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ON THE RECENT OCCURRENCE OF ELASMOBRANCH SPECIES IN TUNIS SOUTHERN LAGOON (NORTHERN TUNISIA, CENTRAL MEDITERRANEAN)

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ABSTRACT

During the investigations conducted after an environmental restoration of the Tunis Southern Lagoon, close to the Gulf of Tunis (northern Tunisia), seven elasmobranch species were collected for the first time in the area: Rhinobatos cemiculus, R. rhinobatos, Torpedo marmorata, T. torpedo, Raja radula, Dasyatis pastinaca *and* Pteromylaeus bovinus. *Three species*, R. rhinobatos, T. torpedo *and* P. bovinus, *seem to live permanently in the area. The seven species are described and their uncommon occurrence commented.*

Key words: elasmobranchs, environmental restoration, Tunis Southern Lagoon, Tunisia, Mediterranean

RECENTE SEGNALAZIONE DI VARIE SPECIE DI RAZZE NELLA LAGUNA MERIDIONALE DI TUNISI (TUNISIA SETTENTRIONALE, MEDITERRANEO CENTRALE)

SINTESI

Nel corso di ricerche condotte dopo un intervento di rinnovo ambientale nella laguna meridionale ai margini del Golfo di Tunisi (Tunisia settentrionale), sono state segnalate sette specie di Elasmobranchii: Rhinobatos cemiculus, R. rhinobatos, Torpedo marmorata, T. torpedo, Raja radula, Dasyatis pastinaca *e* Pteromylaeus bovinus. *Sembra che le specie* R. rhinobatos, T. torpedo *e* P. bovinus *siano divenute stanziali. Gli autori descrivono tutte e sette le specie ed esaminano le ragioni che hanno portato alla loro presenza nella zona.*

Parole chiave: Elasmobranchii, rinnovo ambientale, laguna meridionale di Tunisi, Tunisia, Mediterraneo

INTRODUCTION

Records of elasmobranch species are rarely reported from perimediterranean lagoons and generally considered to be occasional, probably due to fortuitous events (Paris & Quignard, 1971; Quignard & Zaouali, 1980, 1981; Rhomdane, 1985).

However, in the Bahiret El Biban, a hyperhaline lagoon located in southern Tunisia, adjoining the Gulf of Gabès, Capapé *et al. (in press)* noted five species, at least, developing and reproducing in the area. By contrast, Zaouali (1977) reported a non-occurrence of elasmobranch species in both Tunis Northern and Southern Lagoons, adjoining the Gulf of Tunis, in northern Tunisia (Fig. 1). Both areas have been recently subjected to environmental restoration and, soon after, investigations were conducted in order to assess its effects on both areas (Ben Charrada, 1992; Ben Maiz, 1997; Vandenbroek & Ben Charrada, 2001; Ben Souissi, 2002; Ben Souissi *et al.*, 2003).

During the investigations focusing on ichthyological fauna from the Tunis Southern Lagoon, 65 species were identified, 51 of which were recorded for the first time in the area, including seven elasmobranch species (Ben Souissi *et al., in press)*. These species are presented and described in the present article and their occurrence commented in greater detail.

MATERIAL AND METHODS

Formerly, the Tunis Southern Lagoon covered 1,120 ha, with depths ranging from 0.15 to 1.1 m; the average depth was about 0.6 m. As a consequence of an ecological restoration, the surface has been considerably reduced, now covering 720 ha, with a regular depth of about 2.10 m throughout the lagoon, except in restricted areas where it reaches 4 m at the most (Ben Souissi *et al., in press*). It appears as an elongated ellipse directed SW-NE: 36°17′53.4″ and 36°47′48.0″ N, and 10°12′22.2″ and 10°16′41.4″ E. Its northern border is the navigation channel, which is 10 km long and max. 12 m deep (Fig. 2).

Before the lagoon's ecological rehabilitation, the average monthly salinity ranged between 30.9 and 48.9 psu, with a peak of 51.9 psu that occurred in 1995; after rehabilitation it ranged between 37 and 38.3 psu and the monthly average was 37.8 psu (Ben Souissi *et al.*, 2003).

By contrast, both monthly and annual temperature values did not show significant differences before and after the rehabilitation (Ben Souissi *et al.*, 2003).

Our investigations were regularly conducted between 2001 and 2004, three times at least per week. Elasmobranch species were collected soon after they were landed. They were mainly caught by gill-nets and trammel nets, occasionally by cast-nests, landing-nets, anglers and diving. Fresh and sometimes alive specimens were examined.

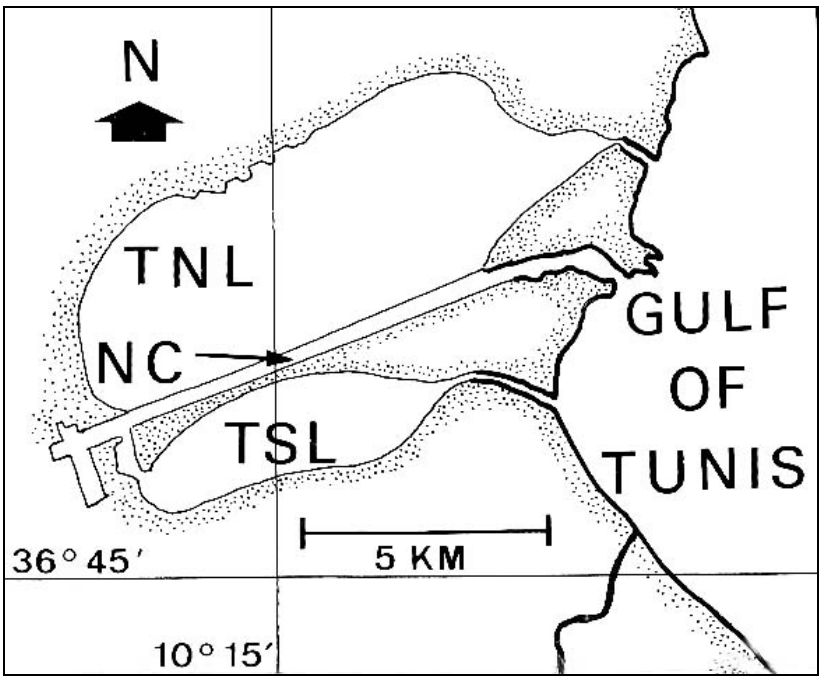

Fig. 1: Map of Tunis Lagoon showing both Tunis Northern Lagoon (TNL) and Tunis Southern Lagoon (TSL), and navigation channel (NC) after the environmental restoration.
Sl. 1: Zemljevid Tuniške lagune s severno (TNL) in južno laguno (TSL) in navigacijskim kanalom (NC) po okoljski prenovi.

Methods of measurements and counts are given following Tortonese (1956), Bini (1967), Hulley (1970, 1972), Capapé & Quignard (1975), Capapé *et al.* (1981), Cowley & Compagno (1993). For males, the clasper length was measured following Collenot (1969). For rhinobatids and torpedinids, total length (TOT) and for skates and rays, disk-width (DW) were used for percentage references.

All the specimens described below are preserved, each with its catalogue number, in 5% buffered formaline in the Ichthyological Collection of the Institut National Agronomique de Tunis (INAT).

RESULTS

Seven species belonging to five families were recorded in the Tunis Southern Lagoon.

Family Rhinobatidae

Blackchin guitarfish *Rhinobatos cemiculus* (E. Geoffroy Saint-Hilaire, 1817)

The specimen under Cat. No. RHI-Rhc-02 (Fig. 3) was captured on 28 October 2004 by gill-net in the mid-part of the lagoon, at a depth of ca. two metres, on sandy-muddy-detritic bottom partially covered with macroalgae such as *Cladophora vagabunda* (Linnaeus, 1758). It was 823 mm TOT and weighed 1701 g.

Disk sub-triangular with snout elongated, acute at distal end and tip strongly rounded, anterior margin slightly convex at level of eyes, posterior and inner margins rounded. Rostral ridges narrowly separated, slightly converging at midline. Pelvic fins quite separate from pectoral fins, sub-triangular and acute at distal end. First dorsal fin largely behind tip of pelvic fins. Anterior nasal lobes not reaching to level of inner corner of nostril. Tail large and broad distinctly marked off the disk broadly depressed dorso-ventrally, with well-developed lateral folds.

Disk-width 32.9%, disk-length 40.7%, pre-oral length 17.1%, pelvic span 22.5%, pelvic fin anterior margin 8.3%, caudal fold length 35.7% all in total length. Pre-orbital length 3.8 times, width between the first pair of gill-slits 3.3 times and distance between the fifth pair of gill-slits 2.4 times in interorbital width. Eyeball length 50%, spiracle length 46.0% in interorbital width. Snout angle 55°. Mouth slightly arched 2.4 times in pre-oral length. Tail length 54.9% in total length, 1.4 times in disk-length and 1.7 times in disk-width.

Dorsal and ventral surfaces entirely smooth. Thorns present around inner margin of orbits, between spiracles and shoulders and along midline of disk and tail. Total tooth rows 94/105 in upper/lower jaws.

Dorsal surface brownish with transversal darker strips on tail, rather beige on outer margin of disk and fins. Ventral surface white with black notch on snout.

Measurements, counts, description and colour are summarized in Table 1 and are in agreement with Norman (1926), Tortonese (1956), Bini (1967), Capapé *et al.* (1981), Fischer *et al.* (1987).

Aspects of the reproductive biology and diet of the blackchin guitarfish from specimens caught in the Gulf of Gabès and the Bahiret El Biban, were studied by Capapé & Zaouali (1979, 1994). Sizes at first sexual maturity of males and of females are 1000 mm and 1100 mm TOT, respectively. Adult females are generally larger than males, maximal TOT for males and females are 1920 mm and 2300 mm respectively. So, the described specimen is juvenile. In the area, the specimen was included among the first species that entered the lagoon; however, at present, its capture remains very rare. Three specimens were collected, with 639 mm, 823 mm and 919 mm TOT, and weighing 877 g, 1701 g and 2297 g.

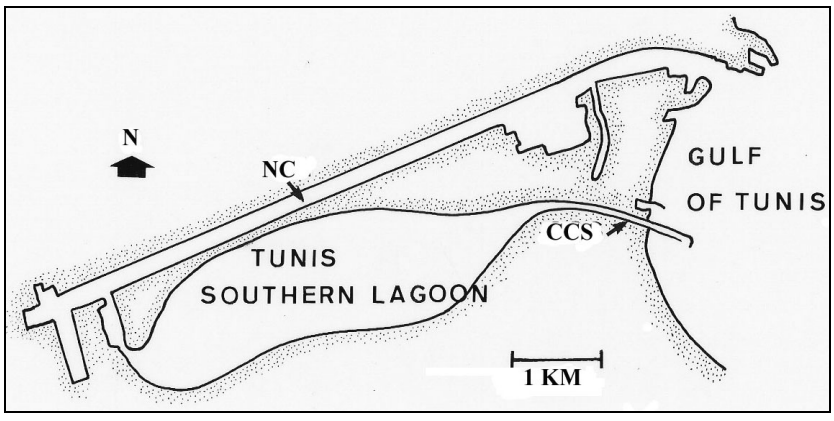

Fig. 2: Tunis Southern Lagoon, showing navigation channel (NC) and the channel of communication with sea (CCS).
Sl. 2: Tuniška južna laguna z navigacijskim kanalom (NC) in kanalom, ki laguno povezuje z morjem (CCS).

Tab. 1: Total mass (in g) and measurements (in mm and as % TOT) of** R. cemiculus **and** R. rhinobatos **from Tunis Southern Lagoon.
Tab. 1: Celotna masa (v g) in dimenzije (v mm in % TOT) pri vrstah** R. cemiculus **in** R. rhinobatos **iz Tuniške južne lagune.

Species	***Rhinobatos cemiculus***		***Rhinobatos rhinobatos***	
Cat. No.	RHI-Rc-02		RHI-Rrh-01	
Total mass (g)	1701		2058	
Measurements	mm	% TOT	mm	% TOT
Total length (TOT)	823	100.0	854	100.0
Disc length	335	40.7	330	38.6
Disc width	271	32.9	284	33.2
Disc depth	48	5.8	45	5.2
Eyeball length	17	2.1	27	3.2
Cornea	10.0	1.2	17	2.9
Pre-orbital length	133	16.2	104	12.1
Inter-orbital width	35	4.2	31	3.6
Spiracle length	16	1.9	22	2.6
Spiracle width	12	1.5	11	1.3
Inter-nasal width	67	8.1	55	6.4
Nasal curtain	27	3.3	22	2.6
Inter-spiracular width	42	5.1	42	4.9
Pre-oral length	141	17.1	114	13.3
Mouth width	60	7.3	65	7.6
First gill slit	12	1.5	13	15.2
Second gill slit	14	1.7	13	15.2
Third gill slit	12	1.5	13	15.2
Fourth gill slit	12	1.5	13	15.2
Fifth gill slit	10	1.2	9	1.1
Width between first gill slit	111	13.5	108	12.6
Width between fifth gill slit	79	9.6	79	9.2
Snout tip to eye	138	16.8	110	13.0
Snout tip to mouth	153	18.6	128	15.0
Snout tip to first gill slit	196	23.9	175	20.4
Snout tip to fifth gill slit	229	27.8	207	24.2
Snout tip to pelvic fin	315	38.3	320	37.4
Snout tip to vent	345	41.9	336	39.4
Pectoral fin anterior margin	271	32.9	260	30.4
Pectoral fin posterior margin	118	14.3	126	14.8
Pectoral fin inner margin	20	2.4	23	2.7
Pelvic fin anterior margin	68	9.8	73	8.5
Pelvic fin posterior margin	66	9.2	81	9.5
Pelvic fin inner margin	46	6.6	45	5.3
Span of pelvic fins	186	21.3	18	2.1
Tail base width	86	10.4	90	10.5
Tail base depth	40	4.8	38	4.5
Tail length	452	54.9	480	56.2
Snout tip to first dorsal	482	58.6	490	57.3
Snout tip to second dorsal	593	72.1	625	73.1
Snout tip to caudal dorsal birth	680	82.6	723	84.6
Snout tip to caudal ventral birth	700	85.1	751	87.9
Caudal superior	83	13.0	133	15.5
Pelvic fins base to first dorsal origin	85	10.3	105	12.3
Caudal superior edge	143	17.4	133	15.6
Caudal inferior edge	53	6.4	62	7.3
Caudal posterior edge	85	10.3	68	8.0
First dorsal anterior edge	85	10.3	89	10.4
First dorsal posterior edge	56	6.8	68	8.0
First dorsal inner edge	24	2.9	20	2.3
First dorsal base	38	4.7	43	5.0
Second dorsal anterior edge	85	10.3	85	9.9
Second dorsal posterior edge	58	7.0	62	10.8
Second dorsal inner edge	20	2.4	18	2.1
Second dorsal base	41	5.0	45	5.3
Inter-dorsal distance	75	9.1	99	11.6
Second dorsal to caudal birth	46	5.6	57	66.7
Caudal careen length	294	35.7	301	35.2

Common guitarfish *Rhinobatos rhinobatos* (Linnaeus, 1758)

The specimen with Cat. No. RHI-Rhr-01 (Fig. 4) was captured on 17 September 2003, by trammel net, close to the channel of communication with sea, and it weighed 2058 g.

General morphology similar to *R. cemiculus* but snout shorter and strongly rounded. Rostral ridges widely separated throughout length and converging little in front. Anterior nasal lobes reaching to inner corner of nostril.

Disk-width 33.2%, disk-length 38.6%, pre-oral length 13.3%, pelvic span 21.0%, pelvic fin anterior margin 8.5%, caudal fold length 35.2% all in total length. Pre-orbital length 3.4 times, width between the first pair of gill-slits 3.5 times and distance between the fifth pair of gill-slits 2.5 times the inter-orbital width. Eyeball length 87.1%, spiracle length 70.9% in inter-orbital width. Snout angle 85°. Mouth slightly arched 1.75 times in pre-oral length. Tail length 56.2% in total length, disk-length 1.45 times and disk-width 1.8 times all in tail length.

Dorsal and ventral surface entirely smooth. Thorns present around inner margin of orbits, between spiracles and along midline of disk and tail. Total tooth rows 105/112 in upper/lower jaws.

Dorsal surface beige to brownish with darker notches and transversal bluish strips on tail, rather beige on outer margin of disk and fins. Belly whitish; rather darker on margins of disk and tail.

Measurements, counts, description and colour are summarized in Table 1 and are in agreement with Norman (1926), Tortonese (1956), Bini (1967), Capapé *et al.* (1981), Fischer *et al.* (1987).

Aspects of the reproductive biology of the common guitarfish were studied by Capapé *et al.* (1997) and its diet and feeding habits by Capapé & Zaouali (1979) from specimens caught in the Gulf of Gabès and in the Bahiret El Biban. Size at first sexual maturity were 750 and 850 mm TOT for males and females, respectively, and maximum size for males and females 1400 mm and 1620 mm TOT, respectively. The smallest gravid female observed was 860 mm TOT. Numerous small free living specimens with residual have been found in the lagoon. Their sizes ranged from 290 mm to 400 mm (Capapé *et al.*, *in press)*.

The described specimen is an adult female. Previously considered as rare in the Tunis Southern Lagoon, *Rhinobatos rhinobatos* has become rather common in the area since the summer 2004. Fifteen specimens were captured during this period on sandy-muddy bottoms, where benthic invertebrates such as molluscs and decapod crustaceans were especially abundant. Their TOT ranged between 624 and 854 mm (mean: 714 ± 63.9 mm) and their mass between 711 and 2058 g (mean: 1188.8 ± 3006.6 g). The relationship total mass (TM) *vs.* total length (TOT) is: TM (g) = 4.44 TOT (mm) - 2002.31; n = 15; r = 0.93.

Family Torpedinidae

Marbled electric ray *Torpedo marmorata* Risso, 1810

The specimen with Cat. No. TOR-Tom-01 (Fig. 5) was captured on 25 February 2004, by trammel-net. It was 192 mm TOT and weighed 155 g.

Disk rather rounded and subcircular, enlarged pectoral confluent with sides of head. Snout short, subtruncate. Pelvic fins quite separate from pectoral fins, subtriangular and acute at distal end. Tail distinct with two dorsal fins and caudal fin well-developed, this latter with a low keel on each side. Distal end of pelvic fin at level of second dorsal origin. Spiracle with seven tentacles, one tentacle on posterior margin being the largest.

Disk-width 63.0%, disk-length 60.4%, pre-oral length 9.8%, pelvic span 32.3%, pelvic fin anterior margin 10.4%, caudal fold 13% all in total length. Pre-orbital length 3 times width between first pair of gill-slits and width between the fifth pair of gill-slits 3.3 times in interorbital width. Spiracle 2.2 times in eyeball length. Mouth crescentic with longitudinal fold on each side. Tail length 29.2% in total length, 2.1 times in disk-length and 2.16 times in disk-width. Total tooth rows 26/24 in upper/lower jaws.

Dorsal surface brownish with dark notches. Belly beige with margin slightly brownish.

Measurements, counts, description and colour are summarized in Table 2 and are in agreement with Tortonese (1956), Bini (1967), Cadenat *et al.* (1978) and Fischer *et al.* (1987).

Aspects of the reproductive biology and feeding habits of specimens from the Gulf of Tunis were studied by Capapé (1979), who noted that males and females are adult above 290 and 390 mm TOT, respectively. The observed female is juvenile.

The marbled electric ray is occasionally captured in the Tunis Southern Lagoon.

Tab. 2: Total mass (in g) and measurements (in mm and as % TOT) of** T. marmorata **and** T. torpedo **from Tunis Southern Lagoon.

Tab. 2: Celotna masa (v g) in dimenzije (v mm in % TOT) pri vrstah** T. marmorata **in** T. torpedo **iz Tuniške južne lagune.

Species	***Torpedo marmorata***		***Torpedo torpedo***	
Cat. No.	TOR-Tom-01		TOR-Tot-02	
Total mass (g)	155		94	
Measurements	mm	% TOT	mm	% TOT
Total length (TOT)	192	100.0	178	100.0
Disk-length	116	60.4	94	52.8
Disk-width	121	63.0	110	61.7
Disk-depth	18	9.4	20	11.2
Eyeball length	9	4.7	10	4.5
Cornea	3	1.6	4	2.2
Pre-orbital length	15	7.8	10	5.6
Inter-orbital width	10	5.2	8	4.5
Spiracle diameter	4	2.1	4	2.2
Nasal curtain	11	6.0	9	5.4
Inter-nasal width	20	10.4	11	6.0
Space between eye and spiracle	6	3.1	2	1.2
Inter-spiracular width	11	5.7	8	4.5
Pre-oral length	19	9.8	18	10.1
Mouth width	16	8.3	11	6.1
First gill slit	5	2.6	4	2.2
Second gill slit	5	2.6	5	2.8
Third gill slit	6	3.1	5	2.8
Fourth gill slit	6	3.1	6	2.8
Fifth gill slit	9	4.7	4	2.2
Width between first gill slit	33	17.2	26	14.6
Width between fifth gill slit	28	15.6	23	12.9
Snout tip to eye	17	8.8	13	7.3
Snout tip to mouth	21	10.9	17	9.5
Snout tip to first gill slit	47	24.7	41	23.0
Snout tip to fifth gill slit	66	34.3	60	33.7
Snout tip to pelvic fin	101	52.0	82	46.1
Snout tip to vent	114	59.4	93	52.2
Pectoral fin anterior margin	47	24.4	57	32.0
Pectoral fin posterior margin	102	53.1	65	36.5
Pectoral fin inner margin	7	3.6	13	7.3
Pelvic fin anterior margin	20	10.4	25	14.0
Pelvic fin posterior margin	30	15.6	35	19.7
Pelvic fin inner margin	9	4.7	5	2.8
Span of pelvic fins	62	32.3	55	31.0
Tail base width	15	7.8	14	7.8
Tail base depth	10	5.2	11	6.2
Tail length	56	2.9	64	36.0
Snout tip to first dorsal	128	66.6	105	59.0
Snout tip to second dorsal	145	75.5	127	71.3
Snout tip to birth of dorsal caudal	163	84.5	147	82.6
Snout tip to birth of ventral caudal	160	83.3	144	81.0
Caudal superior edge	31	16.1	26	14.6
Caudal inferior edge	26	13.5	24	13.4
Caudal posterior edge	30	15.6	28	15.7
First dorsal anterior edge	22	11.5	23	12.9
First dorsal posterior edge	14	7.3	14	7.9
First dorsal inner edge	4	2.1	5	2.8
First dorsal base	13	6.8	12	6.7
Second dorsal anterior edge	20	10.4	17	9.6
Second dorsal posterior edge	10	5.2	10	5.6
Second dorsal inner edge	3	1.6	6	3.4
Second dorsal base	10	5.2	10	5.6
Inter-dorsal distance	6	3.2	9	5.1
Second dorsal to caudal birth	8	4.2	10	5.6
Caudal careen length	25	13.0	30	16.9

Common torpedo *Torpedo torpedo* (Linnaeus, 1758)

Two specimens are preserved in INAT Ichthyological Collection under Cat. Nos. TOR-Tot-01 (Fig. 6) and TOR-Tot-02. They were captured on 23 April 2003 by trammel net. They were 167 and 178 mm TOT and weighed 84 and 94 g. The morphometric measurements of the following description are based on the second specimen only.

General morphology similar to *Torpedo marmorata*, but posterior tip of pelvic fin before second dorsal fin origin. Spiracles with eight short tentacles or knobs.

Disk-width 61.7%, disk-length 52.8%, pre-oral length 10.1%, pelvic span 31.0%, pelvic anterior margin 14.0%, caudal fold 16.9% all in total length. Pre-orbital length 2.6 times width between first pair of gill-slits and width between the fifth pair of gill-slits twice in inter-orbital width. Spiracle 0.8 times in eye-ball length. Tail length 36% in total length, 1.5 times in disk-length, and 1.7 times in disk-width. Total tooth rows 22/20 in upper/lower jaws.

Dorsal surface uniform brownish with whitish notches and five blue-centred ocellae with yellowish margin.

Measurements, counts, description and colour are summarized in Table 2 and are in agreement with Tortonese (1956), Bini (1967), Quignard & Capapé (1974), Capapé & Desoutter (1981) and Fischer *et al.* (1987).

Aspects of the reproductive biology and feeding habits of common torpedoes from the Gulf of Tunis were studied by Quignard & Capapé (1974) who noted that males and females are adult above 190 and 390 mm TOT, respectively. The observed female was juvenile.

The common torpedo is the most abundant and common elasmobranch species encountered in the Tunis Southern Lagoon after its environmental restoration. This recent invader seems to be well adapted to these new abiotic and biotic parameters. Males and females, juveniles and adults are captured all year round throughout the area.

Much of the 16 observed specimens were juvenile. Their TOT ranged from 100 to 255 mm (mean: 160 ± 42.2 mm) and their mass from 84 to 178 g (mean: 78 ± 65.6 g). The relationship total mass (TM) *vs.* total length (TOT) is: TM (g) = 1.47 TOT (mm) - 1553.90; n = 16; r = 0.94.

Family Rajidae

Rough ray *Raja radula* Delaroche, 1809

Two specimens are preserved in INAT Ichthyological Collection under Cat. Nos. RAJ-Rar-01, (Fig. 7), and RAJ-Rar-02. They were both captured on 22 April 2003 by trammel net. They were 78 and 88 mm DW, respectively, and weighed 14 and 15 g, respectively. The morphometric measurements of the following description are based on both specimens.

Disk sub-quadrangular, obtuse in front, with snout slightly marked and rounded, anterior margin slightly concave at level of eyes and outer corners; outer angles broadly rounded; posterior margins convex. Pelvic fins quite separate from pectoral fins, bilobed with anterior lobe connected with posterior lobe along outer margin of fin. First dorsal larger than second dorsal.

Disk-depth 10.2-10.3%, disk-length 88.5-88.6%, preoral length 20.8-21.2%, pelvic span 44.3-44.9%, pelvic fin anterior margin 19.2-19.3% all in disk-width. Pre-orbital length 2.6-2.7 times, width between first gill slits 2.7-2.8 times, width between fifth gill-slits 1.6 times in interorbital width. Eyeball length 1.6 times in spiracle length and as long as interorbital width. Snout angle 125°. Mouth slightly arched 1.6 times in pre-oral length, nasal curtain fringed as long as mouth. Tail length 103-104% in disk-length, 55.5-55.8% in total-length, 85.2-85.9% in disk-width. Total tooth rows 34/36 in upper/lower jaws for both specimens.

Dorsal surface entirely covered with minute spinules, except on snout. Small separate thorns around eyes, a line of three or four minute thorns on mid-disk, an irregular line of thorns from the origin of tail to first dorsal; two or three thorns between dorsal fins. Ventral surface entirely smooth.

Measurements, counts, description and colour are in agreement with Tortonese (1956), Bini (1967), Capapé (1974), Capapé & Desoutter (1979) and Fischer *et al.* (1987).

The rough ray is often reported from Tunisian waters, where it is commonly caught and landed at fishing sites located along the coast especially in the Gulf of Tunis (Quignard & Capapé, 1971; Capapé, 1974; Bradaï, 2000) and slightly less in the Gulf of Gabès (Ennajar, 2002). Data on the reproductive biology and diet and feeding habits of the specimens from the Gulf of Tunis had been previously provided (Capapé, 1974, 1976a). Males and females from the Gulf of Tunis are adult above 320 and 340 mm disk-width respectively. The described specimens are juvenile. *Raja radula* is rather uncommon in the area, juvenile specimens are only captured, generally during the night.

Tab. 3: Total mass (in g) and measurements (in mm and as % DW) of two specimens of** R. radula **from Tunis Southern Lagoon.
Tab. 3: Celotna masa (v g) in meritve (v mm in % DW) pri dveh primerkih vrste** R. radula **iz Tuniške južne lagune.

Cat. No.	**RAJ-Rar-01**		**RAJ-Rar-02**	
Total mass (g)	14		15	
Measurements	mm	% DW	mm	% DW
Total length	120	153.8	135	153.4
Disk-length	69	88.5	78	88.6
Disk-width (DW)	78	100.0	88	100.0
Disk-depth	8	10.3	9	10.2
Eyeball length	6	7.7	6.1	6.9
Cornea	3	3.8	3.3	3.8
Pre-orbital length	16	20.5	17.8	20.2
Inter-orbital width	6	7.7	6.6	7.5
Spiracle length	3.6	4.6	4	4.5
Spiracle width	1.4	1.8	1.6	1.8
Inter-nasal width				
Nasal curtain	10.5	13.5	11.7	13.3
Inter-spiracular width	9	11.5	10.1	11.5
Pre-oral length	16.5	21.2	18.3	20.8
Mouth width	10	12.8	10.9	12.4
First gill slit	2	0.6	2	2.3
Second gill slit	2	0.6	2	2.3
Third gill slit	2	0.6	2	2.3
Fourth gill slit	1.5	1.9	1.5	1.7
Fifth gill slit	1.5	1.9	1.5	1.7
Width between first gill slit	19	24.4	21	23.9
Width between fifth gill slit	10	12.8	11.3	12.8
Snout tip to eye	17	21.8	19.1	21.7
Snout tip to mouth	17	21.8	19.5	22.2
Snout tip to first gill slit	26	33.3	29	33.0
Snout tip to fifth gill slit	32	41.0	36	40.9
Snout tip to pelvic fin	53	67.9	60	68.2
Snout tip to vent	54	69.2	61	69.3
Pectoral fin anterior margin	56	71.8	63	71.6
Pectoral fin posterior margin	40	51.3	45	51.1
Pectoral fin inner margin	12	15.4	14	15.9
Pelvic fin anterior margin	15	19.2	17	19.3
Pelvic fin posterior margin	16	20.5	18	20.5
Pelvic fin inner margin	9	11.5	10	11.4
Span of pelvic fins	35	44.9	39	44.3
Tail base width	5	6.4	6	6.8
Tail base depth	4	5.1	4.5	5.1
Tail length	67	85.9	75	85.2
Snout tip to first dorsal	10	12.8	12	13.6
Snout tip to second dorsal	11	14.1	13	14.3
Superior caudal edge	3	3.8	3	3.4
Inferior caudal edge	2	3.6	2.5	2.8
First dorsal anterior edge	9	11.5	10	11.4
First dorsal posterior edge				
First dorsal base	5	6.4	6	6.8
Second dorsal anterior edge	6	7.7	7	7.9
Second dorsal posterior edge				
Second dorsal base	5	6.4	5.5	6.3
Inter-dorsal distance	4	5.1	4	4.6
Second dorsal to caudal birth	5	6.4	6	6.8

Family Dasyatidae

Common stingray *Dasyatis pastinaca* (Linnaeus, 1758)

The specimen with Cat. No. DAS-Dap-01 (Fig. 8) was captured on 31 January 2004, close to the channel of communication with the sea. It was 352 mm DW and weighed 1652 g.

Disk rhomboid with anterior margins slightly convex at level of eyes and rounded at their distal end, while the posterior margins straight anteriorly and convex posteriorly. Snout minute and pointed. Pelvic fins quadrangular and with outer corner obviously rounded. Tail slender and slightly compressed dorso-ventrally. Dorsal surface of the tail with fold posterior to the sting but not extending to the end of the tail, ventral fold extending to the end of the tail. Disk-depth 15.1%, disk-length 86.6%, pre-oral length 19.6%, span of pelvic fins 39.7%, pelvic fin anterior margin 17.9%, ventral tail fold 34.1% all of disk-width. Pre-orbital length 0.95 times in interorbital width; preoral length 19.3 % disk-width, 1.01 times in interorbital width and 0.98 in width between first gill-slits. Snout angle in front of eyes 120°. Eyes moderately large, eyeball length 2.95 times in interorbital width; spiracles large, oblique and rather oval, 0.86 times in eyeball length, 2.95 times in interorbital width, 0.46 times in width between fifth gill slit. Mouth slightly arched, skin flap on upper jaws with 32 oral papillae. Five buccal papillae, three central elongated and a single one, verruca-like, on both side. Total tooth rows 48/52 in upper/lower jaws.

Dorsal surface rather olive-brown, fairly rosy along the margin of the pectoral fin and toward the snout; pelvic fins also beige with golden marks surrounding the eyes and along the mid-part of pectoral. Caudal sting beige. Belly off-white to beige with margins grey and tip of snout brownish.

Measurements, counts, description and colour are summarized in Table 4 and are in agreement with Tortonese (1956), Bini (1967), Capapé (1977a, 1983), Fischer *et al.* (1987), Cowley & Compagno (1993) and Golani & Capapé (2004).

The common stingray has often been reported from Tunisian waters, where it is commonly caught and landed at fishing sites located along the coast (Quignard & Capapé, 1971; Capapé, 1976b, 1977a; Bradaï, 2000).

However, the species is more abundant in the northern than in the southern area (Quignard & Capapé, 1971; Bradaï, 2000) and especially in the Gulf of Tunis. It sometimes enters estuarine waters, such as the River Miliane close to Tunis, in order to expel its near-term embryos (see Capapé *et al.*, *in press*). Data on the reproductive biology and diet and feeding habits of the Gulf of Tunis specimens had been previously provided (Capapé, 1975, 1976b). The specimen is an adult male (see Capapé, 1976b). The common stingray is occasionally captured in the Tunis Southern Lagoon.

Tab. 4: Total mass (in g), measurements (in mm and as % DW) and counts of** D. pastinaca **from Tunis Southern Lagoon.
Tab. 4: Celotna masa (v g), dimenzije (v mm in % DW) in meristični podatki pri vrsti** D. pastinaca **iz Tuniške južne lagune.

Cat. No.	**DAS-Dap-01**	
Total mass (g)	1652	
Measurements	mm	% DW
Total length	660	187.5
Disk-length	305	86.6
Disk-width	352	100.0
Disk-depth	53	15.1
Eyeball width	22	6.3
Cornea	12	3.4
Pre-orbital length	68	19.3
Inter-orbital width	65	18.5
Spiracle length	19	5.4
Spiracle width	13	3.7
Inter-nasal width	35	9.9
Nasal curtain	40	11.4
Interspiracular width	63	17.8
Pre-oral length	69	19.6
Mouth width	36	10.2
First gill slit	10	2.8
Second gill slit	11	3.1
Third gill slit	12	3.4
Fourth gill slit	12	3.4
Fifth gill slit	8	2.3
Width between first gill slit	70	19.9
Width between fifth gill slit	41	11.6
Snout tip to eye	81	23.0
Snout tip to mouth	71	20.2
Snout tip to first gill slit	120	34.0
Snout tip to fifth gill slit	155	44.0
Snout tip to pelvic fin	262	74.4
Snout tip to sting	403	114.5
Sting length	101	28.7
Snout tip to vent	275	78.1
Pectoral fin anterior margin	231	65.6
Pectoral fin posterior margin	216	61.4
Pectoral fin inner margin	45	12.8
Pelvic fin anterior margin	63	17.9
Pelvic fin posterior margin	36	10.2
Pelvic fin inner margin	24	6.8
Pelvic fin base	60	17.0
Span of pelvic fins	155	44.0
Clasper length	121	34.3
Tail base width	30	8.5
Tail base depth	16	4.5
Tail length	382	108.5
Ventral tail fold length	120	34.1
Dorsal tail fold length	72	20.5
Counts		
Oral papillae	32	
Buccal papillae	1+4+1	
Teeth rows upper jaw	48	
Teeth rows lower jaw	52	

Family Myliobatidae

Bull ray *Pteromylaeus bovinus* (E. Geoffroy Saint-Hilaire, 1817)

The specimen with Cat. No. MYL-Ptb-01 (Fig. 9) was captured on 20 April 2003 by tramail. It was 310 mm DW and weighed 416 g.

Disk lozenge-shaped with anterior margin strongly convex and pectoral strongly falciform especially at their distal end, while posterior margin strongly concave posteriorly not continuous with rostral fins at side of head. Snout produced, narrower than the skull, blunted at the end. Pelvic fins quadrangular and with outer corner rounded. Tail slender rather rounded and slightly compressed dorso-ventrally, bearing on the dorsal part a small dorsal fin and a serrated sting behind it. Disk-depth 14.5%, disk-length 63.5%, pre-oral length 11.6%, span of pelvic fins 22.6%, pelvic fin anterior margin 11.9% all of disk-width. Pre-orbital length 0.91 times in interorbital width; pre-oral length 11.6% disk-width, 1.1 times in interorbital width and 10.2 times width between fifth gill-slits spiracles length 1.3 times. Snout angle 90°. Eyes prominent lateral, eyeball length 1.2 times in interorbital width; spiracles large opening laterally, 1.2 times in eyeball length, 1.4 times in interorbital width, 0.13 times width between fifth gill-slit. Anterior nasal valves confluent, free behind. Mouth slightly arched 1.6 times in pre-oral length, 129% in nasal curtain length. Tail length 69.4% in total length, 2.2 times in disk-length and 1.3 times in disk-width. Dorsal fin originating before pelvic fin tip. Teeth tesselate in seven rows in both jaws.

Dorsal surface rather brownish with four olive transverse stripes on head and seven on disk. Tail and dorsal fin uniformly brownish. Sting beige.

Measurements, counts, description and colour are summarized in Table 5 and are in agreement with Tortonese (1956), Bini (1967), Capapé & Quignard (1975) and Fischer *et al.* (1987).

The bull ray is commonly captured in southern Tunisia, especially in the Gulf of Gabès, slightly less in the Gulf of Hammamet and rarely in the Gulf of Tunis, in spring and summer, generally. With regard to the specimens from the first area, aspects of reproductive biology were reported by Capapé & Quignard (1975), while their diet and feeding habits were studied by Capapé (1977b). Capapé & Quignard (1975) noted that size at birth occurs between 270 and 290 mm in Tunisian waters and according to Seck *et al.* (2002) between 250 and 270 mm TOT, in Senegalese waters. The specimen described above exhibited an unhealed scar on the ventral surface. It was a neonate and probably the smallest free-swimming *Pferomylaeus bovinus* recorded to date, 310 mm disk-width and 410 g in mass (see Tab. 5); the previous one being of Seck *et al.* (2002): 355 mm disk-width and 460 g, from off Senegal. All the 14 observed

Tab. 5: Total mass (in g) and measurements (in mm and as % DW) of** P. bovinus **from Tunis Southern Lagoon.
Tab. 5: Celotna masa (v g) in dimenzije (v mm in % DW) pri vrsti** P. bovinus **iz Tuniške južne lagune.

Cat. No.	**MYL-Ptb-01**	
Total mass (g)	416	
Measurements	mm	% DW
Total length	592	191.9
Disk-length	187	67.3
Disk-width	310	100.0
Disk-depth	45	14.5
Maximum snout width	51	16.5
Dorsal snout width	37	11.9
Snout length	18	5.8
Snout depth	10	3.2
Snout tip to pectoral	46	14.8
Cephalic fin length	40	12.9
Anterior interspiracular width	17	5.5
Posterior interspiracular width	23	7.4
Eyeball length	27.5	8.9
Eyeball width	13	4.2
Cornea length	9	2.9
Cornea width	7	2.3
Pre-orbital length	30	9.7
Inter-orbital width	33	10.6
Spiracle length	23	7.4
Spiracle width	7	2.5
Inter-nasal width	32	10.3
Nasal curtain	17	5.5
Pre-oral length	36	11.6
Mouth width	22	7.1
First gill slit	6	1.9
Second gill slit	5	1.6
Third gill slit	5	1.6
Fourth gill slit	5	1.6
Fifth gill slit	2	0.6
Width between first gill slit	47	1.6
Width between fifth gill slit	30	0.9
Snout tip to eye	31	10.0
Snout tip to mouth	36	11.6
Snout tip to first gill slit	63	20.3
Snout tip to fifth gill slit	83	26.8
Snout tip to pelvic fin	161	51.9
Snout tip to sting	225	72.6
Snout tip to dorsal	174	56.1
Snout tip to vent	163	52.6
Pectoral fin anterior margin	160	51.6
Pectoral fin posterior margin	150	48.4
Pectoral fin inner margin	23	7.4
Pelvic fin anterior margin	37	11.9
Pelvic fin posterior margin	25	8.1
Pelvic fin inner margin	18	5.8
Span of pelvic fins	70	22.6
Clasper length	18	5.8
Tail base width	12	3.9
Tail base depth	10	3.2
Tail length	411	132.6
Sting length	5	1.6
Dorsal anterior edge	17	5.5
Dorsal posterior edge	12	3.9
Dorsal inner edge	1	0.3
Dorsal base	30	9.7

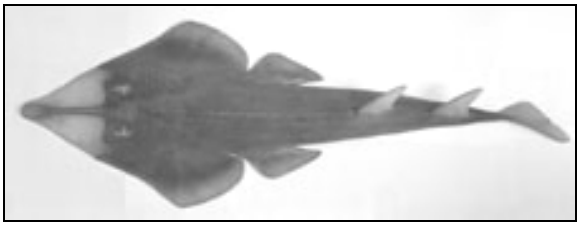

Fig. 3: Blackchin guitarfish *R. cemiculus* ***(E. Geoffroy Saint-Hilaire, 1817).***
Sl. 3: Vrsta *R. cemiculus* ***(E. Geoffroy Saint-Hilaire, 1817).***

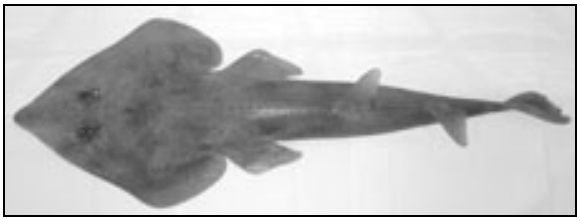

Fig. 4: Common guitarfish *R. rhinobatos* ***(Linnaeus, 1758).***
Sl. 4: Vrsta *R. rhinobatos* ***(Linné, 1758).***

Fig. 5: Marbled electric ray *T. marmorata* ***(Risso, 1810).***
Sl. 5: Navadni električni skat *T. marmorata* ***(Risso, 1810).***

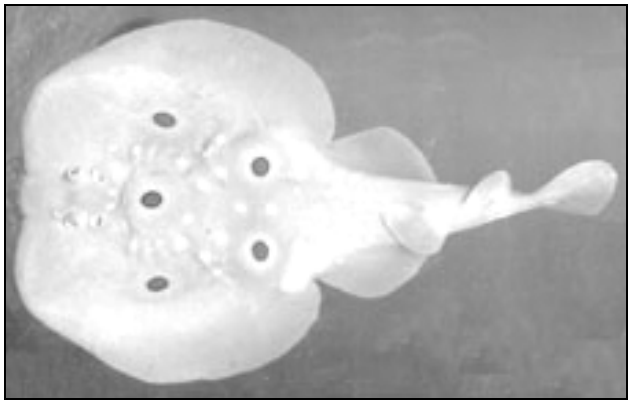

Fig. 6: Common torpedo *T. torpedo* ***(Linnaeus, 1758).***
Sl. 6: Pegasti električni skat *T. torpedo* ***(Linné, 1758).***

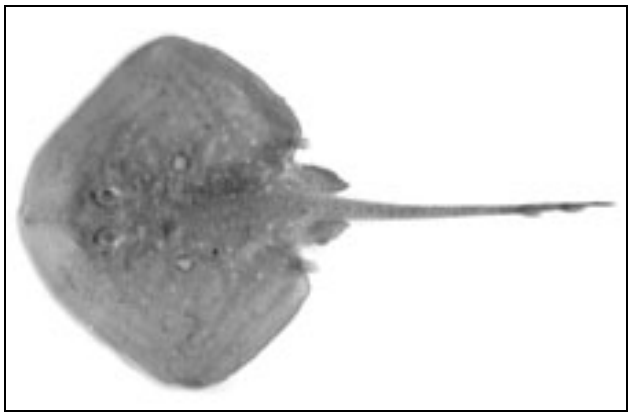

Fig. 7: Rough ray *R. radula* ***(Delaroche, 1809).***
Sl. 7: Vrsta skata *R. radula* ***(Delaroche, 1809).***

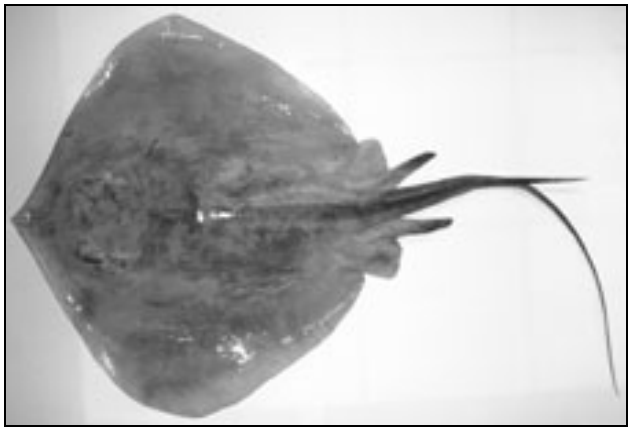

Fig. 8: Common stingray *D. pastinaca* ***(Linnaeus, 1758).***
Sl. 8: Navadni morski bič *D. pastinaca* ***(Linné, 1758).***

Fig. 9: Bull ray *P. bovinus* ***(E. Geoffroy Saint-Hilaire, 1817).***
Sl. 9: Kljunati morski golob *P. bovinus* ***(E. Geoffroy Saint-Hilaire, 1817).***

specimens were juveniles referring to previous observations of Capapé & Quignard (1975) and Seck *et al.* (2002). Their disk width ranged from 310 to 497 mm (mean 410.5 ± 45.5 mm) and their mass from 416 to 883 g (mean: 779 ± 160.9 g). The relationship total mass (TM) *vs.* disk width (DW) is: TM (g) = 415.7 DW (mm) - 2603.10; n = 14; r = 0.91.

DISCUSSION

Prior to its environmental restoration, the Tunis Southern Lagoon was close to the stage of collapse and in danger of becoming completely azoic. The recent occurrence of a large biodiversity, comprising benthic invertebrates and fish fauna, shows that water quality was successfully improved in the area (Ben Souissi *et al.*, 2003; Ben Souissi *et al.*, *in press)*. Moreover, the large number of fish species recorded in the Tunis Southern Lagoon shows that it is now subjected to strong influence of marine flux. This phenomenon has been confirmed by the occurrence of seven elasmobranch species, previously unknown in the area.

Most of the observed specimens in each species were juvenile. Their small sizes allowed them to enter the channel of communication between the area and the Gulf of Tunis, in order to take refuge in the Tunis Southern Lagoon and to avoid both interspecific competition pressure and predation risk by larger elasmobranch species, such as sharks. By contrast, the occurrence of small free-swimming specimens, such as *R. radula* and *P. bovinus* (probably neonates), did not allow us to believe that they were born in the Tunis Southern Lagoon, as no adult females of both species were found, but close to the communication channel with the sea.

Three species, *T. torpedo, R. rhinobatos* and *P. bovinus*, only are relatively abundant in the Tunis Southern Lagoon. The first species was abundant in other Tunisian lagoons, such as the Lagoon of Bizerte in northern Tunisia (Ben Brahim & Capapé, 1997; Ben Brahim *et al.*, 1998; Capapé *et al.*, *in press*) and the Bahiret El Biban, southern Tunisia, the second species was captured in the latter area only where it lives and reproduces (Capapé *et*

al., 1997; Capapé *et al.*, *in press*), concomitantly with its close relative species *R. cemiculus* (Capapé & Zaouali, 1994; Capapé *et al.*, *in press*). Although *T. torpedo*, *R. rhinobatos* and *P. bovinus* could be considered permanently present in the area and grew normally (see relationship size *vs.* mass), no sufficient data are available at present to suggest that sustainable populations are definitely established in the area. Further investigations are needed in order to state, whether or not, they are neocolonisers in the Tunis Southern Lagoon.

The scarcity of *T. marmorata* and *R. cemiculus* in the area is probably due to the interspecific competition pressure with *T. torpedo* for the former and with *R. rhinobatos* for the latter. Moreover, this may be due to fact that *T. marmorata* and *R. cemiculus* are considered to be less abundant in the Gulf of Tunis, which is the source of the seven elasmobranch species recorded in the area. By contrast, *P. bovinus* is less abundant in the Gulf of Tunis than the common eagle ray *Myliobatis aquila* (Linnaeus, 1758) according to Capapé & Quignard (1974, 1975) and Bradaï (2000). Moreover, although *P. bovinus* was rather common in the Gulf of Gabès (Capapé & Quignard, 1975; Bradaï, 2000), it was never recorded in the Bahiret El Biban (Capapé *et al.*, *in press*). *P. bovinus* probably takes refuge in the Tunis Southern Lagoon in order to avoid competition pressure with *M. aquila*, which is more abundant in the area, but both species feed on same preys (Capapé, 1976c, 1977b). On the other hand, specific changes in fish diversity cannot be excluded in the Gulf of Tunis, such as in the Adriatic Sea (Lipej & Dulčić, 2004). Further, Quignard & Capapé (1971), Capapé & Quignard (1975) and Capapé *et al.* (1981) noted *R. cemiculus*, R. *rhinobatos* and *P. bovinus* very common in the Gulf of Gabès and rather rare in the Gulf of Tunis. According to Postel (1956), Ben Othman (1973) and Bradaï (2000), the waters of Gulf of Gabès are considered to have sub-tropical affinities. Migrations of exotic species, such as Lessepsian migrants or originating from the eastern tropical Atlantic, are regularly reported from off the northern Maghrebine shore (Hemida *et al.*, 2002, 2003; Bradaï *et al.*, 2004). Migration of species from the Gulf of Gabès to northernmore areas remains a suitable hypothesis. So, the occurrence of these species, and especially the two latter species that are rather common in Tunis Southern Lagoon, could be considered only as a conjunctural phenomenon. The neo-colonisation of the Tunis Southern Lagoon by benthic invertebrates originating from the Red Sea could also partially explain this occurrence (see Ben Souissi *et al.*, 2003). Since the 1960s, Tunisian waters have been regularly invaded by new Lessepsian species, as reported in some previous papers (see Bradaï *et al.*, 2004). This phenomenon was observed in several Mediterranean areas (see Quignard & Tomasini, 2000; Dulčić *et al.*, 2003; Lipej & Dulčić, 2004) and is probably due to the fact that inshore and offshore waters become warmer (see Francour *et al.*, 1994). In the Tunis Southern Lagoon, however, no significant changes in water temperature were clearly observed before and after the environmental restoration. The Tunis Southern Lagoon, recently subjected to a large marine flux, is probably becoming a trophic area (*sensu* Guélorget & Perthuisot, 1983, 1992), where predators such as elasmobranchs species find sufficient food. Nevertheless, further investigations are needed in order to show whether the elasmobranch species recorded to date are permanent inhabitants in the area and whether they could finally be considered paralic species (*sensu* Guélorget & Perthuisot, 1983, 1992), such as those of the Bahiret El Biban (Capapé & Zaouali, 1994, 1995; Capapé *et al.*, *in press)*.

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O NEDAVNEM POJAVLJANJU RAZLIČNIH VRST SKATOV V TUNIŠKI JUŽNI LAGUNI (SEVERNA TUNIZIJA, SREDNJE SREDOZEMLJE)

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POVZETEK

Med raziskavami, opravljenimi po okoljski obnovi Tuniške južne lagune, ki meji na Tuniški zaliv (severna Tunizija), je bilo v laguni prvič zabeleženih sedem vrst hrustančnic, in sicer: Rhinobatos cemiculus, R. rhinobatos, Torpedo marmorata, T. torpedo, Raja radula, Dasyatis pastinaca *in* Pteromylaeus bovinus. *Za tri izmed njih,* R. rhinobatos, T. torpedo *in* P. bovinus, *se zdi, da stalno živijo v tem območju. Avtorji opisujejo vseh sedem vrst in razglabljajo o vzrokih za nenavadno pojavljanje teh vrst.*

Ključne besede: hrustančnice, okoljska obnova, Tuniška južna laguna, Tunizija, Sredozemlje

REFERENCES

Ben Brahim, R. & C. Capapé (1997): Nageoire dorsale supplémentaire chez une torpille ocellée, *Torpedo (Torpedo) torpedo* des eaux tunisiennes (Méditerranée Centrale). Cybium, 21(2), 223–225.

Ben Brahim, R., A. A. Seck & C. Capapé (1998): Albinisme chez la torpille ocellée, *Torpedo (Torpedo) torpedo* (Linnaeus, 1758). Cybium, 22(1), 83–86.

Ben Charrada, R. (1992): Le lac de Tunis après les aménagements. Paramètres physico-chimiques de l'eau en relation avec la croissance des macroalgues. Mar. Life, 1(1), 29–44.

Ben Maiz, N. (1997): Le lac Nord de Tunis: un milieu en mutation. Actes du séminaire gestion et conservation des zones humides tunisiennes. Sousse, Tunisie, octobre 1997, p. 77–84.

Ben Othman, S. (1973): Le sud tunisien (golfe de Gabès): hydrologie, sédimentologie, faune et flore. Ph.D. Thesis. University of Tunis, Tunisia,166 pp.

Ben Souissi, J. (2002): Impact de la pollution sur les communautés macrobenthiques du lac sud de Tunis avant sa restauration environnementale. Ph.D. Thesis. University of Tunis, Tunisia, 267 pp.

Ben Souissi, J., M. Rezig & J. Zaouali (2003): Appearance of invasive species in the southern lake of Tunis. In: Özhan, E (ed.): Proceedings of the Sixth International Conference on the Mediterranean Coastal Environment, MEDCOAST 03. Ravenna, Italy, 7–11 October 2003, p. 911–922.

Ben Souissi, J., H. Mejri, O. Guélorget, A. El Abed, J. Zaouali, C. Reynaud & C. Capapé: Observations on fish species recorded in Tunis Southern Lagoon after an environmental restoration (Northern Tunisia, Central Mediterranean). Vie Milieu. *(in press)*

Bini, G. (1967): Atlante dei pesci delle coste italiane. 1. Leptocardi, Ciclostomi, Selaci. Mondo Sommerso, Milano, 106 pp.

Bradaï, M. N. (2000): Diversité du peuplement ichtyque et contribution à la connaisssance des sparidés du golfe de Gabès. Ph.D. Thesis. University of Sfax, Tunisia, 600 p.

Bradaï, M. N., R. Ktari, J. Ben Souissi, N. Ben Hadj Hamida, M. Ghorbel, O. Jarboui, A. Bouaïn & H. Missaoui (2004): Liste commentée des poissons exotiques recensés en Tunisie. Rapp. Comm. int. Mer Médit., 37, p. 312.

Cadenat, J., C. Capapé, & M. Desoutter (1978): Description d'un Torpedinidae nouveau des côtes occidentales d'Afrique *Torpedo (Torpedo) bauchotae* (Pisces, Torpediniformes). Cybium, 4, 29–42.

Capapé, C. (1974): Contribution à la biologie des Rajidae des côtes tunisiennes. II. *Raja radula* Delaroche, 1809. Répartition géographique et bathymétrique, sexualité, reproduction. Arch. Inst. Pasteur Tunis, 51(3), 211–228.

Capapé, C. (1975): Contribution à la biologie des Dasyatidae des côtes tunisiennes. II. *Dasyatis pastinaca* (1758): régime alimentaire. Ann. Inst. Michel Pacha, 1–15.

Capapé, C. (1976a): Etude du régime alimentaire de deux Rajidae communs dans le golfe de Tunis, *Raja miraletus*, Linné, 1758 et *R. radula* Delaroche, 1809. Rapp. Comm. int. Mer Médit., 23(8), 39–41.

Capapé, C. (1976b): Contribution à la biologie des Dasyatidae des côtes tunisiennes. I. *Dasyatis pastinaca* (Linné, 1758). Répartition géographique et bathymétrique, sexualité, reproduction, fécondité. Ann. Mus. Civ. Stor. Nat. Genova, 81, 22–32.

Capapé, C. (1976c): Etude du régime alimentaire de l'Aigle de mer, *Myliobatis aquila* (L., 1758) des côtes tunisiennes. J. Cons. Explor. Mer, 37(1), 29–35.

Capapé, C. (1977a): Les espèces du genre *Dasyatis* Rafinesque, 1810 (Pisces, Rajiformes) des côtes tunisiennes. Cybium, 2, 75–105.

Capapé, C. (1977b): Etude du régime alimentaire de la Mourine vachette, *Pteromylaeus bovinus* (Geoffroy Saint-Hilaire, 1817), (Pisces, Myliobatidae) des côtes tunisiennes. J. Cons. Explor. Mer, 37(3), 214–220.

Capapé, C. (1979): La torpille marbrée, *Torpedo marmorata* Risso, 1801 (Pisces, Rajiformes) des côtes tunisiennes: nouvelles données sur l'écologie et la biologie de la reproduction de l'espèce avec une comparaison entre les populations méditerranéennes et atlantiques. Ann. Sci. nat. Zool. Paris, 1, 79–97.

Capapé, C. (1983): Nouvelles données sur la morphologie des Dasyatidae (Pisces, Rajiformes) des côtes tunisiennes. Bull. Inst. Natl. Sci. Tech. Océanogr. Pêch. Salammbô, 10, 69–98.

Capapé, C. & J. P. Quignard (1974): Dimorphisme sexuel et observations sur *Myliobatis aquila* (L., 1758). Contribution à l'étude du genre *Myliobatis*, Cuvier, 1817. Ann. Mus. Civ. Stor. Nat. Genova, 50, 1–27.

Capapé, C. & J. P. Quignard (1975): Contribution à la systématique et à la biologie de *Pteromylaeus bovinus* (Geoffroy Saint-Hilaire, 1817), (Pisces, Myliobatidae) des côtes tunisiennes. Bull. Mus. Natl. Hist. Nat. 3, 240, 1329–1347.

Capapé, C. & M. Desoutter (1979): Note sur la validité de *Raja atra* Müller et Henlé, 1841. Cybium, 5, 71–85.

Capapé, C. & J. Zaouali (1979): Etude du régime alimentaire de deux Sélaciens communs dans le golfe de Gabès (Tunisie): *Rhinobatos rhinobatos* (Linné, 1758) et *Rhinobatos cemiculus* (Geoffroy Saint-Hilaire, 1817). Arch. Inst. Pasteur Tunis, 56(3), 287–305.

Capapé, C. & M. Desoutter (1981): Nouvelle description de *Torpedo (Torpedo) torpedo* (Linné, 1758) (Pisces, Torpedinidae). Bull. Mus. Natl. Hist. Nat. 7A, 4, 1205–1217.

Capapé, C. & J. Zaouali (1994): Distribution and reproductive biology of the blackchin guitarfish, *Rhinobatos cemiculus* (Pisces: Rhinobatidae) in the Tunisian waters. Aust. J. Mar. Freshw. Res., 45, 551–561.

Capapé, C. & J. Zaouali (1995): Reproductive biology of the marbled stingray, *Dasyatis marmorata* (Steindachner, 1892) (Pisces: Dasyatidae) in the Tunisian waters. J. Aquaric. Aquat. Sci., 7, 108–119.

Capapé, C., J. P. Quignard & J. Zaouali (1981): Nouvelles descriptions de *Rhinobatos rhinobatos* (Linné,1758) et *Rhinobatos cemiculus* Geoffroy Saint-Hilaire, 1817 (Pisces, Rhinobatidae). Bull. Off. natn. Pêch. Tunisie, 5(1), 1–27.

Capapé, C., R. Ben Brahim & J. Zaouali (1997): Aspects de la biologie de la reproduction de la guitare commune, *Rhinobatos rhinobatos* L., 1758 (Rhinobatidae) des eaux tunisiennes (Méditerranée centrale). Ichtyophysiol. Acta, 20, 113–127.

Capapé, C., O. Guélorget, J. P. Quignard, A. El Abed, J. Zaouali & J. Bensouissi (2004): The Elasmobranch species from the Bahiret El Biban (Southern Tunisia, Central Mediterranean): a survey. Annales Ser. hist. nat., 14(1). *(in press)*

Collenot, G. (1969): Etude biométrique de la croissance relative des ptérygopodes chez la Roussette, *Scyliorhinus canicula* (L.). Cah. Biol. Mar., 10, 309–323.

Cowley, P. D. & L. V. J. Compagno (1993): A taxonomic re-evaluation of the blue stingray from southern Africa (Myliobatiformes: Dasyatidae). S. Afr. J. Mar. Sci., 13, 135–149.

Dulčić, J., A. Pallaoro & L. Lipej (2003): Lessepsian fish migrants reported in the Eastern Adriatic Sea: an annotated list. Annales Ser. hist. nat., 13(2), 137–144.

Ennajar, S. (2002): Contribution à l'étude bio-écologique des élasmobranches hypotrêmes de la région de Gabès. Ph.D. Thesis. University of Sfax, Tunisia, 132 pp.

Fischer, W., M. L. Bauchot & M. Schneider (eds.) (1987): Fiches FAO d'identification des espèces pour les besoins de la pêche. Révision 1. Méditerranée et mer Noire. Zone de pêche 37. Vol II. Vertébrés. FAO, Rome, p. 761–1530.

Francour, P., C. F. Boudouresque, J. G. Harmelin, M. L. Harmelin-Vivien & J. P. Quignard (1994): Are the Mediterranean waters becoming warmer? Information from biological indicators. Mar. Poll. Bull., 28, 523–526.

Golani, D. & C. Capapé (2004): First records of the blue stingray, *Dasyatis chrysonota* (Smith, 1828) (Chondrichthyes: Dasaytidae), off the coast of Israel. Acta Adriat., 45(2), 107–112.

Guélorget, O. & J. P. Perthuisot (1983): Le domaine paralique. Expressions géologiques, biologiques et économiques du confinement. Trav. Lab. Géol. Ecol. Paris, 16, 1–136.

Guélorget, O & J. P. Perthuisot (1992): Paralic ecosystems. Biological organization and functioning. Vie Milieu, 42(2), 215–251.

Hemida, F., D. Golani, Y. Diatta, & C. Capapé (2003): On the occurrence of the tripletail, *Lobotes surinamensis* (Bloch, 1790) (Osteichthyes: Lobotidae) off the coast of Algeria (Southern Mediterranean). Annales Ser. hist. nat., 13(2), 145–148.

Hemida, F., R. Seridji, N. Labidi, J. Bensaci & C. Capapé (2002): New data on *Carcharhinus* spp. (Chondrichthyes: Carcharhinidae) from off the Algerian coast (southern Mediterranean). Acta Adriat., 43(2), 83–93.

Hulley, P. A. (1970): An investigation of the Rajidae of the west and south coasts of Southern Africa. Ann. S. Afr. Mus., 55(4), 151–220.

Hulley, P. A. (1972): The origin, interrelationship and distribution of southern African Rajidae (Chondrichthyes, Batoidei). Ann. S. Afr. Mus., 65(1), 1–103.

Lipej, L. & J. Dulčić (2004): Current status of Adriatic fish biodiversity. In: Griffiths, H. I. & B. Kryštufek (eds.): Balkan Biodiversity. Kluwer Academic Publ., Dordrecht, p. 291–306.

Norman, J. R. (1926): A synopsis of the rays of the family Rhinobatidae, with a revision of the genus *Rhinobatus*. Proc. Zool. Soc. Lond., 4, 941–982.

Paris, J. & J. P. Quignard (1971): La faune ichthyologique des étangs languedociens de Sète à Carnon (Ecologie, Ethologie). Vie Milieu, 22 (Suppl.), 301–327.

Postel, E. (1956): Les affinités tropicales de la faune ichtyologique du golfe de Gabès. Bull. Inst. Océanogr. Pêch. Salammbô, 53, 64–68.

Quignard, J. P. & C. Capapé (1971): Liste commentée des Sélaciens de Tunisie. Bull. Inst. Océanogr. Pêch. Salammbô, 2(2), 131–142.

Quignard, J. P. & C. Capapé (1974): Recherches sur la biologie d'un Sélacien du golfe de Tunis, *Torpedo torpedo* Linné, 1758 (Ecologie, sexualité, reproduction). Bull. Inst. Océanogr. Pêch. Salammbô, 3(1–4), 99–129.

Quignard, J. P. & J. P. Tomasini (2000): Mediterranean fish biodiversity. Biol. Mar. Medit., 7(3), 1–66.

Quignard, J. P. & J. Zaouali (1980): Les lagunes périméditerranéennes. Bibliographie ichtyologique annotée. Première partie: les étangs français de Canet à Thau. Bull. Off. Natn. Pêch. Tunisie, 4(2), 293–360.

Quignard, J. P. & J. Zaouali (1981): Les lagunes périméditerranéennes. Bibliographie ichtyologique annotée. Deuxième partie: les étangs français d'Ingril à Porto Vecchio. Bull. Off. Natn. Pêch. Tunisie, 5(1), 41–96.

Rhomdane, M. S. (1985): Lagune de Ghar El Melh: milieu, peuplements et exploitation. Ph.D. Thesis. University of Tunis, Tunisia, 245 pp.

Seck, A. A., Y. Diatta, A. Gueye-Ndiaye & C. Capapé (2002): Observations on the reproductive biology of the Bull Ray, *Pteromylaeus bovinus* (E. Geoffroy Saint-Hilaire, 1817) (Chondrichthyes: Myliobatidae) from the coast of Senegal (eastern tropical Atlantic). Acta Adriat., 43(1), 87–96.

Tortonese, E. (1956): Leptocardia, Ciclostoma, Selaci. In: Fauna d'Italia. Calderini Edit., Bologna, 334 pp.

Vandenbroek, J. & R. Ben Charrada (2001): Restoration and development project of south Lake of Tunis and its shores. Terra Aqua, 85, 1–20.

Zaouali, J. (1977): Le lac de Tunis: facteurs climatiques, physico-chimiques et crises dystrophiques. Bull. Off. Natn. Pêch. Tunisie, 1(1), 37–49.