

Timing of fission in the starfish *Allostichaster capensis* (Echinodermata:Asteroidea) in laboratory

Tamara Rubilar¹, Catalina Pastor¹ & Enriqueta Díaz de Vivar²

1 Centro Nacional Patagónico, CONICET, Puerto Madryn, Chubut, Argentina; Phone: 54-2965-451024 Fax: 54-2965-451543; rubilar@cenpat.edu.ar; pastor@cenpat.edu.ar.

2 Universidad Nacional de la Patagonia San Juan Bosco, Fac. de Ciencias Naturales, Puerto Madryn, Chubut, Argentina, undiaz@cenpat.edu.ar

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Abstract: Timing of fission in the fissiparous starfish *Allostichaster capensis* under laboratory conditions is described. *A. capensis* generally splits across the disc along the fission plane during the spring, and then each half regenerates the missing arms during the rest of the year. The fission process can last eight hours. The healing process starts immediately after fission. *A. capensis* has impressive regeneration ability, including a comet, without signs of disc, regenerated two new arms. Rev. Biol. Trop. 53(Suppl. 3): 299-303. Epub 2006 Jan 30.

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According to Lawrence and Herrera (2000) asexual reproduction by fission is the rarest way of reproduction in echinoderms. About 80 of the roughly six thousands extant species of echinoderms are capable of asexual reproduction by fission or arm autotomy during the benthic phase (Mladenov 1996). However, some starfish reproduce asexually by fission (Emson and Wilkie 1980, Ottesen and Lucas 1982, Achituv and Sher 1991, Mladenov and Burke 1994, Alves *et al.* 2002). According to Mladenov and Burke (1994) there are three families of starfish with fissiparous species: Asterinidae, Asteroiidae and Solasteridae.

The genus *Allostichaster* belongs to the Asteroiidae family. Within this genus, almost all species are fissiparous: *A. insignis* (Farquhar) in New Zealand (Fell 1959), *A. polyplax* (Müller and Troschel) in New Zealand and Australia (Barker *et al.* 1992) and *A. capensis* (= *inaequalis*) (Perrier, 1875) in the South Atlantic Ocean. In the Western Atlantic Ocean, *A. capensis* is distributed from Buenos Aires to Tierra del Fuego and the Falkland Islands

(Islas Malvinas), from the subtidal zone to 100 m depth, usually on hard bottoms (Clark and Downey 1992).

Timing of fission in natural environments is unknown for *A. capensis*. Studies have been centered in reproductive aspects (Rubilar *et al.* 2005). However it is known that fission is a seasonal process that happens every spring, when seawater temperature starts to increase and day length is maximum (Rubilar *et al.* 2005).

A. capensis shows a distinctive asymmetry with two sets of arms of different sizes. This asymmetry seems to be lost in the last stages of regeneration (Rubilar 2004) although it is always possible to distinguish the plane of fission and the non-regenerative arms from the regenerative ones due to the slight difference in size and colour (Fig. 1). Before the process of fission starts in October-November (spring) (Rubilar *et al.* 2005), the two sets of arms are opposite to each other (Fig. 2).

The aim of this study was to describe the timing fission process of the fissiparous *Allostichaster capensis* in laboratory conditions

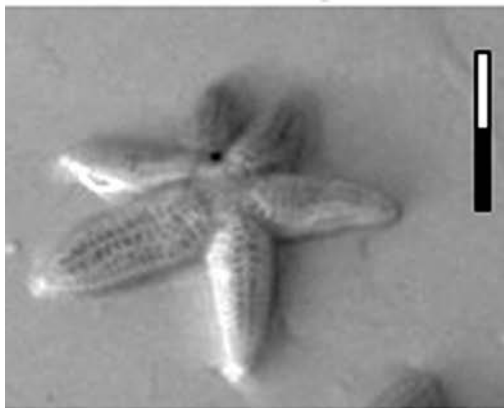


Fig. 1. *Allostichaster capensis*. Individuals almost completely regenerated. Note the differences between the regenerative and the non-regenerative arms. Scale bars: white 1 cm, black 1 cm.

Fig. 1. *Allostichaster capensis*. Individuos casi completamente regenerados. Nótese las diferencias entre los brazos regenerados y los no regenerados. Barra de escala: blanca 1 cm, negra 1 cm.

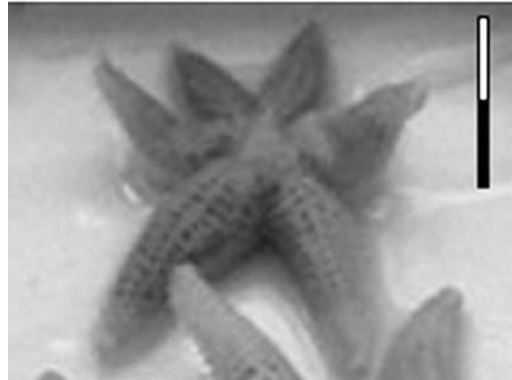
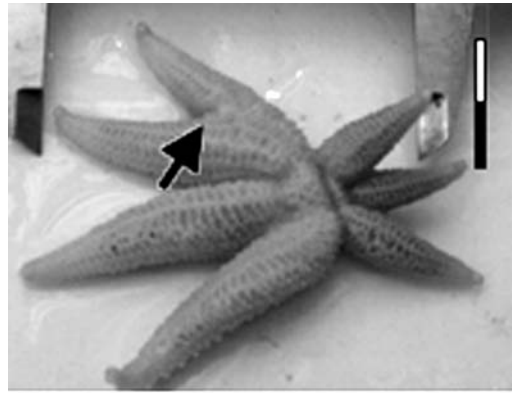


Fig. 2. *Allostichaster capensis*. Arm arrangement prior fission. Arrow indicates abnormal bifurcation of the arm. Scale bars: white 1 cm, black 1 cm.

Fig. 2. *Allostichaster capensis*. Arreglo de los brazos anterior a la fisión. La flecha indica bifurcaciones anormales del brazo. Barra de escala: blanca 1 cm, negra 1 cm.

Individuals were collected by scuba diving in Kaiser Bay, Golfo Nuevo (46°45'S; 65°0'W) at 10 m depth in November 2001 during the fission peak of the population (Rubilar *et al.* 2005). Individuals of different sizes and configuration of arms were selected (N=15), maintained six weeks in laboratory tanks with circulating water (18°C - 33.8‰ salinity) and fed once a week during the whole experiment with *Aulacomya ater ater*, favourite prey of *A. capensis* (Pucheta and Urban 1989). Fission was observed and the outcome was recorded as number individuals resulting from fission (Table 1). Organisms were classified into five sizes according to Rubilar *et al.* (2005): size

1: 10-20 mm, size 2: 21-30 mm, size 3: 31-40 mm, size 4: 41-50 mm, size 5: > 51 mm.

At the beginning of the fission process the body wall begins to lose its stiffness just before the two halves start, literally, to walk away from each other in opposite directions opening a wound across the disc. The oral tissue splits easily, taking about four hours. The two halves remain joined only by the aboral tissues and continue moving forward until the tissue breaks completely. The process can last up to around eight hours.

After the fission, the two new individuals are usually immobile while the healing of the wound is taking place. The body wall contracts to seal the wound. After a few weeks the tips of the new arms are visible (Fig. 3, 4).

The process of fission has been described for others species: *Allostichaster polyplax*, *Coscinasterias calamaria* and *Stephanasterias albula* (Emson 1978, Crump and Barker 1985,

Mladenov *et al.* 1986). According to Mladenov *et al.* (1986) there appear to be three different patterns of fission in starfish depending on the number of arms, Nevertheless only one pattern was found in *A. capensis* as Emson (1978) found in *A. polyplax*. Even individuals with four and five arms showed this pattern in *A. capensis*. However, one individual with five arms split into three new individuals, two with two arms and one comet. The comet had no disc. However, it sealed the wound and started to regenerate two new arms. By the end of the experiment the two new arms had *ca* 1cm (Fig. 5).

A. capensis shows an amazing capacity for regeneration. Individuals with all kinds of configurations of arms and sizes underwent fission and regenerated (Rubilar *et al.* 2005). Even a comet without a disc is able to generate new arms. This deviant reproduction can be an adaptation to stress (Lawrence and Herrera 2000). Mladenov and Burke (1994) found in

TABLE 1
Allostichaster capensis. *Outcome of fission*

CUADRO 1
Allostichaster capensis. *Resultado de la fisión*

Size	N° of arms of parent individuals	Resulting individuals	Number of arms of individual n°1	Number of arms of individual n°2	Number of arms of individual n°3
1	6	2	3	3	---
3	6	2	3	3	---
3	6	2	3	3	---
2	4	2	2	2	---
2	6	2	4	2	---
2	5	2	3	2	---
3	6	2	3	3	---
4	6	2	3	3	---
4	5	2	2	3	---
3	6	2	3	3	---
3	6	2	3	3	---
2	5	3	2	2	1
4	5	2	2	3	---
5	5	1	---	---	---
5	6	2	3	3	---

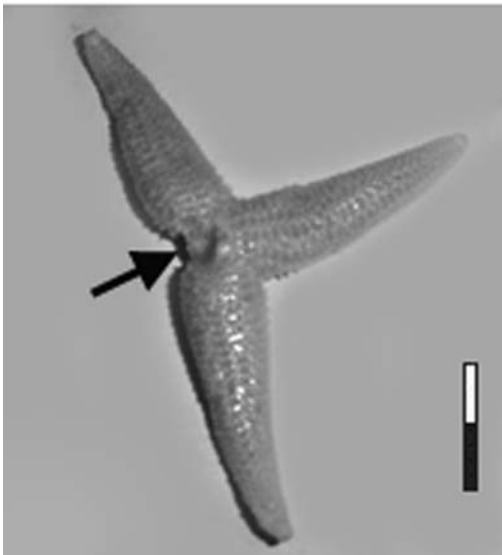
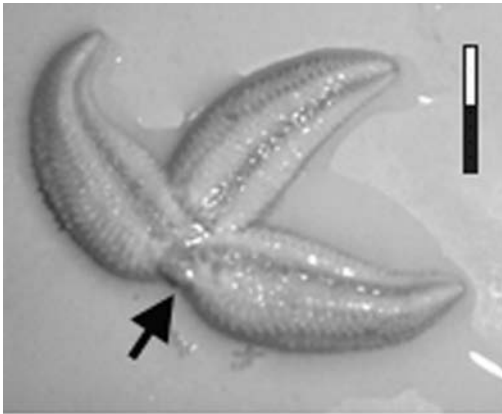


Fig. 3. *Allostichaster capensis*. Individuals recently split. Note wound sealing by contraction of the body wall. Scale bars: white 1 cm, black 1 cm.

Fig. 3. *Allostichaster capensis*. Individuos recientemente separados. Nótese el cierre de la herida por contracción de las paredes del cuerpo. Barra de escala: blanca 1 cm, negra 1 cm.

Coscinasterias calamaria that a poorer diet reduces the energy channeled into sexual reproduction and may act as a further stimulus to fission. Apparently *A. capensis* has insufficient food availability in Bahía Kaiser (Rubilar 2004). However, the proximate factors that induce fission in starfish are still poorly understood (Mladenov and Burke 1994). Discussion has focused on exogenous and endogenous stimuli.

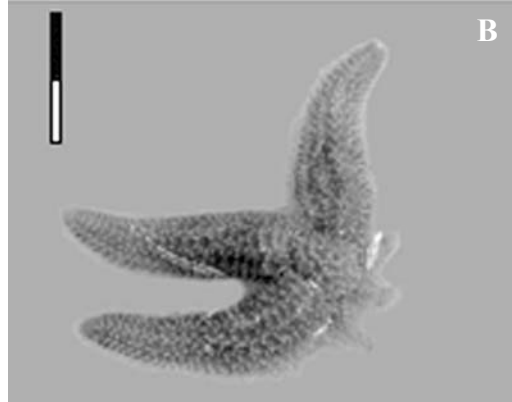


Fig. 4. *Allostichaster capensis*. Regenerating individuals. a) Individual with two non-regenerative arms producing five new arms. b) Individual with three non-regenerative arms is regenerating three new arms. Scale bars: white 1 cm, black 1 cm.

Fig. 4. *Allostichaster capensis*. Individuos regenerándose. a) individuo con dos brazos no regenerados produciendo cinco brazos nuevos. b) Individuo con tres brazos no regenerados está regenerando tres nuevos brazos. Barra de escala: blanca 1 cm, negra 1 cm.



Fig. 5. *Allostichaster capensis*. Comet six weeks after fission. Scale bars: white 1cm, black 1cm.

Fig. 5. *Allostichaster capensis*. Cometa de seis semanas luego de la fisión. Barra de escala: blanca 1 cm, negra 1 cm.

It seems possible that fission may be an important way of reproduction of some species and genera. The fact that the genus *Allostichaster* and the genus *Coscinasterias* show a seasonal pattern of fission supports this idea.

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RESUMEN

Se describe el proceso de fisión de la estrella de mar físipara *Allostichaster capensis* del Golfo Nuevo. *A. capensis* generalmente se divide en dos individuos por el plano de fisión durante la primavera, luego por el resto del año, cada mitad regenera los órganos perdidos. El proceso de fisión puede durar hasta ocho horas y la herida comienza a cicatrizar inmediatamente después de la fisión. *A. capensis* presenta una capacidad impresionante de regeneración ya que inclusive un cometa sin señales de disco regeneró dos brazos nuevos.

Palabras claves: Equinodermos, asteroideos, fisión, reproducción asexual.

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