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Unilateral microphthalmia and slow growth rate in a natural population of the marine teleost *Pampus argenteus* (Actinopterygii: Perciformes: Stromateidae)

Einseitige Mikrophthalmie und verlangsamtes Wachstum in einer natürlichen Population des marinen Teleostiers *Pampus argenteus* (Actinopterygii: Perciformes: Stromateidae)

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Summary: Eye deformity was reported in a natural population of *Pampus argenteus* collected from the Shatt al-Arab River, Basrah, Iraq. Fifty individuals forming 26.3% of the total samples collected showed a unilateral microphthalmia, where the right eye was smaller in size than the left eye. The calculation of the relative condition factor showed that the normal fish were in better condition than the abnormal individuals. Literature suggests various causes for eye size anomalies, e.g. scrapes due to handling, stocking density, netting activity, metabolic disorders or injuries associated with rearing conditions or infectious diseases, but those of the herein reported clustering of microphthalmia are unknown.

Keywords: Fish, eye deformity, eye-sight, condition factor, environment.

Zusammenfassung. Wir berichten von Augenmissbildungen in einer natürlichen Population von *Pampus argenteus* aus dem Shatt al-Arab River, Basrah, Iraq. Fünfzig Individuen, d.h. 26,3 % der Gesamtprobe, wiesen eine einseitige Microphthalmie auf.. Das rechte Auge war stets kleiner als das linke Auge. Werte für den relativen Konditionsfaktor belegen, dass die ‚normalen' Fische in besserer Verfassung waren als die anormalen. In der Literatur werden verschiedene Ursachen für solche Anomalien genannt, z.B. Abschürfungen, Besatzdichte, Netzfang, Stoffwechselstörungen, durch die Aufzucht bedingte Verletzungen oder Infektionskrankheiten, jedoch sind die Ursachen für die hier beobachtete Häufung von Mikrophthalmie unbekannt.

Schlüsselwörter: Fischauge, Sehfähigkeit, Konditionsfaktor, Umwelt

1. Introduction

During the life of fishes different types of deformities can occur in both wild (Slooff 1982) and farmed fish (Matsuoka 2003) and can also happen starting from the larval stages (Korsøen et al. 2009; Noble et al. 2012). Deformities in fishes can lead to hindering in the body functions and can be detrimental to fish wellbeing (Huntingford et al. 2006) and process of production.

In the last few decades, the issue of fish welfare has attained importance among those who deal with fishes such as researchers, aquaculturists, retailers, quality assurance schemes, NGOs and also consumers (Huntingford et al. 2006). Concerns from such parties about this issue extend further and a number of national and international legislations and policies provide specific guidelines on preventing and dealing with injuries and abnormalities during aquaculture production, for example (the Council of Europe recommendations for farmed fish, 2005, http://www.coe.int/t/e/legal_affairs/legal_co-operation/biological_safety,_use_of_animals/Farming/Rec%20fish%20E.asp).

From a purely biological viewpoint anomalies can hamper growth rate (Miyashita et al. 2000), impact feeding and feeding ability (Kurokawa et al. 2008), increased vulnerability to infection (Turnbull et al., 1996) and as a result levels of mortality is increased (Cobcroft & Battaglene 2009). Fish deformities can affect directly the economic and the social status of the fish market (Michie 2001). Becoming acquainted with state of fish abnormalities through the observations, examinations and descriptions and reducing the presence of the different cases of anomalies will add value to high welfare standards of the fish (Olesen et al. 2010).

For fishes, the sense of vision is considered a complex form of alerting state to avoid any dangerous visual event (Ruzzante 1994).On the other hand, vision plays an important role in locating preys and other food items to continue remaining alive. Therefore, cases in aquatic ocular pathology and ocular abnormalities are often utilised as sign of fish health. It is frequently believed that eye anomalies have a genetic basis (Kennedy et al. 2004; Dhakal et al. 2015) or other causes such as disease (Karvonen & Seppäälä 2008), different types of pollution (Silverside 1976; Bilotta et al. 2004; Jezierska et al. 2009; Li et al. 2012). They can also be the result of developmental errors (Tave & Handwerker 1994).

In both the freshwater and marine waters of Iraq in particular and the Arabian Gulf area in general, eye abnormalities of fish have not been reported. Therefore, this is the first report on eye abnormality in teleost fishes for the region, which it considered as an important addition to the world marine science library. The aim of the present study was to record and describe the case of the unilateral microphthalmia in *Pampus argenteus* collected from Shatt al-Arab River, Basrah, Iraq, approximately 30 years ago.

2. Material and methods

A total of 190 specimens of *Pampus argenteus* were collected from Shatt al-Arab River, Basrah Iraq (fig. 1) in the period November 1981 to September 1982 using gill net. Specimens were kept on ice during the journey back to the laboratory. The fish samples were carefully examined for any morphological abnormalities and 50 individuals have shown unilateral microphthalmia. Standard length and eye diameter were measured to the nearest 0.1 cm. Fish weight was recorded to the nearest 0.01 g using Sartorius electronic balance model ENTRIS 60202-1S. The specimens ranged in size between 40 and 293 mm SL, and weighed between 3.2 and 1370 g.

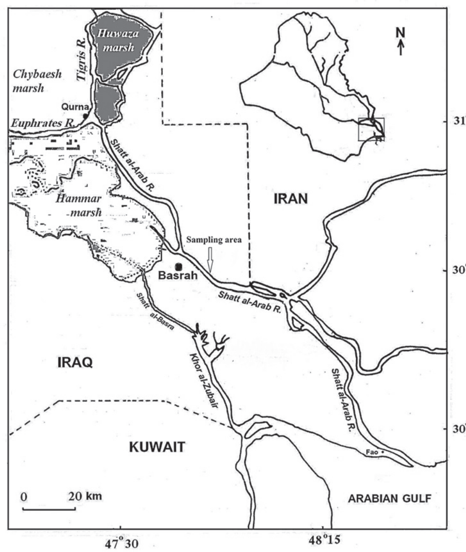


Fig. 1: Map with sampling locality and vicinity.
Abb. 1: Karte mit Fundort und Umgebung.

Of the total 190 specimens collected in the area, including the abnormal fish, four juvenile fish were excluded and the rest of 136 fish were considered to find out the relationships between SL and total body weight (TW), SL and eye diameter (ED) and for estimation of relative condition factor (Kn) to know whether the specimens are capable to grow normally in their habitat, such patterns apply both abnormal and normal specimens. The length-weight-relationships were estimated separately for normal and abnormal specimens using the equation, $W = aL^b$, where, W is the total body weight in g, SL is the standard length in mm and ‘a’ and ‘b’ are the constants to be determined. Analysis of covariance (ANCOVA) (Snedecor & Cochran 1967) test was used to find out the significant difference if any, between the relationships of normal and abnormal fish. The coefficient of determination (r^2) was used as an indicator of the quality of the linear regression (SCHERRER 1984). SL-ED relationships were established using regression analysis. The values of Kn were estimated adapting the formula of LE CREN (1951) as, $Kn = TW/aL^b$ where TW = observed weight (g), aL^b = calculated weight obtained from the length-weight relationship.

The collection of the specimens was accomplished when the senior author was in service at the Marine Science Centre, University of Basrah, Iraq in the period 1980-1993. The collection was made in the years 1980-1981, when the 1st Gulf war was going on and when the research status at University of Basrah was hampered due to the war activities. Therefore, no histological examinations were performed and only basic information was obtained for the fish specimens.

3. Results

Of the 190 sampled at random 50 (26.3%) had unilateral microphthalmia, where their right eye appeared smaller than the left eye (fig. 2). The eye diameter of the normal and the abnormal specimens ranges 8.0-17.5 and 4.3-8.9 mm respectively. Most of the abnormal eye (90%) had gross ocular inflammation and haemorrhages. No other morphological anomalies were observed in the eyed-deformed specimens.

The length-weight relationships of normal (fig. 3A) and abnormal (fig. 3B) fish differed significantly ($P < 0.05$) (tab. 1). The r^2 values for normal fish and abnormal fish were 0.9894 and 0.8175, respectively. The higher b value in normal fish than in abnormal fish shows that the normal fish gain more weight in the environment than the abnormal fish. The SL-ED relationships for normal (fig. 4A) and abnormal (fig. 4B) fish showed the r^2 values being 0.861 and 0.8874, respectively.

The Kn values are calculated to understand the general well-being of the fish. The Kn values estimated for normal fish (fig. 5A) indicated an average of 1.0445, whereas in the abnormal fish (Fig. 5B) the average value was 0.9971. This shows that the normal fish were in better condition than the abnormal individuals.

The fishes with microphthalmia have shown lower growth rates than the normal individuals collected from the same area and from the same catch. Such deviation from the growth rate level that the normal specimens show is clearly seen in the L-W-relationship plot (fig. 3). Similarly, the ED measurements of the abnormal specimens stand as outliners in the linear regression of the ED-SL (fig. 4). The retarded growth rate in the fish samples with microphthalmia can be explained on the bases that these individuals are facing problem in locating food.

4. Discussion

Although the data are over 30 years old, they represent the only reported case of eye anomaly

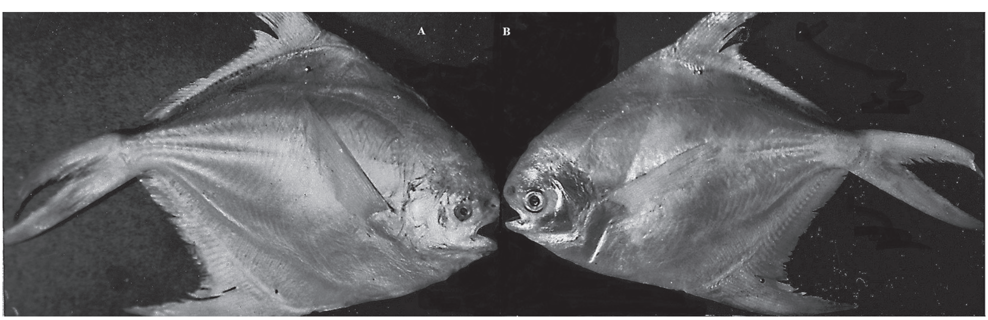


Fig. 2: Representative specimen of the abnormal *Pampus argenteus* collected from Shatt al-Arab River, Basrah, Iraq showing microphthalmia. **A** Right side. **B** Left side.

Abb. 2: Repräsentatives Exemplar eines anormalen *Pampus argenteus* aus dem Shatt al-Arab River, Basrah, Iraq mit Microphthalmie. **A** Rechte Seite. **B** Linke Seite.

Tab. 1: Comparison of length-weight relationships between normal (n = 136) and abnormal specimens (n = 50) of *Pampus argenteus*.
Tab. 1: Vergleich der Verhältnisse von Länge und Gewicht von normalen (n = 136) und anormalen (n = 50) *Pampus argenteus*..

						Deviations from regression				
Source	d.f.	ssx	ssy	spxy	Reg.coef	d.f.	S.S.	M.S	F	Prob
Within										
Normal	136	10.05626	112.1254	33.40071	3.321386	133	1.188711	0.008938		
Abnormal	50	0.517259	2.465809	1.021116	1.974089	49	0.450036	0.009184		
						182	1.638747	0.009004		
Pooled W	186	10.57352	114.5912	34.42182	3.255476	183	2.531747	0.013835		
		Difference between slopes				1	0.893	0.893	64.54791	1.12212E-13
Between B										
W+B	186	10.57642	141.6585	34.14124		184	31.44882			
		Between adjusted means				1	28.91707	28.91707	2090.187	4.6806E-102

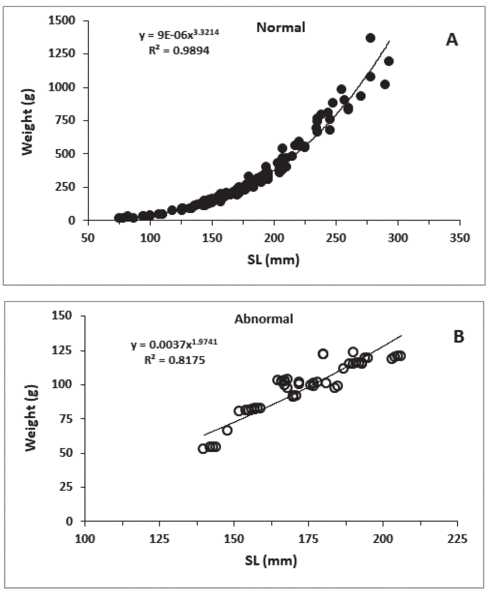


Fig. 3: Length-weight relationships of *Pampus argenteus*. **A** Normal (n = 136). **B** Abnormal (n = 50).
Abb. 3: Verhältnis von Länge und Gewicht von *Pampus argenteus*. **A** Normal (n = 136). **B** Anormal (n = 50).

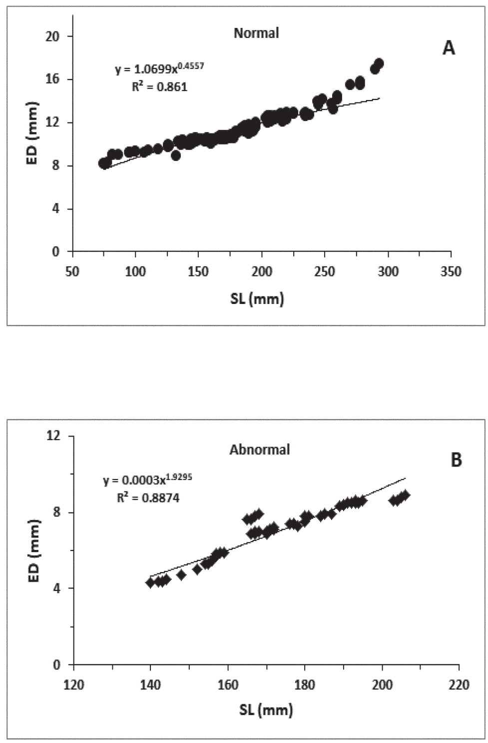
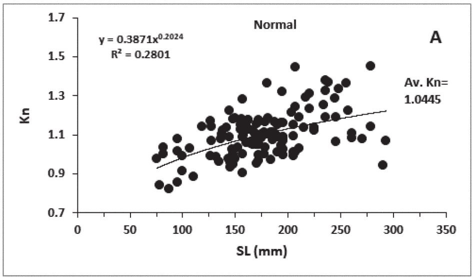


Fig. 4: Relationship of the standard length (SL) and eye diameter (ED) of *Pampus argenteus*. **A** Normal (n = 136). **B** Abnormal (n = 50).
Abb. 4: Verhältnis von Standardlänge (SL) und Augendurchmesser (ED von *Pampus argenteus*. **A** Normal (n = 136). **B** Abnormal (n = 50).

for *Pampus argenteus* from the freshwater areas of Iraq and the Arabian Gulf region. Results show that fish individuals with unilateral eye abnormalities seem to have less chance to have a normal growth rate as those of the normal individuals.

The substantially reduced final weight, specific growth rate and condition factor observed in fishes with abnormal eyes obviously suggests that the case of unilateral microphthalmia may risk growth and condition of those specimens.

Any changes in the fish‘s eye-sight during the early stages of life due to loss or damage could be effective in the case of *P. argenteus* as this species is a visual predator similar to many spe-



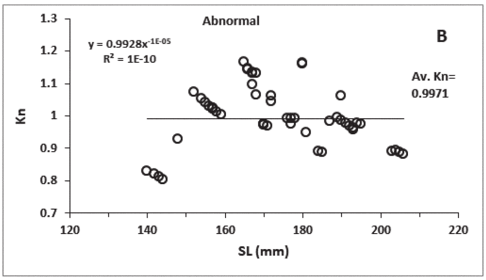


Fig. 5: Relative condition factor (Kn) of *Pampus argenteus* **A** Normal (n = 136). **B** Abnormal (n = 50).
Abb. 5: Relativer Konditionsfaktor (Kn) von *Pampus argenteus*. **A** Normal (n = 136). **B** Abnormal (n = 50).

cies of fish at larval stage (Davis & Olla 1995; Porter & Theilacker 1999). Such damage or loss can affect the antipredator behaviour, where the fish exhibit rapid burst of swimming as a panic response (Quist & Guy 2004). On the other hand, *P. argenteus* is a zooplanktivorous fish and any changes in the eye sight could affect the mechanistic foraging models that account for visual reactive field volumes (Werner & Hall 1974), prey visibility (Zaret & Kerfoot 1975), prey motion (Zaret 1972) and the apparent size of prey (O'Brien et al. 1976).

Ultimately, the causes of the herein reported anomaly in *P. argenteus* are not clear, but other authors have discussed reasons for eye size anomalies in fish such as scrapes due to handling, stocking density (Wedemyer 1992), netting activity (Dobson & Schuurman 1990) metabolic disorders (Candan & Erguven 1992), injuries associated with rearing conditions (Colorni 1989) or infectious diseases (Miyazaki 1982; Toranzo et al. 1993). In Shatt al-Arab River, individuals of *P. argenteus* are usually collected by gill net, which might be one of the mechanical causes of microphthalmia.

As no histological examinations were performed on the fish samples due to the reasons mentioned above, it is not possible to determine whether the fish specimens collected have been infected with parasites.

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