Growth, mortality and spawning season of the spangled emperor (*Lethrinus nebulosus* Forsskal, 1775) in coastal waters of Hormozgan Province in the Persian Gulf and Oman Sea

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Received: June 2009 Accepted: September 2009

Abstract

The population parameters and spawning season of the Spangeld emperor (*Lethrinus nebulosus*) were studied in coastal waters of Hormouzgan province. The monthly calculated mean values of gonadosomatic index (GSI) of females were indicate to increase from February, reach the highest in March and decline in June. The spawning season peak of *L. nebulosus* occurred in March. The Von Bertalanffy growth parameters, $L\infty$, K and t_0 were estimated as, 67.2cm, 0.16.year^{-1} and -1.161 year, respectively. The relationship between weight and length (Fork Length) can be expressed as $W=0.051\ L^{2.722}$, which indicates that Spangled Emperor has negative alometric growth.Using length converted catch curve, total mortality (Z) was estimated as 1.13 year^{-1} and natural mortality was estimated using Pauly's equation, as 0.57 per year. Finally, the fishing mortality (F) was 0.56, which gives an exploitation rate (E) of 0.50.

Keywords: *Lethrinus nbulosus*, Spawning, Growth parameters, Spawning, Mortality rates, Hormouzgan Province

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[DOR: 20.1001.1.15622916.2010.9.1.11.3]

Introduction

Fisheries management relies on understanding the fish population's dynamics while determining the biological parameters, including size at maturity, duration of the spawning season, as well as growth and mortality estimates (Tracey *et al*., 2006).

Fishes of the family Lethrinidae are abundant in the coastal part of tropical and subtropical Indo-Pacific. *Lethrinus nebulosus* (Forsskål, 1775), is distributed throughout the Indo-West Pacific from the Red Sea and East Africa to southern Japan and Samoa (Young & Martin, 1982). There are about 20 species of this family (Lethrinidae) in the FAO area51 (Fischer & Bianchi, 1984). *Lethrinus nebulosus* is a large tropical species reaching 80.0cm total length and 8.4kg total weight (Randall, 1995). Studies on the biological aspects of the *L. nebulosus* including age, growth and mortality as well as food and feeding habits have been carried out in the Pacific Ocean, Red Sea and the Persian Gulf (Kuo & Lee, 1986; Morales-Nin, 1988; Rathacharen *et al*., 1995; Al Sakaff & Esseen, 1999; Al-Sayes *et al*., 1988; Ibrahim *et al*., 1988; Ezzat *et al*., 1992; Grandcourt *et al.*, 2006).

Along the 4 Iranian coastal provinces in south part (from east to west) Sistan and Baluchestan, Hormouzgan, Bushehr and Khouzestan), spangled emperor is targeted by local fishers who used different fishing methods such as traps (locally named Gargoor and Gillnets). Owning to its high value and demand *L. nebulosus* has become a target species for a part of fishermen in southern waters of Iran especially for Hormozgan province fishermen. Landing data from 1997 to 2007 shows that more than 60% of the *L. nebulosus* catches were landed in the Hormozgan province and 21% in Bushehr (Table 1). The landing from southern waters of Iran (Persian Gulf and Oman Sea) has slightly increasing trend from 1997 onwards (r = 0/8) (Fig. 1).

Table1: Nominal catch (t) of *L.nebulosus* from Iranian waters of the Persian Gulf and Sea of Oman (Department of Fisheries Statistics, Iranian Fisheries Organization (Shilat), 2008)

Province/year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Khozestan	14	31	60	35	35	91	126	329	162	129	55
Busher	194	190	200	210	219	356	290	397	343	368	264
Hormozgan	461	589	340	395	462	716	816	1437	1260	1315	1089
Sistan & Bluchestan	100	176	170	85	156	106	115	149	33	267	72
Total	769	986	770	725	872	1269	1347	2312	1798	2079	1480

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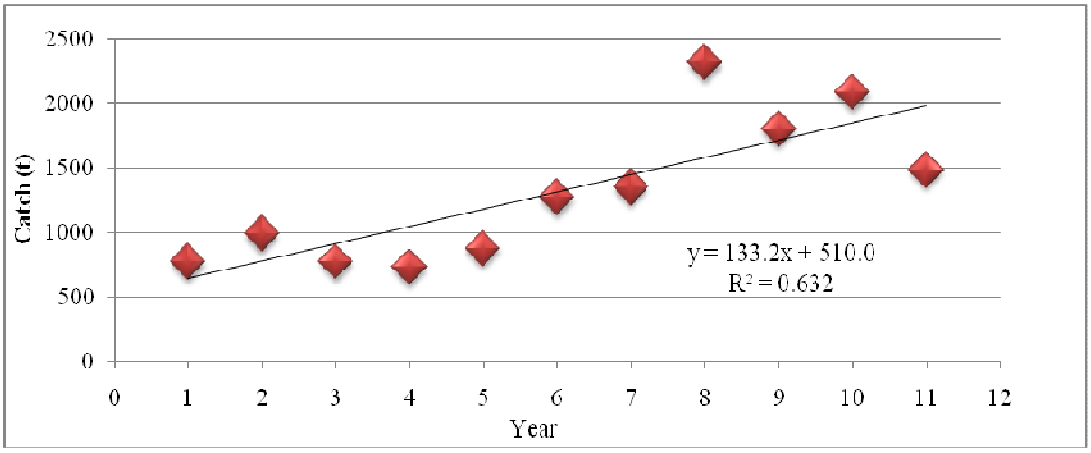


Figure 1: Trend of total yearly catches of *L. nebulosus* in Persian Gulf and Sea of Oman (1997-2007)

The present study was undertaken to evaluate the spawning season and growth characteristics of this species in the Iranian waters, using FiSAT II on size composite data from 2007 to 2008. The objectives of this study are therefore to answer some of the questions pertaining to growth, reproductive activity, mortality and exploitation rate of *L. nebulosus* in Hormozgan province waters.

Materials and methods

Monthly samples of *L. nebulosus* (September 2007 to August 2008) were collected from landing sites (Jask, Kong and Gheshm) of the Hormouzgan province. The study areas are shown in Fig. 2.

The specimens were collected directly and regularly from small scale fishermen. The fork length of 1800 and weight of 300 specimens were measured during study period. Fork length measured to the nearest cm for all fishes and total weight (TW) of individual fishes to the nearest 0.01kg was measured. Each month 30 individuals were sampled and transferred to the laboratory for reproduction studies. The gonad weight in grams was recorded. The gonadosomatic index (GSI) was calculated monthly by the following equation (Biawas, 1993):

GSI = (gonad weight/fish weight without gonad)*100

The time of spawning for *L. nebulosus* in Hormozgan province waters (Persian Gulf and Sea of Oman) is estimated by the relative size or weight of gonads over the one year study period.

The length and weight relationship was determined by the equation $W = a L^b$, in order to verify if calculated b was significantly different from 3, the Student's t-test was employed (Zar, 1996).

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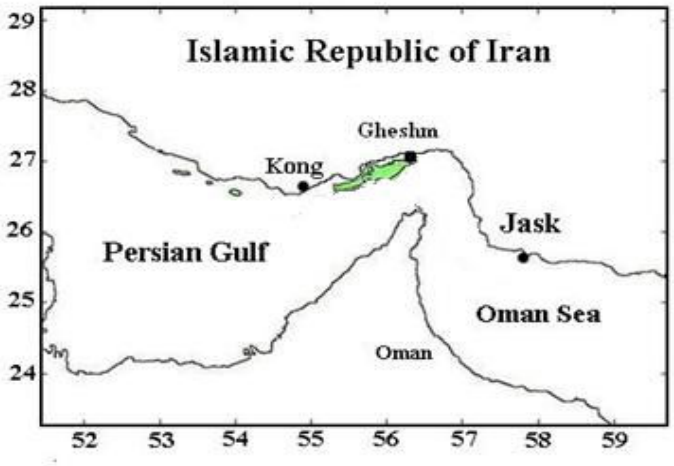


Figure 2: Location of three landing sites where *L. nebulosus* were sampled (2007-2008)

The catch data, available from Department of Fisheries Statistics (Iranian Fisheries Organization, 2008), were also utilized. Length measurements of monthly samples of *L.nebulosus* were pooled and grouped by 1cm interval for purpose of growth estimation.

Bhattacharia's method was used to identify the mean size of different cohorts (Pauly & Caddy, 1985; Sparre & Venema, 1992). The mean size, were then used for the estimation of Von Bertalanffy growth parameters, $L\infty$ and K using modal progression analysis method.

The parameter t_0 of the growth equation was estimated using the following equation (Pauly, 1980):

$$\text{Log}(t_0) = -0.3922 - 0.2752\log(L\infty) - 1.038\log(K).$$

In order to facilitate the comparison of the results with those of other studies, growth performance index (Φ') was estimated by the following equation (Pauly & Munro, 1984):

$$\Phi' = \log(K) + 2\log(L\infty)$$

The total mortality coefficient *Z* was estimated using the linear length-converted catch curve method, using the final estimates of $L\infty$ and k and the length distribution data (Gayanilo & Pauly, 1997). The natural mortality M was estimated using (Pauly, 1980) empirical equation relating M, $L\infty$, k and T.

$$\text{Log}(M) = -0.0066 - 0.279\log(L\infty) + 0.6543\log(K) + 0.4634\log(T)$$

The mean annual environment temperature (T) used in the estimation was 26.5°C (courtesy of the Iran Environment Public Authority). Fishing mortality rate (F) was calculated as (Sparre & Venema, 1992):

$$F = Z - M.$$

The exploitation rate (E), was computed by dividing F by Z (Pauly, 1983).

The computer software FiSAT2 (www.fao.org/fi) and Ms Excel were used for the analysis and estimation of the above mentioned biological parameters.

Results

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The monthly mean values of gonado-somatic (GSI) indexes for females are presented in Figure 3, which shows that the monthly mean value of GSI starts to increase from February, reach the highest in March and decline in June. It could be concluded that there was one peak of spawning period for *L. nebulosus* in March.

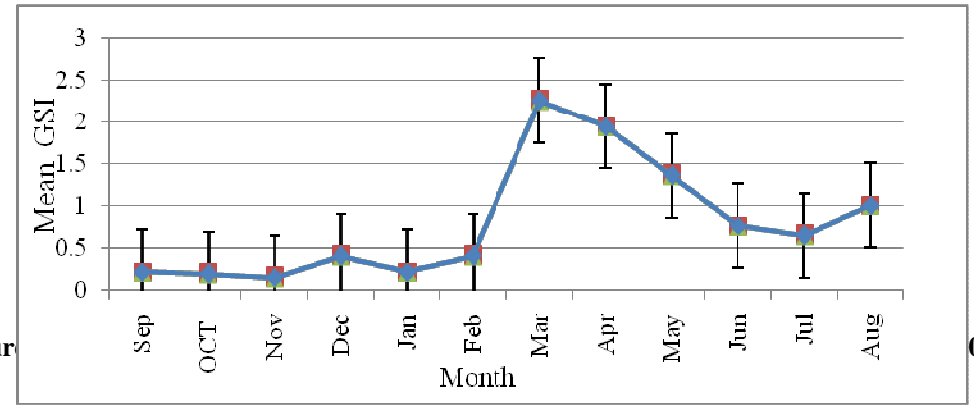
The length frequency (FL) of *L. nebulosus* ranged from 17 to 64.5cm, the size of 39-40cm was predominated (Fig. 4).

The length-weight relationship of the form $W = a L^{b}$ was estimated for both sex together (Fig. 5), and the parameters were estimated as:

a = 0.0518 and b = 2.722, r = 0.987;

Verifying calculated b with 3, using Student's t-test, there was significant difference between calculated b and 3 ($P<0.05$).

Figur **08)**



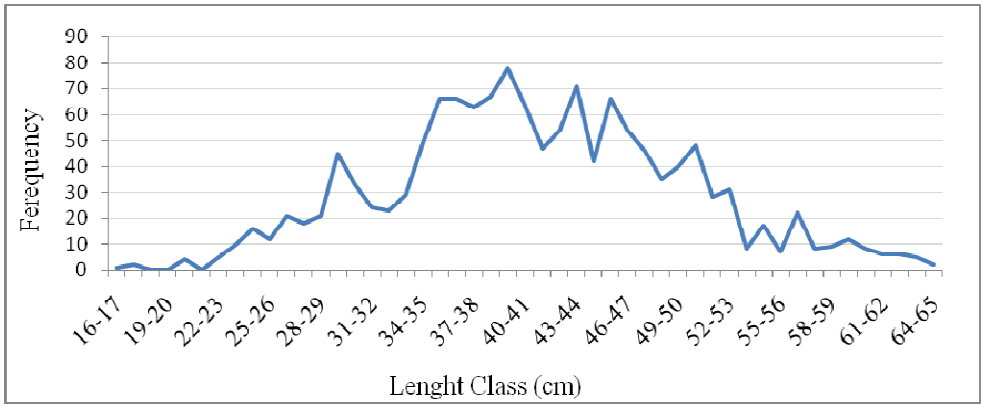


Figure 4: Length frequency distribution for *L. nebulosus* in the Hormozgan province in the Persian Gulf and Oman Sea

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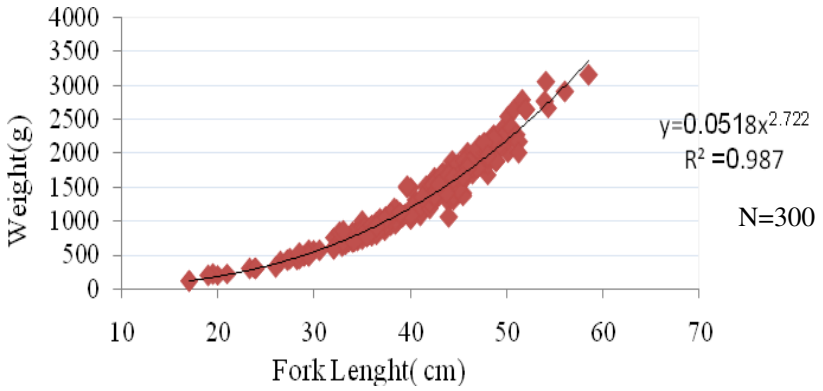


Figure 5: The length-weight relationship curve for both sexes of *L. nebulosus*

The mean lengths identified in the length distribution of *L. nebulosus* for the Hormozgan province was then used to estimate $L\infty$, K and t_0 of the Von Bertalanffy equation as 67.2cm, 0.16 (per year) and -1.161 year, respectively (Fig.6). These results gave a growth performance index (Φ') of 2.86 for this species in this area.

Using length-converted catch curve, total mortality rate (Z) was estimated as 1.13 $year^{-1}$ (r = 0.989) (Fig.7). Natural and Fishing mortality were estimated 0.57 and 0.56 $year^{-1}$ respectively, which give E value as 0.5.

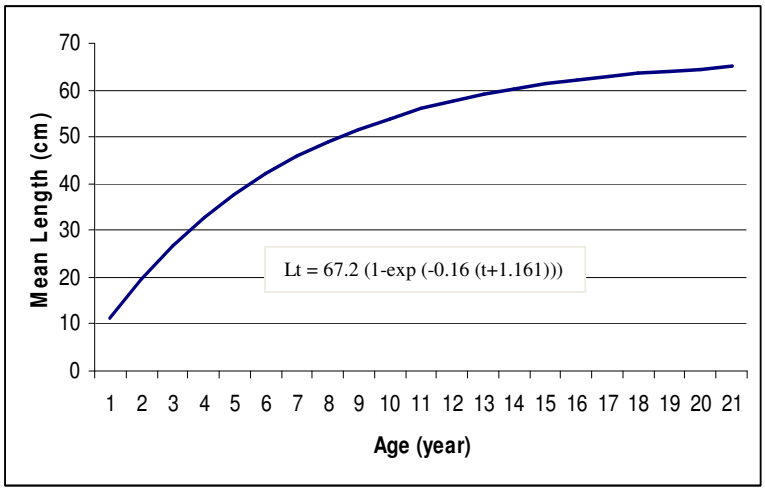


Figure 6: Growth curve fitted from mean lengths of the length frequency distribution for *L. nebulosus* from the Persian Gulf and Oman Sea (Hormouzgan province waters).

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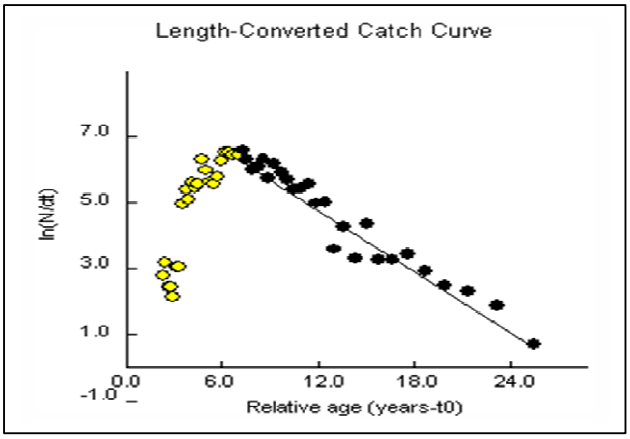


Figure 7: Length-converted Catch Curve for the estimation of total mortality (Z)

Table 2: Length- weight relationship of *L. nebulosus* in FAO area51

(Type of measurement was fork length)

Area	a	b	References
South of Iran	0.051	2.722	Present study
Gulf of Aden	0.0161	2.970	Sanders *et al.*, 1984
Kuwait	0.0173	3.01	Baddar, 1987
Southern Persian Gulf	-------	2.88	Grandcourt *et al.*, 2006

Table 3: Summary of the growth parameters estimated for *L .nebulosus* from the FAO area51

Area	L∞ (cm)	K (per year)	t_0	Source
Southern Persian Gulf	66.2	0.11	-3.00	Grandcourt *et al.*, 2006
Emirate of Abu Dhabi	61.08	0.14	-2.34	Grandcourt *et al.*, 2002
Kuwait	62.73	0.19	F	Baddar, 1987
Coastal area of Mauritius	85-87.26	0.205-0.275	-0.01 t_0 -1	Rathacharen *et al.*, 1995
Gulf of Aden	87	0.09	0.54	Al Sakaff & Esseen, 1999
South waters of Iran (Persian Gulf & Oman Sea)	67.2	0.16	-1.161	Present study

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Discussion

There was well defined peak in the March for reproductive cycle of spangled emperor (*L. nebulosus*) in the Southern Iranian waters (Persian Gulf and Sea of Oman). Comparing the results of the present study with Grandcourt *et al* (2006) study, in the southern Persian Gulf (Abu Dhabi waters), it reveals that the spawning season for this species in southern Persian Gulf (Abu Dhabi waters) occurred from April to May, but in the Iranian waters (Hormouzgan province) occurred from March and ended in June, which shows seasonal reproductive cycles are nearly common among tropical fishes (Grandcourt *et al.,* 2006).

The maximum, minimum and mean weights were 64.5, 17cm and 1303.6g, respectively. The b value of the length-weight relationship for *L. nebulosus* in the present study was estimated to be b=2.722, which indicates negative allometric growth (King, 1995). The b values estimated by different authors for *L. nebulosus* in area51 are demonstrated in Table 2. The reasons for the variation of b in the different regions are said to be due to seasonal fluctuations in environmental parameters, such as physic-ological conditions of the fish at the time of collection, sex, gonadal develop-ment and nutritive conditions in the environment of fish (Biswas, 1993).

The growth curve estimated for this species using the above growth parameters indicates that spangled emperor (*L. nebulosus*) attains 19.6cm, 26.7cm, 32.7cm, 37.8cm and 42.1 cm fork length respectively from 1^+ to 5^+ years age (Fig. 6).

The estimated K (0.16 per year) revealed that, although the spangled emperor can be characterized of fish with low growth rate (Rathacharen *et al*., 1995), but estimated t_0 with negative sign (-1.61) suggests that juveniles of emperor grew more quickly. Various estimate of growth parameters of *L. nebulosus* available from other studies in the FAO area51, are tabulated in Table 3.

Grandcourt *et al*. (2006) calculated $L\infty$ and K for this species in the southern Persian Gulf as 66.2cm 0.11 per year which agree with the results of the present study. Also the results of present study are coinciding with Badder (1987) work in Kuwait waters. A trade-off between growth rate (K) and maximum size ($L\infty$) is often found. This trade off is influenced by several factors, like temperature, mortality, or food availability. Increased food availability causes a shift towards larger maximum size, but may not increase the growth rate (Torcu-Koc *et al*., 2004).

Our value of Φ' (2.8) is similar to that estimated by Grandcourt *et al.*, 2002 (2.8) for the Emirate of Abu Dhabi waters, suggesting a similar growth pattern for this stock of *L. nebulosus* in these two area, when accounting for inter-correlation in parameter estimation. It is however, interesting to note that, growth parameters ($L\infty$, K and t_0) estimated in the

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Gulf of Aden and Mauritius coastal area are highly variable in comparing to other areas which might be due to different ecological situations of Aden Gulf and Mauritius coastal areas with other areas in north-west Indian Ocean.

The total mortality was estimated at 1.13 $year^{-1}$ and natural mortality at 0.57 $year^{-1}$ resulting in optimal fishing mortality and consequently an optimal value of exploitation rate (E=0.5). The total and natural mortality estimated in the present study is higher than the values estimated by Grandcourt *et al.*, 2006 (Z= 0.56, M= 0.20) in Persian Gulf and Oman Sea which might be due to lower fishing pressure on *L. nebulosus* in other part of the Persian Gulf and Oman Sea.

Small changes in the growth parameters used could seriously affect the computed mortality rates (Tserpes & Tsimenidis, 2001) and to describe the current position of this stock there were lack of information on the effect of fishing on recruitment and behavior pattern of spangled emperor. However, the exploitation ratio E = 0.50, revealed rational exploitation of this stock in the study area. In addition, to keep the level of fishing at which catches are sustainable, conserve the level of spawning stock and reduce the effect of fishing on the biomass, the fisheries strategy should be planned so that the fishing period follows the reproductive period.

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بررسی پارامترهای رشد، نرخ مرگ و میر و فصل تخمریزی ماهی شعری معمولی (***Lethrinus nebulosus***) در آبهای ساحلی استان هرمزگان (خلیج فارس و دریای عمان)

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تاریخ دریافت: خرداد ۱۳۸۸ تاریخ پذیرش: شهریور ۱۳۸۸

چکیده

در این تحقیق، پارامترهای جمعیتی و فصل تخمریزی ماهی شعری (*Lethrinus nebulosus*) در آبهای ساحلی استان هرمزگان مطالعه شد. بررسی تغییرات ماهانه GSI جنس ماده نشان می‌دهد تخمریزی این گونه از اسفند ماه تا خرداد ماه و اوج رسیدگی جنسی در اسفند ماه می‌باشد. پارامترهای رشد فون برتالانفی، شامل طول بی‌نهایت، نرخ رشد و t_0 بترتیب ۶۷/۲ سانتیمتر، ۰/۱۶ در سال و ۱/۱۶۱- سال تخمین زده شد. با توجه به پارامترهای رشد محاسبه شده، ماهی شعری جزء گونه‌های با نرخ رشد کم محسوب می‌شود. رابطه بین طول چنگالی و وزن آن بصورت $W = ۰/۰۵۱FL^{۲/۷۲۲}$ تعیین گردید. با توجه به مقدار b محاسبه شده ماهی شعری دارای رشد آلومتریک منفی می‌باشد. مرگ و میر طبیعی، صیادی و کل بترتیب ۰/۵۷، ۰/۵۶ و ۱/۱۳ و ضریب بهره‌برداری ۰/۵۰ برآورد شد.

کلمات کلیدی: شعری معمولی، *Lethrinus nebulosus*، تخمریزی، ضریب رشد، ضریب مرگ و میر، استان هرمزگان

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