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Reproductive biology of three ray species: *Gymnura micrura* (Bloch & Schneider, 1801), *Dasyatis guttata* (Bloch & Schneider, 1801) and *Dasyatis marianae* Gomes, Rosa & Gadig, 2000, caught by artisanal fisheries in Northeastern Brazil

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Abstract: Two hundred forty-eight specimens of *Gymnura micrura*, 154 *Dasyatis guttata* and 24 *Dasyatis marianae* were sampled. *G. micrura* and *D. guttata* juveniles represented 78 and 88% of the sample, respectively, whereas all *D. marianae* individuals were adults. The maturity size of *G. micrura* males and females was estimated from 27 to 30 cm disk width (DW) and 34 to 36 cm DW, respectively. The maturity size of *D. guttata* males and females was estimated from 41 to 46 cm DW and 50 to 55 cm DW, respectively. Birth size of *G. micrura* was estimated between 15 and 17.4 cm DW, the one of *D. guttata* between12.3 and 15.3 cm DW and the one of *D. marianae* between 13 and 14 cm DW. Female rays appeared to mature at larger sizes than males and reached a larger maximum size. *Gymnura micrura* is characterized by one functional ovary (the left) and two functional uteri. This reproductive system differs from that of the genus *Dasyatis,* in which just the left uterus is functional. Vitellogenesis in the three species proceeds simultaneously with gestation and a new cohort of ripe oocytes is ready for ovulation after parturition. *Gymnura micrura* appeared to be reproductively active throughout the year in the study area. Two litters per year and a gestation period lasting 5-6 months are suggested for *D. guttata* and *D. marianae*.

Résumé : *Reproduction de trois espèces de raies :* Gymnura micrura *(Bloch & Schneider, 1801),* Dasyatis guttata *(Bloch & Schneider, 1801) et* Dasyatis marianae *Gomes, Rosa & Gadig, 2000, capturées par les pêcheries artisanales du nord-est du Brésil.* Deux cent quarante-huit exemplaires de *Gymnura micrura*, 154 *Dasyatis guttata* et 24 *Dasyatis marianae* ont été échantillonnés. Les juvéniles de *G. micrura* et *D. guttata* représentent respectivement 78 et 88% de l'échantillon. Tous les exemplaires de *D. Marianae* étaient des adultes, la taille estimée à la naissance est de 13-14 cm de largeur de disque (DW). La première maturité sexuelle des mâles et des femelles de *G. micrura* s´établit respectivement à 27-30 cm DW et 34-36 cm DW, et la taille à la naissance correspond à 15-17,4 cm DW. La première maturité sexuelle des mâles et femelles de *D. guttata* est estimée à 41-46 cm DW et 50-55 cm DW respectivement, et la taille à la naissance a été estimée à 12,3-15,3 cm

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DW. *Gymnura micrura* est caractérisée par un ovaire (gauche) et deux utérus fonctionnels, contrairement au genre *Dasyatis* pour lequel seulement l'utérus gauche est fonctionnel. Chez les trois espèces, la vitellogenèse est simultanée à la gestation. *Gymnura micrura* semble se reproduire toute l'année sur le site étudié. Pour *D. guttata* et *D. marianae*, deux épisodes de reproduction par an et une période de gestation de 5-6 mois sont suggérés.

Keywords: Elasmobranches ● Batoids ● Reproduction ● Smooth Butterfly Ray ● Longnose Stingray ● Fish conservation

Introduction

Little information is available on the Smooth Butterfly Ray *Gymnura micrura* (Bloch & Schneider, 1801), the Longnose Stingray *Dasyatis guttata* (Bloch & Schneider, 1801) and *Dasyatis marianae* Gomes, Rosa & Gadig, 2000. The few studies include Bigelow & Schroeder (1953) on *G. micrura* and *D. guttata*, Daiber & Booth (1960) on *G. micrura* and Thorson (1983) on *D. guttata*. Hardly anything is known about their reproductive biology. Thus, the purpose of the present study is to provide information on the reproductive biology of these species and offer a point of reference for future studies. Reproductive data will help provide basic information for the management and conservation of these species, which are critically important to marine diversity (Camhi et al., 1998) and particularly vulnerable to overfishing (Holden, 1974).

Material and methods

The study area

The Smooth Butterfly Ray is a demersal species that inhabits the coastal waters of the tropical and warm-temperate belt of the Western Atlantic from Maryland (USA) to Brazil, occurring in tropical West Africa as well (Bigelow & Schroeder, 1953). *G. micrura* occurs along the entire coast of Brazil (Lessa et al., 1999), as does the Longnose Stingray, which is also a demersal ray, occurring in inshore waters at tropical-subtropical latitudes of the Western Atlantic from the Southern Gulf of Mexico and West Indies to Southern Brazil (Bigelow & Schroeder, 1953). *Dasyatis marianae* is an endemic ray from the Northeastern coast of Brazil, ranging from the state of Maranhão to the southern portion of the state of Bahia (Gomes et al., 2000).

Caiçara do Norte is located in Northeastern Brazil 150 km from the city of Natal (RN) (Fig. 1). The locals constitute a traditional community where artisanal fishery is the main activity and has the largest fishing fleet in the Northeastern Brazil in number of vessels, ranking among the five most productive fishing sites in the area (IBAMA, 2002). The area is composed of flat, sandy beaches with shallow and turbid waters. Beach rocks are present at a number of sites (Vital et al., 2003). Directly in front of Caiçara, at around 2 km from land, there are deeper 3-5 m sandbanks. The shelf is characterized by a flat morphology, alternating ripple bottoms, sandy fields and irregular forms of rocky reef substrate (Palma, 1979). The annual mean surface water temperature is 27°C, ranging from 26°C in winter to 28°C in autumn. Mean salinity is 36.4 (World Ocean Atlas, 2001)[1].

Methodology

Monthly samples lasting 12 days were taken from landings of the artisanal fleet from September 2003 to August 2004 (with the exception of January). Beach trawls (five nets with 150 m in length and 2.5 cm stretched mesh) were deployed to 3 m in depth throughout the entire year, with the exception of November and December. Trawling takes place on sandbanks from October to December. Handlines and gillnets (100 m length and stretched mesh of 3.0 cm) were deployed throughout the year, operating at depths to 30 m.

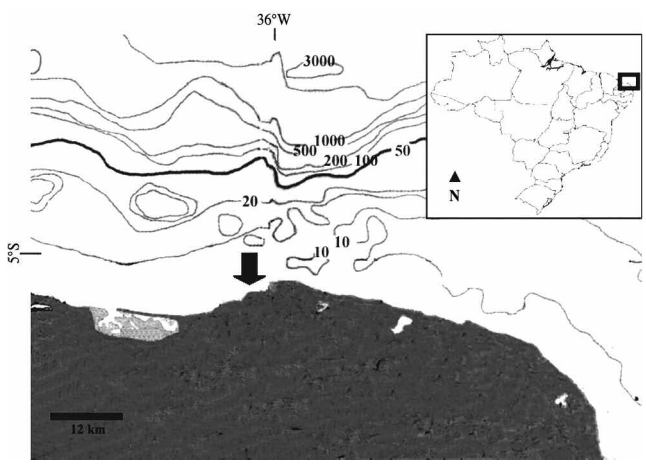

Figure 1. The study area. Arrow indicates the village of Caiçara do Norte.

Figure 1. Aire d'étude. La flèche indique la localisation de la ville de Caiçara do Norte.

[1]National Oceanographic Data Center. 2005. World Ocean Atlas 2001. Web site address: http//www.nodc.noaa.gov/oc5/woao1f/prwoa01f.html

Table 1. Monthly catches of *G. micrura* from Caiçara do Norte, Northeastern Brazil.
Tableau 1. Captures mensuelles de *G. micrura* à Caiçara do Norte, Nord-Est du Brésil.

Specimens	**Months**									
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	**Total**
Male juveniles	3	10	7	6	7	15	8	4	9	**69**
Female juveniles	8	18	21	13	17	14	10	3	21	**125**
Male subadults	1	1	1	1	2	1	3	0	0	**10**
Female subadults	0	1	0	1	1	0	3	0	0	**6**
Male adults	1	2	0	1	4	3	3	0	0	**14**
Female adults	0	1	2	3	4	5	8	0	1	**24**
Total	**13**	**33**	**31**	**25**	**35**	**38**	**35**	**7**	**31**	**248**

Measurements of ray specimens caught included: disk width (DW in cm), clasper length from posterior margin of cloaca to the tip of claspers (CL in cm) and diameter of oocytes (in mm). Estimation of size at sexual maturity were made by observing the calcification of claspers in males as well as the presence of yolky ova in the ovaries and eggs or embryos in the uterus of females. Birth size was estimated from the size of the largest embryo and the smallest neonate examined. Mean values are provided as mean value ± standard deviation (SD).

Results

Gymnura micrura

The Smooth Butterfly Ray was only caught by beach trawls. Table 1 displays the monthly collection, totaling 248 individuals (155 females and 93 males). Females were significantly more numerous than males (Table 2). This unequal sex ratio is due to juveniles, which represented 78% of the sample.

Table 2. Sex ratio for each specimen category and total sample of *G. micrura* from Caiçara do Norte, Northeastern Brazil.
Tableau 2. Sex ratio par stade de développement et pour l'échantillon total de *G. micrura* capturée à Caiçara do Norte, Nord-Est du Brésil.

Specimens	Number of females	Number of males	Ratio	
Juveniles	125	69	1.8:1	$p < 0.01$*
Subadults	6	10	1:1.6	$p = 0.3$
Adults	24	14	1.7:1	$p = 0.1$
Total	*155*	*93*	*1.6:1*	*$p < 0.01$**
Embryos	11	10	1.1:1	$p = 0.8$

* Sex ratio significantly different from 1:1 ratio at a significance level of 0.01 (Chi-Square test).

Considering clasper calcification and the relationship between clasper length and disk width, the maturity size of males was assessed between 27 and 30 cm DW (Fig. 2). Females between 34.3 and 35 cm DW bore oocytes (1-3 mm diameter) without yolk, whereas one female (36 DW) carried oocytes 5 mm in diameter with vitellogenetic activity. The smallest pregnant female measured 39.4 cm DW. Thus, maturity size of females was assessed between 34 and 36 cm DW. Birth size was assessed between 15 and 17.4 cm DW. The largest full-term embryo measured 17.4

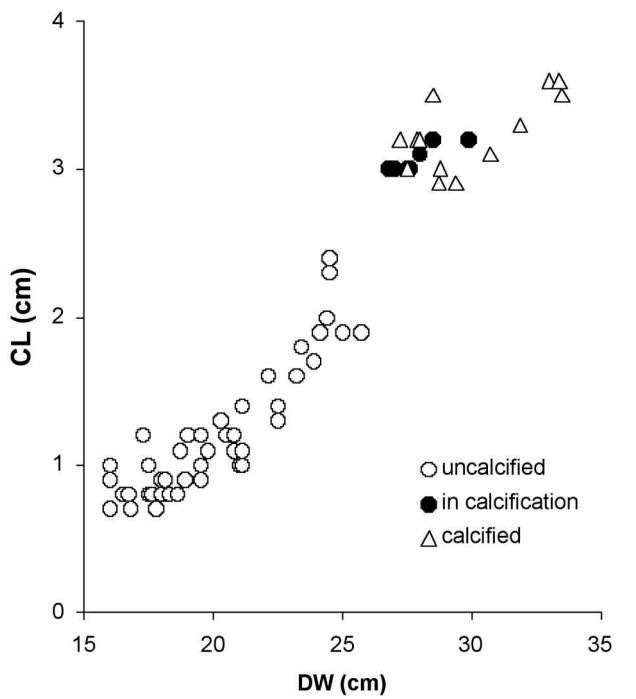

Figure 2. Relationship of clasper length (CL in cm) to disk width (DW in cm) in *G. micrura* males from Caiçara do Norte, Northeastern Brazil.
Figure 2. Longueur des ptérygopodes (CL en cm) en fonction de la largeur du disque (DW en cm) des *G. micrura* mâles capturés à Caiçara do Norte, Nord-Est du Brésil.

Table 3. Condition of ovaries and uteri of adult *G. micrura* from Caiçara (Northeastern Brazil).
Tableau 3. Condition des ovaires et utérus des algues *G. Micrura* de Caiçara (Nord-Est du Brésil)

N° of obs	Month	DW female (cm)	Ovarian activity	Oocyte diameter (mm)	Uterus content	DW embryo (cm)	Observations
1	Apr	55	rest	-	-	-	-
2	Apr	57.5	vitellogenesis	15	embryo	15.7-17.4	-
3	May	50	vitellogenesis	7	-	-	-
4	Jun	54.5	vitellogenesis	4	-	-	-
5	Jun	66	vitellogenesis	5	-	-	-
6	Jul	37.5	vitellogenesis	2.5	-	-	-
7	Jul	41	vitellogenesis	9	-	-	-
8	Jul	40.5	vitellogenesis	13	-	-	-
9	Jul	62.4	vitellogenesis	7	ova	-	-
10	Jul	61.4	rest	-	embryo	10.7-11	-
11	Aug	36	vitellogenesis	5	-	-	-
12	Aug	45.5	vitellogenesis	4	embryo	1.2-1.6	-
13	Aug	39.4	vitellogenesis	13	embryo	2.3	-
14	Aug	53.3	vitellogenesis	7	embryo	5.3-6.3	-
15	Aug	49	vitellogenesis	9	embryo	7.5-7.9	-
16	Aug	59.6	vitellogenesis	10	embryo	8.3	-
17	Aug	50	vitellogenesis	12	embryo	10.8-11.2	-
18	Aug	61	vitellogenesis	4	-	-	post-partum
19	Sep	38.8	vitellogenesis	6	-	-	-
20	Oct	46.7	vitellogenesis	17	ova	-	-

cm DW and the smallest free-living specimen measured 15 cm DW. The largest specimen sampled was a female with a 66-cm DW.

The Smooth Butterfly Ray is an aplacental viviparous species, with only the left ovary functional. The right ovary is smaller or lacking in some individuals. Both uteri are functional. The uterine mucosa of pregnant and post-partum females was clothed by uterine villi (trophonemata). Mean uterine fecundity was 3.0 ± 1.4.

Table 3 displays data on 20 adult females caught throughout the year in Caiçara. Pregnant females were actively vitellogenetic (except observation 10), with the oocyte diameter enlarging as embryos grow and a new cohort of ripe oocytes (~ 15 mm diameter) ready for ovulation shortly after parturition. Non-pregnant females also exhibited vitellogenetic activity (excepted obs. 1). The oocyte diameter did not reveal a seasonal growth pattern. Gravid females occurred in April, July, August and October. However, the embryos displayed no growth pattern throughout the year. In August, a single female was observed with an empty, distended uterus and developed trophonemata, which was considered post-partum. Neonates (size range: 15 to 17.4 cm DW and mean size: 16.3 ± 0.61) were caught throughout the sample period (Table 4).

Table 4. Monthly catches of *G. micrura* neonates from Caiçara do Norte, Northeastern Brazil. N: number of free living specimens between 15 and 17.4 cm DW (estimated birth size) caught each month.

Tableau 4. Captures mensuelles de nouveaux-nés de *G. micrura* à Caiçara do Norte, Nord-Est du Brésil. N: nombre d'individus libres nageurs entre 15 et 17,4 cm DW (grandeur de naissance estimée).

Month	N	Mean DW (mean ± SD) (cm)
Feb	1	17
Mar	1	17
Apr	6	15.8 ± 0.44
May	1	15.9
Jun	4	16.5 ± 0.41
Jul	5	16.3 ± 0.58
Aug	2	15.7 ± 1.06
Sep	5	16.2 ± 0.81
Oct	7	16.6 ± 0.43

Dasyatis guttata

Monthly collections composed 154 specimens (73 females and 81 males, Table 5). Eighteen individuals were caught at depths of down to 10 m by handlines and gillnets. However, juveniles (which represented 88% of catches) were

Table 5. Monthly catches of *D. guttata* from Caiçara do Norte, Northeastern Brazil.
Tableau 5. Captures mensuelles de *D. guttata* à Caiçara do Norte, Nord-Est du Brésil.

Specimens	**Months**										
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Male juveniles	1	9	3	16	14	6	17	1	5	0	**72**
Female juveniles	0	6	0	15	18	9	8	1	7	0	**64**
Male subadults	0	2	0	0	0	0	1	0	0	0	**3**
Male adults	0	2	2	0	0	0	1	1	0	0	**6**
Female adults	0	2	1	0	0	0	0	2	1	1	**7**
Total	**1**	**21**	**6**	**31**	**32**	**15**	**27**	**5**	**13**	**1**	**154**

captured exclusively by beach-trawl. There was no difference in sex ratio for each category of specimens or for the overall sample (Chi-Square test, expected ratio of 1:1, $p > 0.01$).

Three males with DW between 41 and 46 cm presented claspers in the process of calcification, whereas six males over 49 cm DW presented calcified claspers, suggesting a maturity size between 41 and 46 cm DW. Two females 51 to 52 cm DW carried oocytes 4 mm in diameter, with no vitellogenetic activity. However, one female 50 cm DW exhibited vitellogenetic oocytes of 9 mm. The smallest pregnant female measured 62 cm DW. Taking into account this information, the maturity size of females was estimated between 50 and 55 cm DW. The largest full-term embryo measured 15.3 cm DW and the smallest free-living specimen had 12.3 cm DW. Thus, birth size was estimated between 12.3 and 15.3 cm DW. The largest specimen sampled was a female 78.2 cm DW.

The Longnose Stingray is an aplacental viviparous species. Females possess just the left ovary and uterus functional. The right ovary and uterus are smaller or lacking. The uterine mucosa of pregnant and post-partum females was clothed by trophonemata. The gravid females analyzed carried two embryos.

Seven adult females were caught throughout the year in Caiçara (Table 6). Pregnant females exhibited active vitellogenesis, with a new cohort of ripe oocytes (~ 20 mm diameter) ready for ovulation soon after parturition. Non-gravid females also carried a cohort of ripe oocytes ready for ovulation. Adults females occurred in two distinct periods of the year, in early autumn and early spring. Two pregnant females with full-term embryos were caught in early autumn and two females with empty, distended uteri and developed trophonemata (which were considered post-partum) occurred in early-mid spring. Adult males were observed only in early autumn and early spring (Table 5). Neonates (size range: 12.3 to 15.3 cm DW and mean size: 14.4 ± 0.80) were caught throughout most of the sampling period, but were more concentrated in autumn (Table 7).

Dasyatis marianae

A total of 24 specimens (eight females and 16 males) were sampled during monthly collections (Table 8). From October to December, trawling on sandbanks caught nine males and seven females. Between April and September, another seven males and one female were caught at depths between 4 and 20 m by handlines and gillnets. There was no difference in sex ratio (Chi-Square test, expected ratio of 1:1, $p > 0.01$). All males (size range: 26.3 to 31 cm DW) had calcified claspers and were considered adults. All females (size range: 30.2 to 33.3 cm DW) were either pregnant or in the post-partum phase (empty, distended

Table 6. Condition of ovaries and uteri of adult *D. guttata* from Caiçara (Northeastern Brazil).
Tableau 6. Condition des ovaires et utérus des femelles adultes de *D. guttata* capturées à Caiçara do Norte, Nord-Est du Brésil.

N°	Month	DW female (cm)	Ovarian activity	Oocyte diameter (mm)	Uterus content	DW embryo (cm)	Observations
1	Mar	62	vitellogenesis	20	embryo	15-15.3	-
2	Mar	68	vitellogenesis	19	embryo	14.8-15	-
3	Apr	76	vitellogenesis	20	-	-	-
4	Sep	78.2	vitellogenesis	20	-	-	-
5	Sep	62.5	vitellogenesis	18	-	-	-
6	Oct	56	vitellogenesis	19	-	-	post-partum
7	Nov	61	vitellogenesis	20	-	-	post-partum

Table 7. Monthly catches of *D. guttata* neonates from Caiçara do Norte, Northeastern Brazil. N: number of free living specimens between 12.3 and 15.3 cm DW (estimated birth size) caught in each month.

Tableau 7. Captures mensuelles de nouveaux-nés de *D. guttata* à Caiçara do Norte, Nord-Est du Brésil. N: nombre d'individus libres nageurs entre 12,3 et 15,3 cm DW.

Month	N	Mean DW (mean ± SD) (cm)
Feb	0	-
Mar	6	14.1 ± 0.84
Apr	2	13.7 ± 2.05
May	4	14.9 ± 0.33
Jun	10	14.4 ± 0.68
Jul	1	13.5
Aug	3	14.6 ± 0.38
Sep	0	-
Oct	1	15.3

uterus, with developed trophonemata). Females possess just the left ovary and uterus functional. The right ovary and uterus are smaller or lacking. Only a single embryo was found per female.

Eight females were observed (Table 9). Gravid females exhibited vitellogenesis proceeding simultaneously with gestation. Pregnant and post-partum females were caught in spring, the exception was one post-partum female sampled in June. The embryos observed in November and December (obs. 7 and 8 respectively) were well developed and there was an absence of yolk sac, with a scar replacing the umbilical stalk. They were therefore considered full-term and birth size was estimated at about 13-14 cm DW.

Discussion

Juvenile *G. micrura* females were significantly more numerous than juvenile males. This disparity could be explained by a higher mortality rate among newborn males or may be related to sexual segregation in early stages of life. The predominance of *G. micrura* and *D. guttata* juveniles in the samples indicates the use of the shallow waters of Caiçara as a nursery ground (Yokota & Lessa, 2006). It also indicates depth segregation, with the adults living in deeper waters.

The relation between the size and state of sexual development found in the present study is relevant due to the lack of data on the species studied. Female rays from Caiçara appear to mature at larger sizes than males and reach larger maximal sizes. This is probably linked to reproductive strategies in viviparous elasmobranch species (Capapé, 1986; Mellinger, 1989).

In the present study, maturity size for *G. micrura* males and females was assessed between 27 and 30 cm DW and between 34 and 36 cm DW, respectively, and birth size was assessed between 15 and 17.4 cm DW. Bigelow & Schroeder (1953) noted that a *G. micrura* male of 42 cm DW was nearing maturity considering the length of its claspers and that females produce young only when 62.5 to 65 cm DW (citing Gudger, Proc. biol. Soc. Wash., 26, 1913: 100; Radcliffe, Bull. U. S. Bur. Fish., 34, 1916: 277). Birth size might be 15 cm DW (citing Smith, N. C. geol. econ. surv., 2, 1907: 45) to 22.5 cm DW and maximum size may be 121.6 cm DW. Daiber & Booth (1960) indicated that a female 66.9 cm DW was probably becoming sexually mature and found gravid females only with 80 cm DW and embryos with 25.6 cm DW. These findings refer to specimens from the North Atlantic.

The size at first maturity and birth size estimated for *G. micrura* from Caiçara was notably smaller than those estimated for the species along the Atlantic coast of the United States. These data allow us to speculate that differences between Northern Atlantic and Southern Atlantic *G. micrura* would be enough to distinguish two distinct species.

A maturity size between 41 and 46 cm DW was assessed for *D. guttata* males and between 50 and 55 cm DW for females, with birth sizes estimated between 12.3 and 15.3 cm DW. Bigelow & Schroeder (1953) pointed out that the claspers of a male *D. guttata* 45 cm DW were still rudimentary, whereas the size at birth would be somewhat greater than 15 cm DW. However, in analyzing data from Pernambuco, 600 km from Caiçara, the relationship between clasper-length and disk-width depicted a sharp inflection around 45 cm DW (ETEPE, 1995). With data from the state of Maranhão (Northern Brazil), Menni &

Table 8. Monthly catches of *D. marianae* from Caiçara do Norte, Northeastern Brazil.
Tableau 8. Captures mensuelles de *D. Marianae* à Caiçara do Norte, Nord-Est du Brésil.

Specimens	**Months**											
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**Total**
Male adults	0	0	1	1	1	3	0	1	3	4	2	**16**
Female adults	0	0	0	0	1	0	0	0	1	5	1	**8**
Total	**0**	**0**	**1**	**1**	**2**	**3**	**0**	**1**	**4**	**9**	**3**	**24**

Table 9. Condition of ovaries and uteri of adult *D. marianae* from Caiçara (Northeastern Brazil).
Tableau 9. Condition des ovaires et utérus des femelles adultes de *D. marianae* capturées à Caiçara (Nord-Est du Brésil).

N°	Month	DW female (cm)	Ovarian activity	Oocyte diameter (mm)	Uterus content	DW Embryo (cm)	Observations
1	Jun	31.3	rest	-	-	-	post-partum
2	Oct	32	vitellogenesis	6	embryo	7.4	-
3	Nov	32.2	vitellogenesis	22	-	-	post-partum
4	Nov	33.3	vitellogenesis	5	embryo	4.9	-
5	Nov	30.6	vitellogenesis	22	-	-	post-partum
6	Nov	28.6	vitellogenesis	11	-	-	post-partum
7	Nov	30.2	vitellogenesis	9	embryo	13	-
8	Dec	32.4	vitellogenesis	23	embryo	13.8	-

Lessa (1998) stated that males became mature at about 51.5 cm DW. Thorson (1983) estimated that males start maturation between 40 and 45 cm DW and become fully mature between 55 and 60 DW; females start sexual maturation at about 55 cm DW and attain sexual maturity at about 75 cm DW; size at birth was estimated between 16 and 17.5 cm DW. The slight differences between maturity and birth sizes for the Longnose Stingray from Caiçara and those from others regions may be caused by differences related to latitude and/or environmental variations (Nikolskii, 1969; Capapé et al., 2007). For *D. marianae,* no records on maturity or birth size were found in the literature.

Among viviparous rays, the right ovary and uterus undergo varying degrees of reduction or loss (Wourms, 1977). *Gymnura micrura* is characterized by one functional ovary (the left), producing ripe oocytes and two functional uteri, as in other species from the genus (Daiber & Booth, 1960; Capapé et al., 1992). This reproductive system differs from that of the genus *Dasyatis,* in which just the left uterus is functional. Having only a functional left ovary and oviduct appears to be the general rule among dasyatids (Bigelow & Schroeder, 1953; Babel 1967; Struhsaker, 1969; Thorson, 1983; Capapé, 1993). The presence of trophonemata is characteristic of stingrays (Babel, 1967) and permits *G. micrura*, *D. guttata* and *D. marianae* to be classified as matrotrophic viviparous species, in which the female plays an important role in embryonic growth (Wourms, 1981).

The lack of a seasonal growth pattern in oocyte diameter and embryo size and the occurrence of neonates throughout sample period suggest that the Smooth Butterfly Ray is reproductively active throughout the year in the study area. The greater incidence of gravid females in August is probably related to beach trawling, which was mostly concentrated in a sandy area that allows access to slightly deeper waters (4-5 m).

This reproductive pattern contrasts with those found for gymnurids from temperate waters, where parturition occurs in well-defined periods of the year (Daiber & Booth, 1960; Capapé, 1974; Capapé et al., 1992). It concurs, however, with the idea of Bigelow & Schroeder (1953) that "in the tropical parts of its range, where the water temperature changes but little from season to season, newborn *G. micrura* may be expected throughout the year". The duration of the gestation period is unknown, as is the number of litters per year. However, gestation may last few months, as in other gymnurids (Daiber & Booth, 1960; Capapé, 1974; Capapé et al., 1992).

The occurrence of adult Longnose Stingrays exclusively during early autumn and early spring (including two pregnant females with full-term embryos in autumn and two post-partum females in spring) suggest two breeding seasons per year. A greater number of neonates was observed in autumn and, as no samples from beach trawling were taken in November or December, a peak may have existed in spring. As the vitellogenesis proceeds simultaneously with gestation and a new cohort of ripe oocytes is ready for ovulation soon after parturition, gestation probably lasts about 5-6 months.

The capture of post-partum and full-term pregnant *D. marianae* females in spring indicate this season to be the parturition time, but the observation of a port-partum female in June could suggest two litters per year. If this is true, as a new cohort of ripe oocytes is ready for ovulation soon after parturition, gestation could last about 5-6 months, as with *D. guttata*.

A gestation period lasting between two and six months is characteristic of dasyatids (Ranzi, 1932; Wourms, 1977). Although among dasyatids and other myliobatiformes reproductive cycles with one breeding season per year have been suggested (Struhsaker, 1969; Capapé, 1974; Thorson, 1983; Smith & Merriner, 1986; Martin & Cailliet, 1988; Snelson et al., 1988; Villavicencio-Garayzar et al., 1994; Seck et al., 2002; Ismen, 2003), the possibility of reproductive cycles involving more than one litter per year has been considered (Babel, 1967; Capapé, 1974; Thorson, 1983; Capapé, 1993; Capapé & Zaouali, 1995).

Fish from low latitudes tend to exhibit prolonged spawning, a greater number of spawning cycles per year, or even reproduction throughout the year, mainly due to lesser seasonal variations in food supply and consequently longer period of adequate food supply for the young, whereas a halt in feeding is rather prominent in temperate zones (Nikolskii, 1969). The reproductive strategies proposed in the present study may be due to the constant warmer waters of the Caiçara do Norte region throughout the year, which appears to provide the rays species with good environmental conditions and protected nursery grounds (Yokota & Lessa, 2006).

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