Short scientific article
Received: 2011-10-03

UDK 591.159:597.556.221.1(262.26)

MORPHOLOGICAL ABNORMALITIES IN THE ANNULAR SEA BREAM *DIPLODUS ANNULARIS* (OSTEICHTHYES: SPARIDAE) FROM THE LAGOON OF BIZERTE (NORTHEASTERN TUNISIA, CENTRAL MEDITERRANEAN)

Nour El Houda KHENFECH & Moncef BOUMAÏZA
Laboratoire d'Hydrobiologie Littorale et Limnique, Université du 07 novembre à Carthage, Faculté des Sciences, Zarzouna, 7021 Bizerte, Tunisia

Christian REYNAUD & Christian CAPAPÉ
Laboratoire interdisciplinaire de Recherche sur la Didactique, l'Éducation et la Formation, E. A. 3749, case 77, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 5, France
E-mail: capape@univ-montp2.fr

ABSTRACT

Morphological abnormalities observed in annular sea bream Diplodus annularis *(Linnaeus, 1758) collected in the Lagoon of Bizerte (northern Tunisia), such as abnormal body shape, skeletal deformities and a reduced anal fin are presented in this paper. The origins of these abnormalities are commented and discussed.*

Key words: lateral line, vertebral column, hyperkyphosis, scale, environmental pollution

ANORMALITÀ MORFOLOGICHE IN SARAGO SPARAGLIONE *DIPLODUS ANNULARIS* (OSTEICHTHYES: SPARIDAE) DELLA LAGUNA DI BIZERTE (TUNISIA NORD-ORIENTALE, MEDITERRANEO CENTRALE)

SINTESI

Diverse anormalità morfologiche sono state osservate in esemplari di sarago sparaglione Diplodus annularis *(Linnaeus, 1758), catturati nella Laguna di Bizerte (Tunisia settentrionale). Nell'articolo vengono presentate deformità scheletriche, forme corporee anormali e pinne anali ridotte. L'origine di tali anormalità morfologiche viene commentata e discussa.*

Parole chiave: linea laterale, colonna vertebrale, ipercifosi, scaglie, inquinamento ambientale

INTRODUCTION

According to Bradaï (2000), at least 21 sparid species, all economically important, are commonly collected all along the Tunisian coast (Fig. 1); some of them enter brackish areas, such as the Bahiret El Biban in the south and the Lagoon of Bizerte in the north, where they live and reproduce. Sustainable populations, established in the Lagoon of Bizerte (Fig. 2), are targeted by fishermen throughout the year. Sparid production of the area ranges between 2.8% and 7.7% of the total production of sparids for Tunisian waters with mean 4.8 ± 1.5% (Anonymous, 2008). During investigations conducted in the area since 2006, focusing primarily on elasmobranch species (El Kamel *et al.,* 2009a, b), an annular sea bream exhibiting morphological deformities was captured. Comprehensive bibliographies of recorded abnormalities in teleost species did not report any case in *Diplodus annularis* (see Dawson, 1964, 1966, 1971; Dawson & Heal, 1971; Jawad & Hosie, 2007; Jawad *et al.*, 2010). The aim of this note is therefore to describe an abnormal specimen and comment on similar abnormalities previously observed in teleost species. Additionally, we try to explain the cause of such deformities in a specimen captured in a restricted area submitted to intense pollution. The role of pollution on fish species and consequently on fishery production could constitute one of the most important pieces of information for improving fishery monitoring and management in the study area.

MATERIAL AND METHODS

On 15 August 2010, one annular sea bream presenting an abnormal body shape was collected in the northern region of the Lagoon of Bizerte, off Menzel Abderrahman, (37°13′31.34″ N, 9°50′28.79″ E), with commercial gill-net, having 26 mm of mesh size, at a depth of 9 m approximately, on sandy-muddy bottom, with other annular sea breams (Fig. 2).

The fresh specimen was measured to the nearest mm and weighed to the nearest gram. Eviscerated mass, liver mass and gonad mass were also recorded, the stomach content was removed, sorted, weighed and prey items identified whenever possible. Morphometric measurements and meristic counts followed Bauchot & Hureau (1986); they were recorded in the abnormal specimen and compared with those recorded in 3 normal specimens (Tab. 1). Twelve scales were removed from the lateral line of the abnormal specimen and a normal

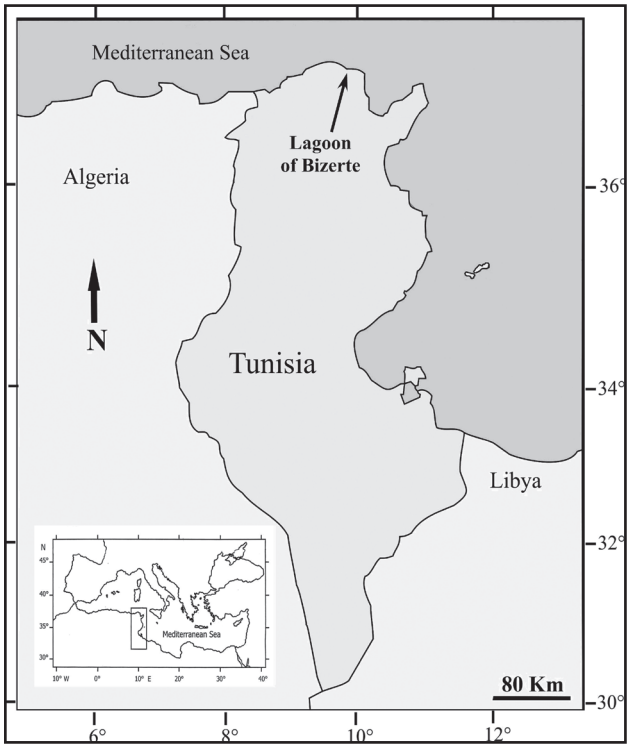

Fig. 1: Map of the Mediterranean Sea showing the Tunisian coast and map of Tunisia showing the location of the Lagoon of Bizerte.
Sl. 1: Zemljevid Sredozemskega morja s tunizijsko obalo in zemljevid Tunizije z označeno Laguno Bizerte.

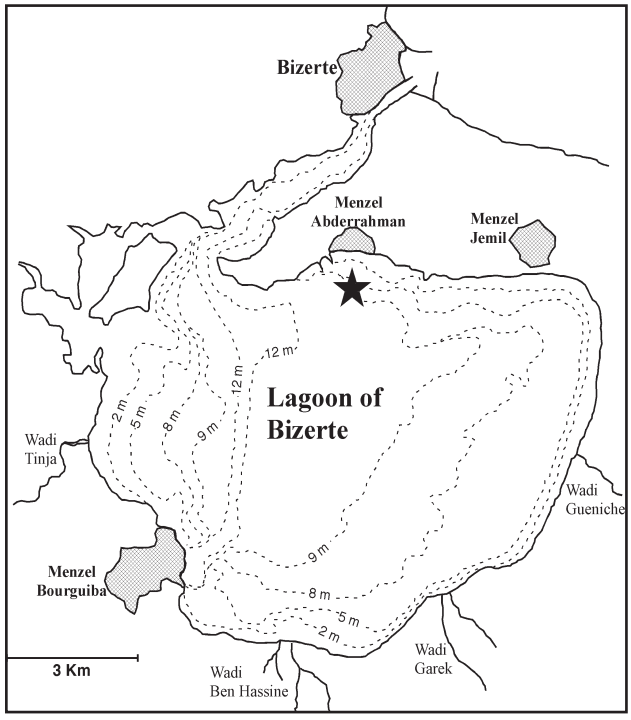

Fig. 2: Map of the Lagoon of Bizerte, showing the capture site (black star) of the abnormal** Diplodus annularis **(FSB-Dip-ann. 01).
Sl. 2: Zemljevid Lagune Bizerte z označeno točko ulova (črna zvezda) abnormalnega primerka** Diplodus annularis **(FSB-Dip-ann. 01).

specimen, and measured from the anterior edge to the posterior edge to the nearest 0.001 mm, by micrometric calliper under binocular microscope.

Some specimens used in this paper were preserved in 10% buffered formalin and deposited in the Ichthyological Collection of the Faculté des Sciences of Bizerte (Tunisia), receiving the catalogue numbers: FSB-Dip-ann 01 for the abnormal specimen, and FSB-Dip-ann 02, FSB-Dip-ann 03, FSB-Dip-ann 04, for the 3 normal specimens, respectively. To study the relationship total length (TL, in mm) *vs.* total mass (TM, in g), 21 specimens were used including the abnormal specimen.

Tab. 1: Morphometric measurements and meristic counts recorded in the abnormal *Diplodus annularis* ***(FSB-Dip--ann. 01), and 3 normal*** *D. annularis* ***(FSB-Dip-ann. 02. 03 and 04).***
Tab. 1: Morfometrični in meristični podatki za abnormalen primerek *Diplodus annularis* ***(FSB-Dip-ann. 01), in 3 normalne primerke*** *D. annularis* ***(FSB-Dip-ann. 02. 03 in 04).***

Reference	**FSB-Dip-ann01**		**FSB-Dip-ann 02**		**FSB-Dip-ann 03**		**FSB-Dip-ann04**	
Weight (g)	45.7		35.9		32.9		37.5	
Morphometric counts	mm	% SL	mm	% SL	mm	% SL	mm	% SL
Total length	138	120.0	134	114.5	135	120.2	136	119.3
Standard length	115	100.0	117	100.0	113	100.0	114	100.0
Anal fin base	3	2.9	23	19.8	25	22.8	24	21.4
Body depth at anal fin origin	17	14.9	40	34.5	41	36.8	36	31.6
Width at anal fin origin	8	7.3	13	11.2	12	11.2	11	10.0
Maximum body width	15	13.3	14	12.4	13	12.2	12	10.6
Anal fin length	10	8.9	31	26.5	30	26.7	31	27.5
Caudal fin length	26	22.9	26	22.8	25	23.1	25	22.4
Caudal peduncle length	10	9.1	9	8.3	9	8.8	9	8.1
Caudal peduncle depth	4	3.3	3	3.2	3	3.2	3	3.1
Dorsal fin base	48	42.1	54	46.7	57	51.0	56	49.6
Cheek depth	11	9.7	11	9.5	10	9.3	9	8.4
Head length	30	26.3	30	25.9	30	27.2	31	27.2
Head width	17	15.6	14	12.4	14	12.8	13	11.7
Eye diameter	4	3.6	4	3.9	4	3.6	3	3.4
Interorbital width	8	7.1	7	6.7	7	6.8	8	7.4
Postorbital length	18	16.3	19	16.7	19	17.3	19	17.4
Pectoral fin length	34	30.3	38	33.2	37	33.3	38	34.1
Length of pelvic fin	24	21.2	23	20.3	22	20.2	25	22.4
Snout length	14	12.7	12	10.5	11	10.6	12	10.8
Distance from snout to anal fin origin	88	77.2	70	60.1	70	62.4	68	60.3
Distance from snout to anus	47	41.1	64	54.7	63	56.3	62	54.9
Distance from snout to dorsal fin origin	37	32.5	35	30.1	36	32.2	39	34.4
Distance from snout to pelvic fin origin	32	28.3	36	31.4	37	33.6	37	33.1
Distance from pelvic fin origin to anus	19	17.1	28	24.8	28	25.1	25	22.3
Body depth at pelvic fin origin	15	13.9	14	12.6	13	11.7	13	11.8
Meristic counts	**FSB-Dip-ann01**		**FSB-Dip-ann 02**		**FSB-Dip-ann 03**		**FSB-Dip-ann04**	
Dorsal fin rays	XI + 11		XI + 11		XI + 11		XI + 11	
Pectoral fin rays	11		12		11		12	
Pelvic fin rays	I + 5		I + 5		I + 5		I + 5	
Anal fin rays	6		III + 11		III + 11		III + 11	
Caudal fin rays	18		16		16		16	
Scales in lateral line	54		46		46		45	
Scales in transversal line	21		18		20		18	

RESULTS AND DISCUSSION

The abnormal *Diplodus annularis* exhibited an irregular and sinuous lateral line (Fig. 3A, a), while in normal specimens it is regular and curved at pectoral fin level (Fig. 3A, b). The specimen was photographed with soft X-rays in order to point out a potential correlation between lateral line and osteological malformations (Fig. 3B). The abnormal specimen presented hyperkyphosis, defined as an exaggerated curvature of the vertebral column at the thoracic region level (Fig. 3B, a), with vertebrae fused and apparently less developed than those observed in the normal specimen (Fig. 3B, b). The number of scales of the lateral line, 54, was higher in the abnormal specimen than in 3 other normal ones, all having 46 scales. Such difference was probably due to the fact that the sinuous lateral line was relatively longer in the abnormal specimen (Tab. 1). Additionally, scales of lateral line removed from each specimen were not morphologically different, but significantly smaller in the abnormal specimen (paired *t*-test, t = 4.31, df = 11, p = 0.007), and consequently more numerous (Fig. 3C, a, b). The anterior belly of the abnormal specimen was hyper developed as an effect of the deformed vertebral column, while the posterior region was strongly reduced, especially in the terminal part. The anal fin of the abnormal specimen was considerably reduced; it was smaller than that of the normal specimen, representing 8.9% SL in the former and 26.5-27.7% SL in the latter, respectively (Tab. 1). Additionally, the pterygiophore supporting the anal fin lacked, no spinous ray was found; only 6 soft rays were counted in the anal fin of the abnormal specimen while all normal specimens had 11 soft rays in the anal fin (Tab. 1, Fig. 3D).

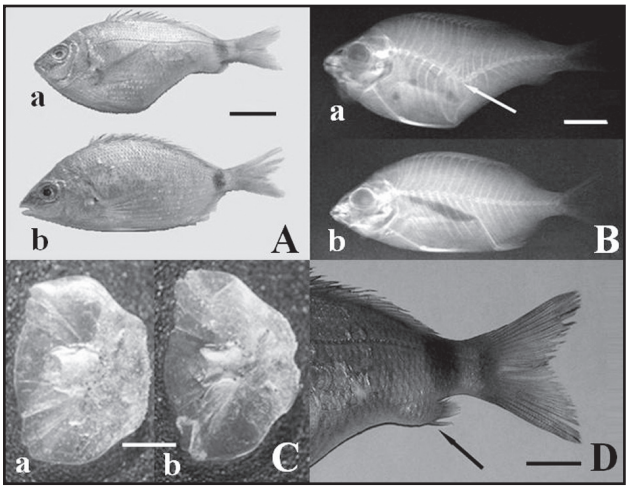

***Fig. 3: (A)** Diplodus annularis**, both specimens were caught in the lagoon of Bizerte, scale bar 25 mm; a - abnormal specimen (FSB-Dip-ann. 01); b - normal specimen (FSB-Dip-ann. 02). (B) X-Ray photograph of** D. annularis**, scale bar 20 mm; a - abnormal specimen (FSB-Dip-ann. 01) with arrow pointing out the hyperkyphosis of the vertebral column; b - normal specimen (FSB-Dip-ann. 02). (C) Scales of lateral line removed from** D. annularis**, scale bar 1 mm; a - abnormal specimen (FSB-Dip-ann. 01); b - normal specimen (FSB-Dip-ann. 02). (D) Terminal region of the abnormal** D. annularis **(FSB-Dip-ann. 01), arrow showing the reduced anal fin, scale bar 20 mm.*

***Sl. 3: (A)** Diplodus annularis**, oba primerka ulovljena v Laguni Bizerte, merilo 25 mm; a - abnormalen primerek (FSB-Dip-ann. 01); b - normalen primerek (FSB-Dip-ann. 02). (B) Rentgenski posnetek** D. annularis**, merilo 20 mm; a - abnormalen primerek (FSB-Dip-ann. 01), puščica kaže na hiperkifozo hrbtenice; b - normalen primerek (FSB-Dip-ann. 02). (C) Luske s pobočnice** D. annularis**, merilo 1 mm; a - abnormalen primerek (FSB-Dip-ann. 01); b - normalen primerek (FSB-Dip-ann. 02). (D) Zadnji del abnormalnega primerka** D. annularis **(FSB-Dip-ann. 01), puščica kaže na zmanjšano podrepno plavut, merilo 20 mm.*

Lateral line deformation and scale deformity were the result of irregular scalation, mechanical dysfunction in ontogeny, and probably environmental and genetic factors according to Jawad *et al.* (2006-2007). They could also be due to skeletal malformation, as observed in the present specimen having a hyperkyphosis; similar patterns were reported by Jardas & Homen (1977) in the whiting *Merlangius merlangus* (Linnaeus, 1758) and the bogue *Boops boops* (Linnaeus, 1758). Jardas & Homen (1977) added that such anomalies were not very rare in teleost species from the Adriatic, and suggested that parasitic infection could be also the cause of skeletal deformations.

Jawad *et al.* (2010) noted that anomaly in fins could hinder the performance of the specimen especially its capacity to get food and to avoid predators. In the case presented herein, the observed deformities did not affect the life of the abnormal specimen which lived and developed in the wild as other normal specimens of the same size class, as shown by the relation between TL *vs.* TM plotted in Fig. 4, with TM = 0.267 TL + 0.579; r = 0.827. Similar patterns were observed by Al-Mamry *et al.* (2010) in silver pomfrets *Pampus argenteus* (Euphrasen, 1788). In contrast, Matsuoaka (1987) and Boglione *et al.* (2006) noted a lethal effect caused by severe skeletal deformities in teleost species living in natural conditions. Similar patterns concerning fin absence, reduction of fin, or abnormal fin were listed by Dawson (1964, 1966, 1971) and Dawson & Heal (1971). Biotic factors such as an attack of aquatic organisms cannot be totally excluded (Dulčić & Soldo, 2005), even if it did not concern the studied specimen.

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), vitamin C deficiency has been associated with caudal fin degeneration (Havler, 1972). Several cases of abnormalities were described in animal species collected in the Lagoon of Bizerte, a restricted brackish area polluted by both inorganic and organic nutriments and heavy metals (Mzoughi *et al*., 2002). Such pollution could explain the specimens of *Torpedo torpedo* from the Lagoon of Bizerte presenting abnormalities (Ben Brahim & Capapé, 1997; Ben Brahim *et al*., 1998; El Kamel *et al.*, 2009b; Mnasri *et al.,* 2010; El Kamel-Moutalibi *et al*., 2011). The common torpedo lives buried in sandy bottoms, where pollutants are accumulated. Louiz *et al*. (2007) noted that skeletal deformities observed in 3 gobiid species were significantly higher in the severely polluted areas. Additionally, gastropods are collected in the area, such as the purple dye murex *Bolinus brandaris* (Linnaeus, 1758) and the banded dye murex *Hexaplex trunculus* (Linnaeus, 1758). Both species, at present, exhibit the development of imposex in females, a phenomenon linked to the use of organic biocides, such as tributyltin, the consequence of environmental pollution (Abidli *et al.*, 2008). The annular sea bream described in this note probably constitutes a new instance of abnormality induced by environmental pollution in the Lagoon of Bizerte.

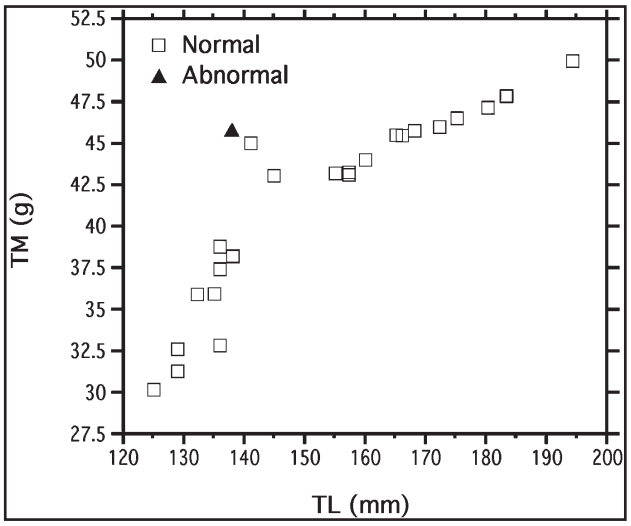

Fig. 4: Relationship total length (TL) *vs.* ***total mass (TM) in 21 specimens of*** *Diplodus annularis* ***collected in the Lagoon of Bizerte.***
Sl. 4: Razmerje celotna dolžina (TL) *vs.* ***celotna masa (TM) 21 primerkov*** *Diplodus annularis****, ulovljenih v Laguni Bizerte.***

MORFOLOŠKE NEPRAVILNOSTI PRI ŠPARU *DIPLODUS ANNULARIS* (OSTEICHTHYES: SPARIDAE) IZ LAGUNE BIZERTE (SEVEROVZHODNA TUNIZIJA, OSREDNJE SREDOZEMLJE)

Nour El Houda KHENFECH & Moncef BOUMAÏZA
Laboratoire d'Hydrobiologie Littorale et Limnique, Université du 07 novembre à Carthage, Faculté des Sciences, Zarzouna, 7021 Bizerte, Tunisia

Christian REYNAUD & Christian CAPAPÉ
Laboratoire interdisciplinaire de Recherche sur la Didactique, l'Éducation et la Formation, E. A. 3749, case 77, Université Montpellier II, Sciences et Techniques du Languedoc, 34095 Montpellier cedex 5, France
E-mail: capape@univ-montp2.fr

POVZETEK

Članek obravnava morfološke nepravilnosti pri šparu Diplodus annularis *(Linnaeus, 1758), ulovljenem v Laguni Bizerte (severna Tunizija), npr. nepravilno obliko telesa, deformacije skeleta in zmanjšano podrepno plavut, ter možne izvore teh nepravilnosti.*

Ključne besede: pobočnica, hrbtenica, hiperkifoza, luska, okoljsko onesnaženje

REFERENCES

Abidli, S., Y. Lahbib & N. Trigui El Ménif (2008): Effects of tribultytlin (Tbt) on the imposex development in two gonochoristic Neogastropods: *Bolinus brandaris* and *Hexaplex trunculus* collected in the Lagoon of Bizerta (Tunisia). International Conference on Monitoring & Modelling of Marine Pollution. Book of Aabstracts. 1-3 December 2008, Kish Island, Islamic Republic of Iran, pp. 89.

Al-Mamry, J. M., L. A. Jawad, I. H. Al-Rasady & S. H. Al-Habsi (2010): First record of dorsal and anal fin deformities in silver pomfrets, *Pam.upas argenteus* (Stromateida, Actinopterygii). An. Biol., 32, 73-77.

Anonymous (2008): Annuaire des statistiques des produits de la pêche en Tunisie, Direction Générale à la Pêche et à l'Aquaculture (DGPA). Ministère de l'Agriculture et des Ressources Hydrauliques (M.A.R.H), 800 p.

Bauchot, M.-L. & C. Hureau (1986): Sparidae. In: Whitehead, J. P., M. L. Bauchot, J. C. Hureau, J. Nielsen & E. Tortonese (Eds.): Fishes of the North-western Atlantic and the Mediterranean, Vol. II. UNESCO, Paris, pp. 883-907.

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.

Boglione, C., C. Costa, M. Giganti, M. Cecchenetti, P. Di Dato, M. Scardi & S. Cataudella (2006): Biological monitoring of wild thicklip grey mullet (*Chelon labrosus*), golden grey mullet (*Liza aurata*) and fathead mullet (*Mugil cephalus*) (Pisces: Mugilidae) from different Adriatic sites: meristic counts and skeletal anomalies. Ecol. Indic., 6, 712-732.

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

Dawson, C. (1964): A bibliography of anomalies of fishes. Gulf Res. Rep., 1, 308-399.

Dawson, C. (1966): A bibliography of anomalies of fishes. Gulf Res. Rep., 2, 169-176.

Dawson, C. (1971): A bibliography of anomalies of fishes. Gulf Res. Rep., 3, 215-239.

Dawson, C. & F. Heal (1971): A bibliography of anomalies of fishes. Gulf Res. Rep., suppl. 3, 215-239.

Dulčić, J. & A. Soldo (2005): Absence of caudal fin in *Solea solea* (Soleidae) collected in the Northern Adriatic. Cybium, 29, 308-309.

El Kamel, O., N. Mnasri, J. Ben Souissi, M. Boumaïza, M. M. Ben Amor & C. Capapé (2009a): Inventory of elasmobranch species caught in the Lagoon of Bizerte (north-eastern Tunisia, central Mediterranean). PANAM-JAS, 4(4), 383-412.

El Kamel, O., N. Mnasri, M. Boumaïza & C. Capapé (2009b): Atypical abnormality in a common torpedo, *Torpedo torpedo* (Chondrichthyes: Torpedinidae) from the Lagoon of Bizerte (northern Tunisia, central Mediterranean). Cah. Biol. Mar., 50(1), 97-101.

El Kamel-Moutalibi, O., N. Mnasri, M. Boumaïza, C. Reynaud & C. Capapé (2011): Abnormalities in common torpedos, *Torpedo torpedo* (Chondrichthyes: Torpedinidae) from the Lagoon of Bizerte (Northern Tunisia, Central Mediterranean). Annales, Ser. Hist. Nat., 21(2), 135-142.

Havler, J. E. (1972): The role of ascorbic acid in fish disease and tissue repair. Bull. Jpn. Soc. Sci. Fish., 38, 79-93.

Jardas, I. & Z. Homen (1977): Nouvelles trouvailles sur les anomalies anatomiques des exemplaires tératologiques des poissons adriatiques. Biljeske-Notes, 34, 1-10.

Jawad, L. A. & A. Hosie (2007): On the record of pugheadedness in snapper, *Pagrus auratus* (Forster 1801) (Perciformes, Sparidae) from New Zealand. Acta Adriat., 48, 205-210.

Jawad, L. A., S. T. Ahyong, & A. Hosie (2006-2007): Malformation of the lateral line and ambicolouration in the triplefin *Grahamina capito* (Jenyns 1842) (Pisces: Tripterygiidae) from New Zealand. Ann. Mus. Civ. Stor. Nat. Ferrara, 9-10, 89-97.

Jawad, L. A., Z. Sadighzadeh & T. Valinassab (2010): Malformation of the caudal fin in the freshwater mullet, *Liza abu* (Actonopterygii: Mugilidae) collected from Karkhe River, Iran. An. Biol., 32, 11-14.

Louiz, I., D. Menif, M. Ben Attia & O. M. Ben Hassine (2007): Incidence des déformations squelettiques chez trois espèces de Gobiidae de la lagune de Bizerte (Tunisie). Cybium, 31(2), 199-206.

Matsuoaka, M. (1987): Development of skeletal tissue and skeletal muscle in the Red Sea bream, *Pagrus major*. Bull. Seikai Reg. Fish. Res. Lab., 65, 1-102.

Mnasri, N., O. El Kamel, M. Boumaïza, M. M. Ben Amor, C. Reynaud & C. Capapé (2010): Morphological abnormalities in two batoid species (Chondrichthyes) from northern Tunisian waters (central Mediterranean). Annales, Ser. Hist. Nat., 20(2), 181-190.

Mzoughi, N., F. Hellal, M. Dachraoui, J.-P. Villeneuve, C. Cattini, S. de Mora & A. El Abed (2002): Méthodologie de l'extraction des hydrocarbures polycycliques. Application à des sédiments de la lagune de Bizerte (Tunisie). C. R. Géosciences, 334, 893-901.

Sfakianakis, D. G., G. Koumoundouros, P. Divanach & M. Kentouri (2004): Osteological development of the vertebral column and of the fins in *Pagellus erythrinus* (L. 1758). Temperature effects on the development plasticity and morphoanatomical abnormalities. Aquaculture, 232, 407-424.

Sloof, W. (1982): Skeletal anomalities in fish from polluted surface waters. Aquat. Toxicol., 2, 157-173.