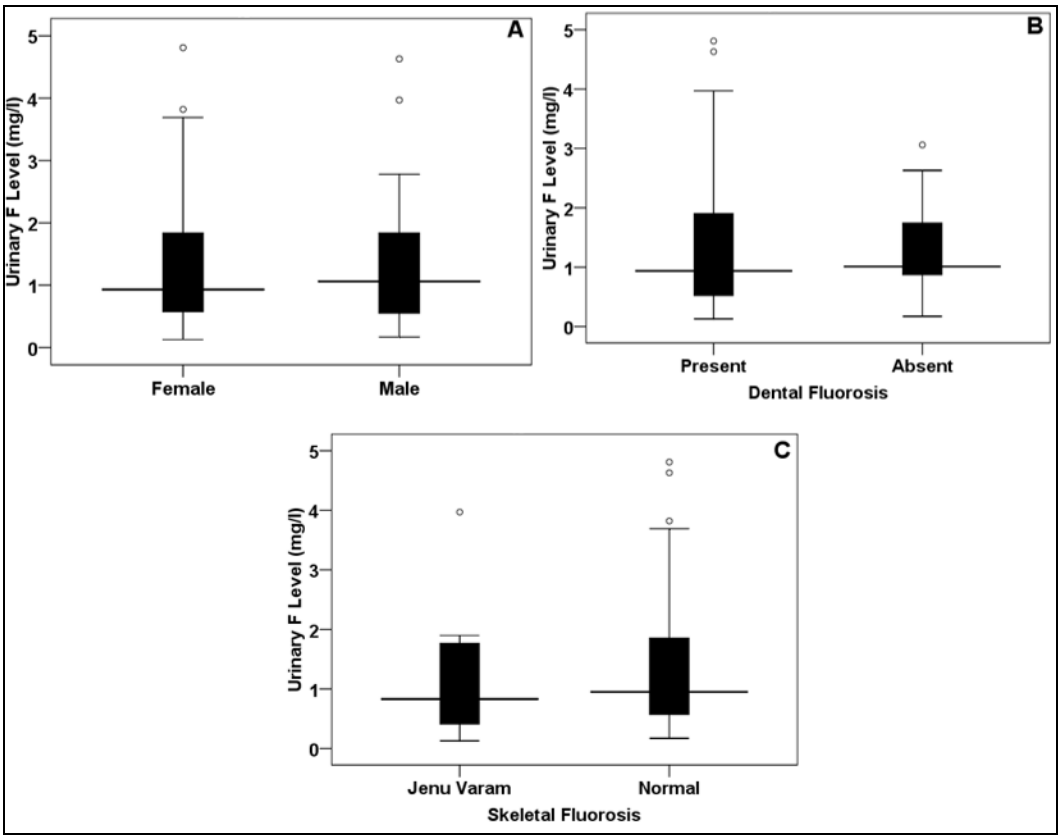

Fig 3: Urinary fluoride level of the participants. The effect of (A) gender (B) dental fluorosis (C) skeletal fluorosis on the urinary fluoride level of the participants.

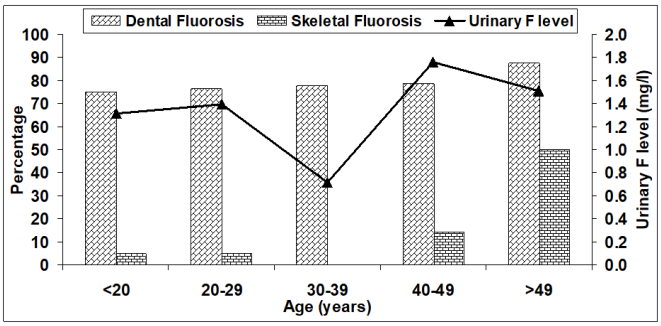

Fig 4: Effect of age on the urinary fluoride level and the prevalence of fluorosis

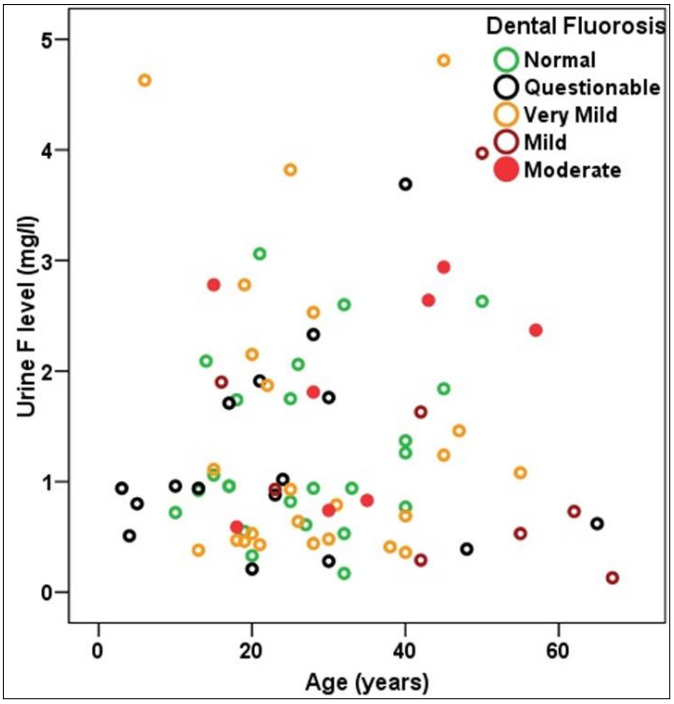

Fig 5: Distribution of urinary fluoride level according to age and prevalence of dental fluorosis

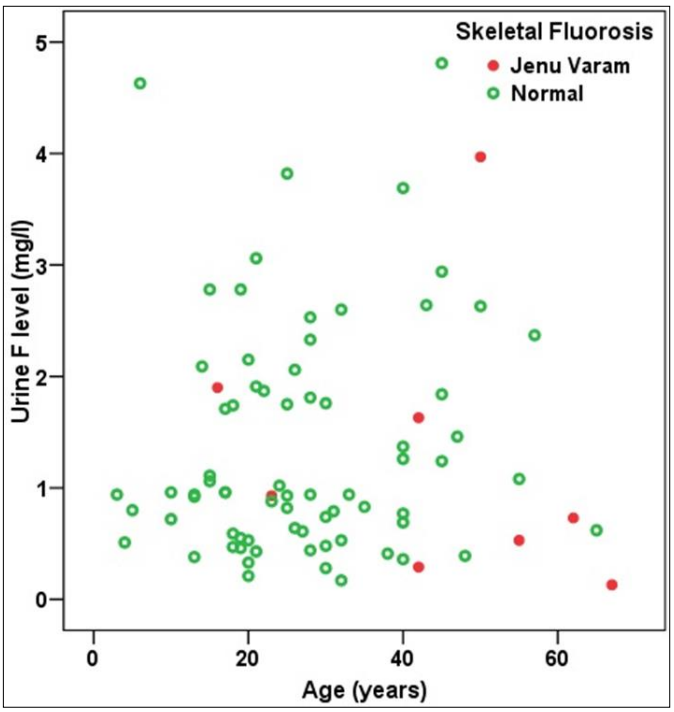

Fig 6: Distribution of urinary fluoride level according to age and prevalence of skeletal fluorosis

Conclusion

This study found that more than three fourth of the participants were suffering from dental fluorosis in this area and this situation is more critical among the female participants.

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