A CASE OF HERMAPHRODITISM IN TORTONESE’S STINGRAY, *DASYATIS TORTONESEI* (ELASMOBRANCHII: RAJIFORMES: DASYATIDAE) FROM THE LAGOON OF BIZERTE, TUNISIA

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Abstract. A normal hermaphroditic Tortonese’s stingray, *Dasyatis tortonesei* Capapé, 1975, captured in the brackish Lagoon of Bizerte (north-eastern Tunisia) is described in this note. It was a large specimen measuring 685 mm total length, 350 mm disk width, and 2190 g of the total body mass. The specimen externally presented medial cuspidate tooth rows on both jaws, and two claspers were present, that were rigid and calcified although shorter than those observed in normal specimens. The dissection of the abdominal cavity revealed on each side, an ovary normally developed that contained yolked oocytes, a complete genital tract and an uterus less developed than in normal adult. Conversely the testes were rudimentary, both Leydig’s glands were developed and a complete, slightly convoluted, male duct existed on the left side only. In all, 13 cases of normal (4) and abnormal (9) hermaphroditism, including the Tunisian *D. tortonesei*, have been found in batoid species, to date, confirming that the phenomenon is very rare among these chondrichthyan fishes.

Keywords: *Dasyatis tortonesei*, normal hermaphrodite, Lagoon of Bizerte, Tunisia, central Mediterranean

The Tortonese’s stingray, *Dasyatis tortonesei* Capapé, 1975, was described from specimens caught off the Tunisian coast (Capapé 1975, 1977). The species, however, was considered a junior synonym of the common stingray *D. pastinaca* (L.) by Séret and McEachran (1986), then re-instated as a valid species by Golani (2005) and Saad et al. (2005), based on the specimens caught in the eastern Levant Basin, and by Neifar et al. (2000) who studied the specimens caught in Tunisian waters. Kabasakal (2002) recorded *D. tortonesei* from Turkey. Outside the Mediterranean Sea, Diatta et al. (2001) recorded the species off Senegal, while Beveridge et al. (2004) considered its occurrence as possible in the Bassin of Arcachon (Atlantic coast of France).

The occurrence of *D. tortonesei* was reported from the entire stretch of the Tunisian coast (Bradaï et al. 2004), although it was the most common in southern areas, especially in the Gulf of Gabès, and less common in northern areas such as the Gulf of Tunis (Capapé 1989). Two specimens were first recorded on 16 January 2009 by El Kamel et al. (2009a), in the brackish Lagoon of Bizerte, located in north-eastern Tunisia (Fig. 1). Furthermore, survey conducted in the area, between January 2007 and May 2012 yielded 25 additional specimens. In total, 27 specimens were observed including 13 males, 13 females, and an abnormal specimen, described the present note.

The abnormal specimen was captured on 14 May 2010, from the depth of approximately 9 m, on soft bottom, off Menzel Abderrahman, close to the nautical channel (37°13′03.67″N and 9°49′32.28″E), using commercial gill-nets of 40 mm stretched mesh (Fig. 2). Immediately after the capture, total length (TL) and disk width (DW) were measured to the nearest mm, and total mass weighed to the nearest g (Fig. 3). Additionally, some organs were removed from the abdominal cavity and weighed to the nearest g.

The abnormal *D. tortonesei* was 685 mm TL, 350 mm DW and weighed 2190 g. Morphometric measurements and meristic counts, following the methodology of Golani and Capapé (2005), are given in Table 1. Two other specimens of *D. tortonesei* caught in the Lagoon of Bizerte...
Fig. 1. Map of the Mediterranean showing Tunisia and map of the coast of Tunisia showing the collection site of hermaphrodite Tortonese’s stingray, *Dasyatis tortonesei* (Lagoon of Bizerte).

Fig. 2. Map of the Lagoon of Bizerte pointing out the capture site (black star) of the hermaphrodite specimen of *Dasyatis tortonesei*.

Fig. 3. Hermaphrodite specimen of *Dasyatis tortonesei* (FSB-D-tort 03) caught in the Lagoon of Bizerte, Tunisia; Scale bar = 100 mm.
### Table 1

Morphometric measurements (in mm and as % TL), meristic counts and masses recorded in the hermaphroditic specimen of *Dasyatis tortonesei* (FSB-D-tort 03) and comparison with two specimens (FSB-D-tort 04, FSB-D-tort 05) from the Lagoon of Bizerte.

| Sex              | FSB-D-tort 03          | %DW | FSB-D-tort 04          | %DW | FSB-D-tort 05          | %DW |
|------------------|------------------------|-----|------------------------|-----|------------------------|-----|
| **Total mass [g]** | 2190                   | 167.07 | 19768                  | 688 | 185.95                 | 1700 |
| **Total length**  | 685                    | 85.37 | 308                    | 89.28 | 300                    | 81.08 |
| **Disk-length**   | 410                    | 100.00 | 345                    | 100.00 | 370                    | 100.00 |
| **Disk width**    | 70                     | 17.07 | 47                     | 13.71 | 64                     | 17.32 |
| **Eyeball width** | 16                     | 3.90  | 17                     | 4.97  | 17                     | 4.46  |
| **Cornea**        | 13                     | 3.17  | 13                     | 3.80  | 14                     | 3.80  |
| **Pre-orbital length** | 68                   | 16.59 | 63                     | 18.26 | 59                     | 15.86 |
| **Inter-orbital width** | 40                 | 9.76  | 42                     | 12.42 | 32                     | 8.58  |
| **Disk-length**   | 29                     | 7.07  | 28                     | 8.21  | 26                     | 7.11  |
| **Disk width**    | 19                     | 4.63  | 20                     | 5.88  | 16                     | 4.24  |
| **Inter-nasal width** | 39                | 9.51  | 35                     | 10.23 | 33                     | 9.02  |
| **Nasal curtain** | 44                     | 10.73 | 41                     | 12.02 | 39                     | 10.41 |
| **Interspiracular width** | 64            | 15.61 | 67                     | 19.38 | 59                     | 15.99 |
| **Pre-oral length** | 70                    | 17.07 | 65                     | 18.85 | 57                     | 15.31 |
| **Mouth width**   | 42                     | 10.24 | 35                     | 10.06 | 34                     | 9.26  |
| **First gill slit** | 11                    | 2.68  | 12                     | 3.53  | 12                     | 3.19  |
| **Second gill slit** | 12                   | 2.93  | 12                     | 3.43  | 13                     | 3.41  |
| **Third gill slit** | 13                    | 3.17  | 11                     | 3.29  | 13                     | 3.64  |
| **Forth gill slit** | 13                    | 3.17  | 95                     | 27.54 | 12                     | 3.36  |
| **Fifth gill slit** | 9                     | 2.20  | 8                      | 2.21  | 6                      | 1.74  |
| **Width between first gill slit** | 80             | 19.51 | 73                     | 21.25 | 72                     | 19.44 |
| **Width between fifth gill slit** | 50             | 12.20 | 44                     | 12.73 | 45                     | 12.04 |
| **Snout tip to eye** | 83                    | 20.24 | 69                     | 20.07 | 70                     | 19.01 |
| **Snout tip to mouth** | 72                    | 17.56 | 69                     | 20.07 | 55                     | 14.95 |
| **Snout tip to first gill slit** | 107               | 26.10 | 100                    | 28.98 | 96                     | 26.00 |
| **Snout tip to fifth gill slit** | 166               | 40.49 | 148                    | 42.76 | 141                    | 38.14 |
| **Snout tip to pelvic fin** | 310               | 75.61 | 265                    | 76.81 | 260                    | 70.27 |
| **Snout tip to sting** | 455               | 110.98 | 418                   | 121.16 | 420                    | 113.51 |
| **Sting length**  |                        |       |                        |       |                        |       |
| **Snout tip to vent** | 293            | 71.46 | 270                    | 78.26 | 275                    | 74.32 |
| **Pectoral fin anterior margin** | 240         | 58.54 | 205                    | 59.42 | 220                    | 59.46 |
| **Pectoral fin posterior margin** | 227       | 55.37 | 200                    | 57.97 | 220                    | 59.46 |
| **Pectoral fin inner margin** | 52            | 12.68 | 43                     | 12.59 | 31                     | 8.42  |
| **Pelvic fin anterior margin** | 59           | 14.39 | 61                     | 17.67 | 63                     | 17.00 |
| **Pelvic fin posterior margin** | 40          | 9.76  | 52                     | 15.11 | 53                     | 14.22 |
| **Pelvic fin inner margin** | 21            | 5.12  | 16                     | 4.63  | 26                     | 6.91  |
| **Pelvic fin base** | 34            | 8.29  | 30                     | 8.74  | 49                     | 13.21 |
| **Span of pelvic fin** | 142          | 34.63 | 148                    | 43.01 | 142                    | 38.25 |
| **Clasper length** | 90            | 21.95 | 137                    | 39.71 | —                      | 0.00  |
| **Tail base width** | 36            | 8.78  | 28                     | 8.16  | 29                     | 7.96  |
| **Tail base depth** | 21            | 5.12  | 21                     | 6.01  | 20                     | 5.39  |
| **Tail length**   | 365          | 89.02 | 395                    | 114.49 | 380                    | 102.70 |
| **Ventral tail fold length** | 113         | 27.56 | 102                    | 29.48 | 129                    | 34.86 |
| **Dorsal tail fold length** | 42            | 10.24 | 25                     | 7.25  | 18                     | 4.96  |

**Counts**

| Oral papillae         | 29 | 28 | 28 |
|-----------------------|----|----|----|
| Bucal papillae        | 1 + 3 + 1 | 1 + 3 + 1 | 1 + 3 + 1 |
| Teeth rows upper jaw  | 47 | 45 | 45 |
| Teeth rows lower jaw  | 42 | 39 | 42 |
were added for comparison. The parameters presented in Table 1 were consistent with previous accounts of *D. tortonesei* provided by Capapé (1977) and McEachran and Capapé (1984). The three specimens were preserved and deposited in the Ichthyological Collection of the Faculté des Sciences de Bizerte, with catalogue numbers, FSB-D-tort 03, 04, and 05 respectively.

The analysis of the medial tooth rows on both jaws of the abnormal specimen showed that they were the typical cuspidate teeth of males, described in dasyatid species (McEachran and Capapé 1984). Both claspers were present, rigid and calcified but shorter than those observed in normal specimens (Capapé 1983); additionally their distal end was not elongate and sharp but broadly rounded, although entirely covered by skin; no scar was visible; the teeth were probably functional (Fig. 4). Both claspers were measured following methodology of Collenot (1969), the left clasper, 90 mm, being slightly smaller than the right one, 92 mm. Additionally, the clasper of the hermaphrodite specimen was smaller that this of the normal specimen of similar size (Table 1). The loss of tail clasper was the consequence of an abnormal development during growth, and not the result of a predation, such pattern was rather reported for tail of skate species (Mnasri et al. 2009, Orlov 2011).

Dissection of the abdominal cavity allowed the primary sexual characters to be investigated (Fig. 5). Two ovaries were present and contained large yolked oocytes (Fig. 6); the left ovary weighed 35.9 g and contained 16 oocytes ranging in diameter from 17 to 21 mm, the right ovary weighed 22.9 g and contained 16 oocytes ranging in diameter from 13 to 18 mm. Both spermiducts were developed, the oviducal gland was more developed in the right side, while two uteri were present, the left uterus appeared to be more developed than the right one, but less than those generally observed in normal female specimens. Occurrence of two ovaries and two uteri could be considered a morphological aberration in a dasyatid species, in which only a single ovary and a single uterus are functional in large specimens (Mellinger 1989).

The specimen exhibited two Leydig’s gland normally developed and two rudimentary testes, both spermiducts were present and slightly convoluted, although no sperm was found in either ducts. In adult male of *D. tortonesei*, as in other dasyatid species, the genital apparatus is typically fully developed on both sides (Capapé 1978,
Mellinger 1989). The liver mass was 123.9 g, the digestive tract mass was 67.7 g. The gut contained remains of food totally digested and unidentifiable, weighing approximately 1 g.

Of the three categories of abnormalities reported by Dawson (1964, 1966, 1971) and Dawson and Heal (1971) in chondrichthians, hermaphroditism is probably the most interesting due to the fact that it directly concerns reproductive organs and reproduction. Atz (1964) noted that hermaphroditism was rarely recorded in chondrichthians. Two types of hermaphroditism are generally reported in chondrichthians such as ‘abnormal hermaphrodite’ and ‘normal hermaphrodite’ following Atz (1964) and Iglésias et al. (2005), defined also as ‘pseudo-hermaphrodite’ and ‘true hermaphrodite’ by Irvine et al. 2002. Normal hermaphrodites or true-hermaphrodites exhibit internally both sexes with claspers and when mature it could assume functions of both male and female, all other cases of hermaphroditism would be defined as abnormal or pseudo-hermaphroditism (Irvine et al. 2002, Iglésias et al. 2005). Additionally, Atz (1964) and Bortone and Davis (1994) noted that intersexuality is considered when primary or secondary characters of both sexes are present in a same specimen.

Externally, the studied specimen exhibited, male secondary characters such as cuspidate teeth and claspers. Internally, it possessed developed female organs and yolked oocytes of ovulatory size; so it could be considered a functioning adult female. On the other hand, the male reproductive organs are consistent with a sub-adult male, totally developed in the left side only, even if the structure of both claspers are characteristic of an adult.

Fig. 5. Ventral view of the abdominal cavity of the hermaphrodite specimen of Dasyatis tortonesei caught in the Lagoon of Bizerte, Tunisia; showing on left side (L) and on right side (R): Leydig’s gland (LG), oviducal gland (OG), ovary (Ova), oviduct (Ovd), spermiduct (S), testis (T), uterus (Ut); Scale bar = 40 mm
Fig. 6. Left ovary (L Ova) and right ovary (R Ova) removed from the abdominal cavity of the hermaphrodite specimen of *Dasyatis tortonesei* caught in the Lagoon of Bizerte, Tunisia; oocyte (Ooc); Scale bar = 25 mm

Table 2

Normal and abnormal cases of hermaphroditism recorded in batoid species from other marine regions, including the specimen described in this note

| Family            | Species                  | Hermaphroditism | Reproductive mode | Capture site                  | Reference                      |
|-------------------|--------------------------|-----------------|-------------------|-------------------------------|--------------------------------|
| Rhinobatidae      | *Rhinobatos horkelii*    | Normal          | Aplacental        | Southern coast of Brazil      | Gianeti and Vooren 2007        |
| Narcinidae        | *Narcine timlei*         | Normal          | Aplacental        | Coast of India                | Nair and Soundararajan 1973    |
| Torpedinidae      | *Torpedo marmorata*      | Abnormal        | Aplacental        | Coast of Tunisia              | Capapé 1974                    |
| Torpedinidae      | *Torpedo torpedo*        | Abnormal        | Aplacental        | Coast of Tunisia              | Quignard and Negla 1971        |
| Arhynchobatidae   | *Bathyraja multispinis*  | Abnormal        | Oviparous         | Coast of Argentina            | Scenna et al. 2007             |
| Rajidae           | *Raja asterias*          | Abnormal        | Oviparous         | French Mediterranean coast    | Quignard and Negla 1971        |
| Rajidae           | *R. clavata*             | Abnormal        | Oviparous         | British waters                | Matthews 1895                  |
|                   |                          |                 |                   |                               | *(in Atz 1964)*                |
| Rajidae           | *R. clavata*             | Abnormal        | Oviparous         | ?                             | Hoek 1894                      |
|                   |                          |                 |                   |                               | *(in Atz 1964)*                |
| Rajidae           | *R. miraletus*           | Normal          | Oviparous         | Coast of Tunisia              | Quignard and Capapé 1972       |
| Rajidae           | *R. miraletus*           | Abnormal        | Oviparous         | Coast of Tunisia              | Quignard and Capapé 1972       |
| Dasyatidae        | *Dasyatis tortonesei*    | Normal          | Aplacental        | Lagoon of Bizerte (Tunisia)   | This study                     |
| Dasyatidae        | *Pteroplatytrygon violacea* | Abnormal      | Aplacental        | Southern coast of Brazil      | Ribeiro-Prado et al. 2009      |
| Myliobatidae      | *Aetomylaeus nicholii*   | Abnormal        | Aplacental        | Indian Ocean (off Pakistan?)  | Capapé and Desoutter 1979      |
male. It appears that the specimen could subsequently assume the function of male, but such hypothesis remains suitable. The specimen was a normal or true hermaphrodite following the definitions of Atz (1964), Irvine et al. (2002), and Iglesias et al. (2005). The presently reported observation is likely to be the first case of a true hermaphrodite in a dasyatid species. Previously, Ribeiro-Prado et al. (2009) described an abnormal hermaphrodite of the pelagic stingray, *Pteroplatytrygon violacea* (Bonaparte, 1832).

Although such abnormalities are considered rare in chondrichthians, a high percentage of true hermaphrodites were observed in the brown lantern shark, *Etmopterus unicolor* (Engelhardt, 1912), by Yano and Tanaka (1989) and the black dogfish, *Centroscyllium fabricii* (Reinhardt 1825), by Yano (1995), while Iglesias et al. (2005) stated that hermaphroditism is the normal condition of reproduction in the longhead catshark, *Apristurus longicephalus* Nakaya, 1975. No similar patterns were reported in batoid species, from which, few instances were recorded, only 15, to date (Table 2).

The causes of hermaphroditism in chondrichthians remain obscure. Atz (1964) noted that they may be due to endogenous-, hormonal-, or genetic factors as in other vertebrate species. Abnormalities in fish species occur during the early stages of development and could constitute an important indicator on unfavourable environmental conditions and pollutants, induced stress in the wild (Sfakianakis et al. 2004). Heavy metals such as Cd, Pb, Zn, and Cu are suspected to cause reduction or absence of fins (Sloof 1982). Several cases of abnormalities were described from animal species collected in the Lagoon of Bizerte, a restricted brackish area polluted by both inorganic and organic nutrients and heavy metals (Mzoughi et al. 2002, Harzallah 2003). Louiz et al. (2007) noted that skeletal deformities observed in 3 gobid species were significantly higher in the areas severely polluted. Such pollution could explain why abnormal specimens of *Torpedo torpedo* (L.) were reported from the Lagoon of Bizerte (Ben Brahim and Capapé 1997, Ben Brahim et al. 1998, El Kamel et al. 2009b, Mnasri et al. 2010, El Kamel-Brahim and Capapé 1997, Ben Brahim et al. 1998, Ben Salem S. 2004. Ichthyofaune autochtone et exotique des côtes tunisiennes: Recensement et biogéographie. Cybium 28 (4): 315–328.

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