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Recent advances in Mediterranean aquaculture finfish species diversification

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 47

2000
pages 89-95

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SUMMARY – This paper summarises some results from different research programs carried out over the last decade on the seed quality of Mediterranean aquaculture finfish. Ever since modern Mediterranean aquaculture began, the Laboratory of Experimental Ecology and Aquaculture of the University of Tor Vergata has been collecting data on sea bass and sea bream. Inspections considered meristic counts and skeletal anomalies. The data analysis of anomalies observed in sea bass and sea bream, both in wild and reared populations, allow the following conclusions to be drawn: (i) it is possible to assess the larval and post-larval quality of sea bass and sea bream by comparing wild and reared phenotypes; and (ii) different rearing techniques may modulate quality from a morphological point of view. Part of this information is currently being applied to new candidates for aquaculture, as common sea bream, pandora, dentex, thick lipped mullet and sharpsnout sea bream and could be further applied to other finfishes in order to evaluate the stage of development of a diversified and responsible Mediterranean aquaculture.

Key words: Skeletal anomalies, wild finfish, reared finfish, new candidate species.

RESUME – *"Qualité de la semence chez les poissons méditerranéens sauvages et élevés". Cet article résume les résultats des différents programmes de recherche conduits dans les dernières dix années sur la thématique de la qualité des alevins de l'aquaculture de la Méditerranée. Depuis la naissance de la moderne aquaculture dans le bassin de la Méditerranée, le Laboratoire d'Ecologie Expérimentale et d'Aquaculture de l'Université de Tor Vergata a commencé à collectionner les données sur le loup (*Dicentrarchus labrax*) et la daurade (*Sparus aurata*). Le domaine des observations a concerné le comptage des caractères méristiques et les déformations squelettiques. L'analyse des données des anomalies observées pour le loup et la daurade, soit pour les populations sauvages, soit pour les lots élevés, a permis les suivantes conclusions : (i) l'évaluation de la qualité larvaire et post-larvaire du loup et de la daurade est possible en comparant des phénotypes sauvages et élevés ; et (ii) les différentes techniques d'élevage peuvent moduler la qualité morphologique des larves et des alevins. Une partie de ces informations est actuellement utilisée sur les nouveaux candidats pour l'aquaculture, comme pagre commun, pageau, denté commun, mulet à grosses lèvres and sar à museau pointu et pourrait trouver une ultérieure utilisation pour d'autres poissons, afin d'évaluer le stade de développement d'une aquaculture méditerranéenne responsable et diversifiée.*

Mots-clés : *Déformations squelettiques, poissons sauvages, poissons élevés, nouveaux candidats.*

Introduction

During the last decade, farmed Mediterranean finfish production has increased extensively. The European production of sea bream and sea bass rose from 2500 mt in 1989 to about 60,000 mt in 1996. On the other hand, although costs have been driven down, market prices almost halved in the period 1990-97, from US$ 16/kg to around US$ 8/kg (Lem and Shehadeh, 1997). These conditions impose new aquaculture strategies. With the large number of tools available, the diversification of the species farmed, the utilisation of less expensive technologies and the improvement of the quality, farmed finfish could ensure acceptable profit margins. In particular, diversification in aquaculture can provide one of the most efficient tools for increasing the number of opportunities in this emerging activity. At present, at global level, more than 200 fish, crustacean and mollusc species are produced (Garibaldi, 1996) using different rearing technologies.

Within this context, the present paper deals with "traditional" farmed Mediterranean species, reared with different technologies, as well as some new species for aquaculture. Quality evaluation based on morphological anomalies has been attempted with reference to the wild phenotype. Morphoanatomical criteria have been adopted to assess the quality of farmed juveniles as they refer to the chronology and conformity of development (Chatain, 1994). Skeletal deformations may be present also in wild fish but with a lower frequency and less severe typology than in farmed fish. Morphological anomalies may therefore represent the consequences of inadequate rearing conditions during larval development and the more serious types can affect the external shape of the fish, leading to a substantial drop in market value.

In this framework, the inspection of differences in the frequency and typology of observed skeletal abnormalities both in wild and reared species, may represent an interesting approach to the certification of quality product, as well as identifying the most suitable production for sea-ranching purposes.

Materials and methods

The investigation involved the "larval monitoring" approach (Boglione *et al.*, 1998a,b,c), carried out on a total of 4402 individuals, including wild groups (Table 1).

Table 1. Characterisation of samplings utilised for anatomical observation: numbers in brackets indicate the sample size

Species	Number of observed individuals	
	Wild	Reared
D. labrax (DL)	DLw (51); DLw5 (67); DLw8 (161)	DLr (958) (from 90 days to commercial size)
S. aurata (SA)	SAw (72); SAwt (88)	SAr (1519): from 70 days to commercial size
C. labrosus (CL)	CLw (345)	(47) CLr: 30 days
D. puntazzo (DP)	DPw (126)	(624) DPr: 50-100 days
P. erythrynus (PE)	0	(130) PEr: 140-204 days
P. pagrus (PP)	0	(144) PPr: 40-60 days
D. dentex (DD)	0	(70) DDr: 30-60 days

According to this methodology, individuals were *in toto* stained with Alizarin red for calcified structures and alcian blue for cartilage (Park and Kim, 1984; Taylor and Van Dike, 1985). Anatomical observations refer to the count and classification of anatomical anomalies (Table 2).

Histograms of frequency of anomalies have been created.

Results

The frequencies of individuals without any anomaly is visualised as histograms in Fig. 1 whilst frequencies of individuals with severe anomalies (as axis and vertebrae deformations) is reported in Fig. 2.

Some examples of observed anomalies are showed in Fig. 3.

Reared dentex, gilthead sea bream and sea bass are the groups with the heaviest malformation charge (Figs 1, 2 and 5). Wild individuals showed very low frequencies of malformed individuals, and, as evidenced in Fig. 2, only DLw showed severe anomalies in as high as 40% of observed individuals.

Table 2. Legend of considered anomalies

Region	
A	Cephalic
B	Pre-hemal
C	Hemal
D	Caudal
E	Pectoral fin
F	Anal fin
G	Caudal fin
H	Dorsal spines
I	Dorsal soft rays
Anomalies	
1	Lordosis
2	Kyphosis
S	Scoliosis
3	Vertebral fusion
4	Vertebral malformation
5	Malformed neural arch and/or spine
6	Malformed hemal arch and/or spine
7	Malformed ray (deformed, absent, fused, supernumerary)
8	Malformed pterygophores (deformed, absent, fused, supernumerary)
9	Malformed hypural (deformed, absent, fused, supernumerary)
10	Malformed epural (deformed, absent, fused, supernumerary)
12	Swim-bladder anomalies
13	Presence of calculi in the urinary ducts
14	Malformed dentale
15	Malformed maxillary and/or premaxillary
16	Dislocation of glossohyal
17	Malformed left opercle
18	Malformed predorsal bones (deformed, absent, fused, supernumerary)
19	Supernumerary vertebra
SB	Saddle back

The analysis of the distribution of anomalies in the different body regions (Fig. 4) indicates major occurrences of malformation in the hemal region (region C) in sea bass; in the caudal region (D and G regions) in gilthead sea bream; in the hemal region (C) and in the pectoral fin (E) in thick lipped mullet; in dorsal fin spines in sharpsnout sea bream. Dentex, common and sharpsnout sea bream, and pandora did not show any particular pattern.

Analysing the single lots (data not shown) it was found that distinct groups of sea bass differed for the type of observed anomalies as well as the lots showed differences not in the type of anomalies but in the values of frequencies of the same caudal anomalies.

The lowest malformations index (a fictitious indicator which value represents how many anomalies are averaged exhibited by each individual, showed in Fig. 5) was observed in wild sharpsnout sea bream (DPw), followed by wild gilthead sea bream (SAw, SAwt), thick lipped mullet (CLw) and sea bass (DLw5).

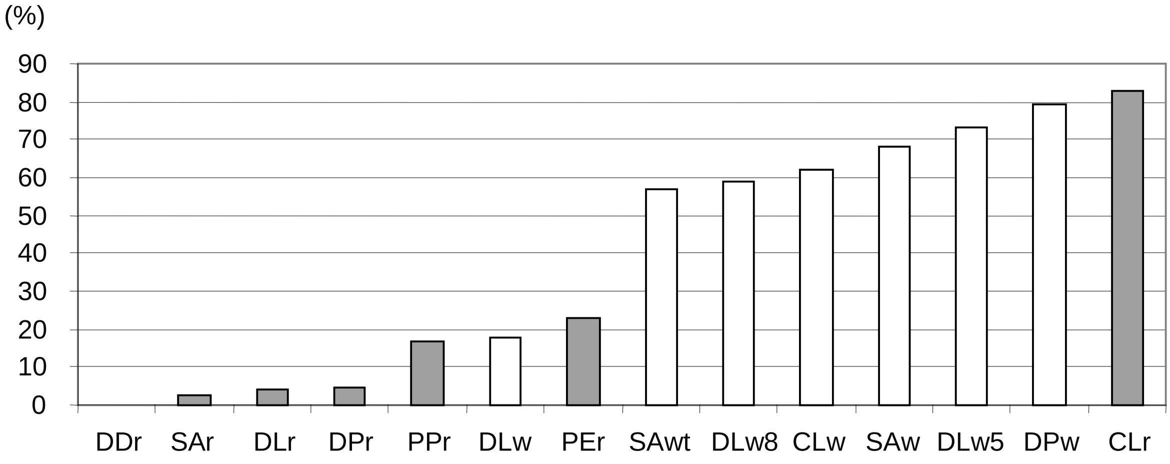

Fig. 1. Frequencies (percent) of individuals with no anomalies in each group (white bar = wild group).

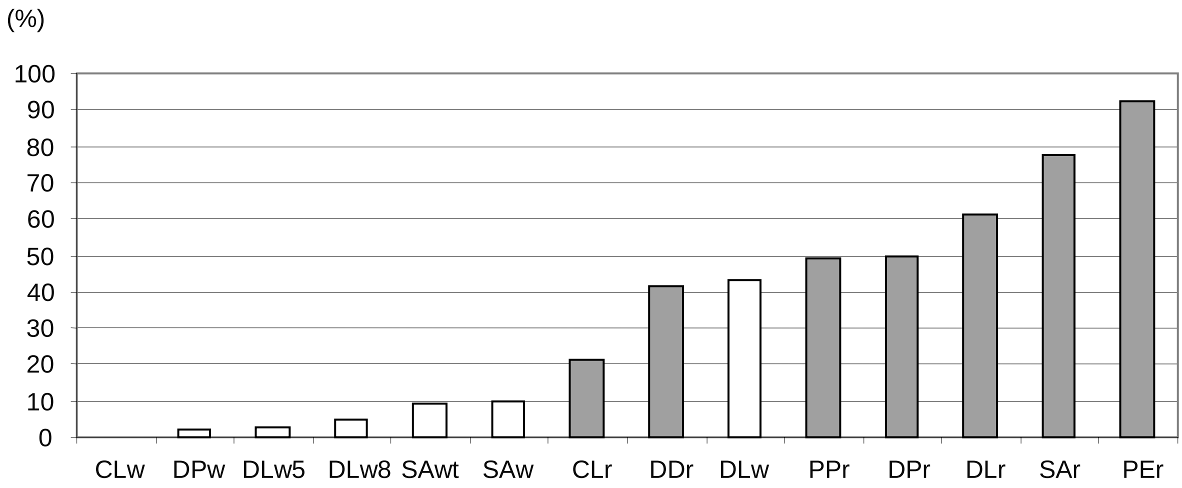

Fig. 2. Frequencies (percent) of individuals with severe anomalies in each group (white bar = wild group).

Fused and deformed branchial lamellae, malformed dentale and pre-maxillar bones and eye anomalies have been observed in the case of new candidate species.

Conclusions

Our results indicate a substantially low quality for reared Mediterranean species: severe anomalies (such as kyphosis, lordosis, scoliosis, vertebrae fusions or deformations and splanchno-cranium anomalies) affected 20-90% (according to the species) of the observed reared individuals. On the other hand, wild samples were generally unaffected by severe anomalies, with the sole exception of wild group of sea bass DLw.

Acknowledgements

Italian Ministry of Agricultural Policy (Law 41/82) funded this study.

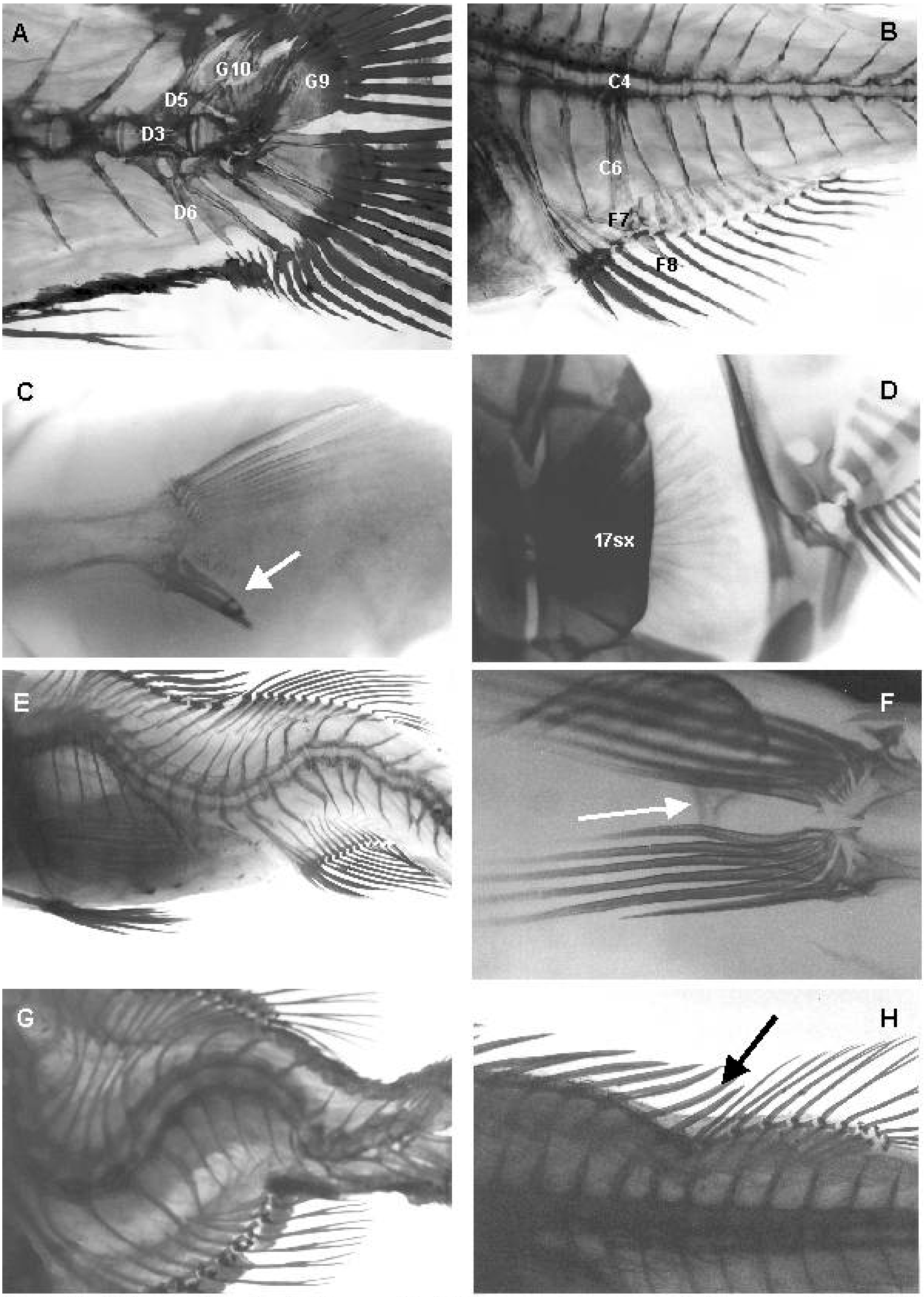

Fig. 3. Skeletal anomalies checked in reared fish. The anomalies are encoded as presented in Table 2. A: sharpsnout sea bream; B: sharpsnout sea bream; C: the arrow indicates an unsymmetrical number of rays in pelvic fins of sharpsnout sea bream; D: curved opercular in sea bass; E: a severe kypho-lordosis and deformed vertebrae in sea bass; F: the arrow points at the base of an additional pelvic fin (heteropteria) in sea bass; G: kypho-lordosis, deformed vertebrae and arches in pandora; H: a malformation (saddle back) inspected in pandora.

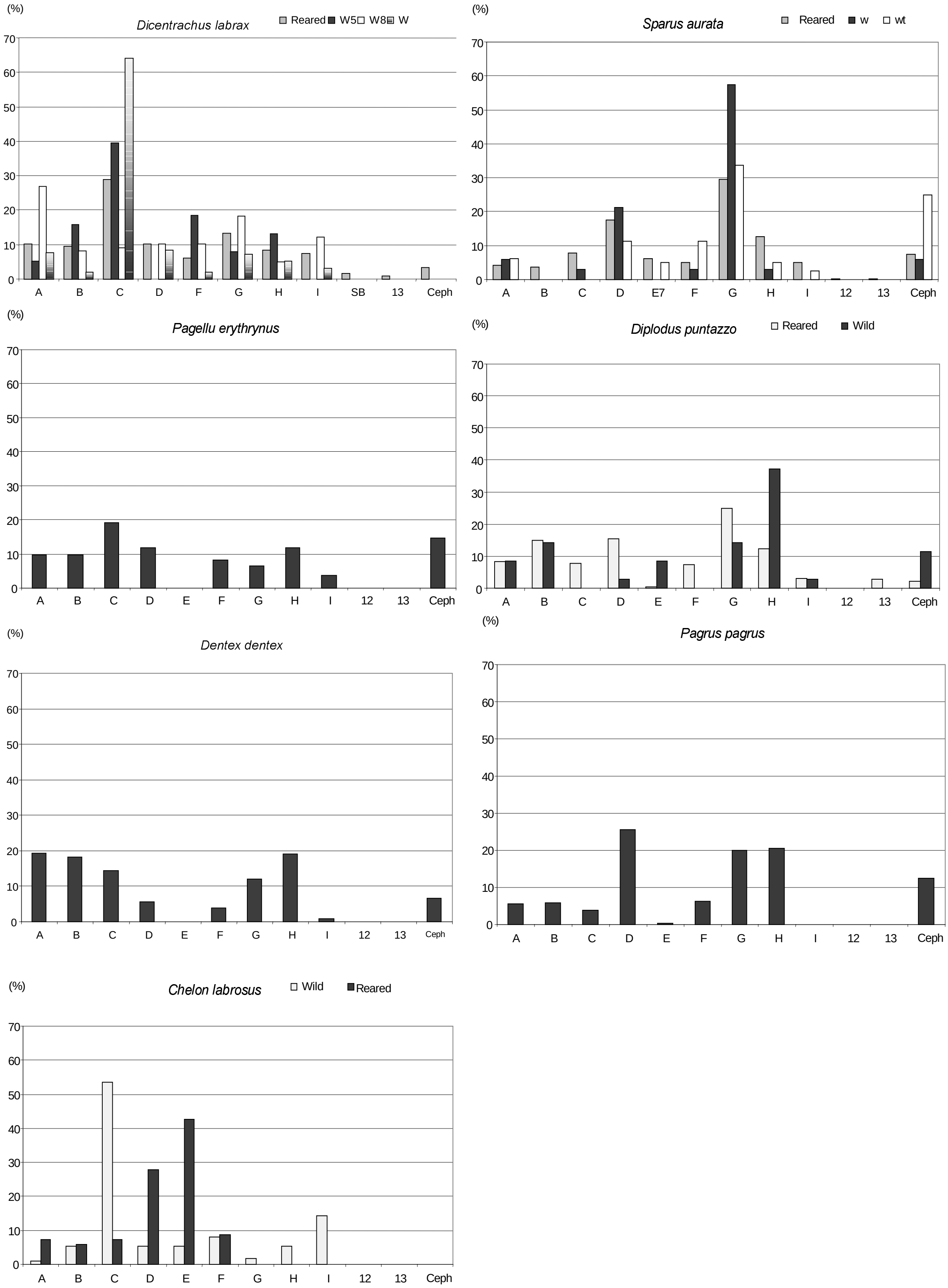

Fig. 4. Relative frequencies of anomalies observed in different body regions in each group. Codes for body regions are referred in Table 2. Dentex, common sea bream and pandora data are referred only to reared individuals.

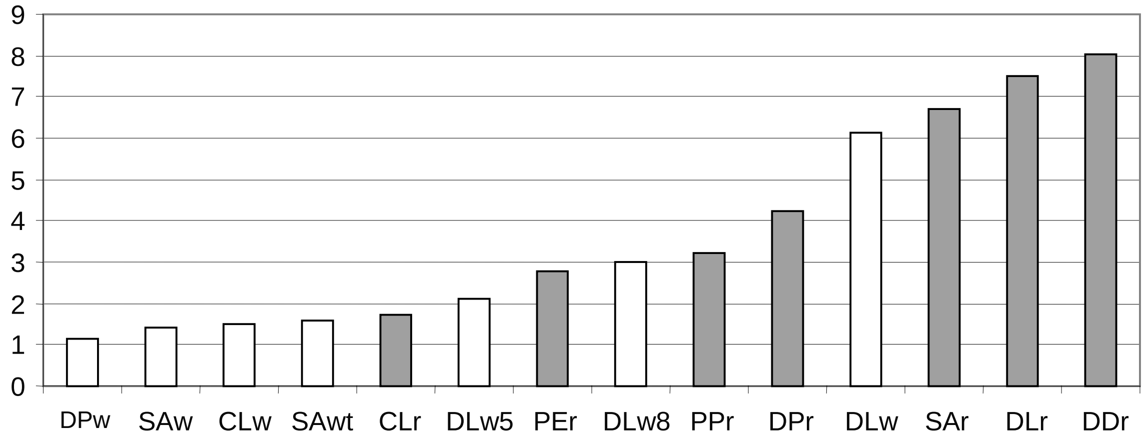

Fig. 5. Malformation index (number of total anomalies inspected in each group/number of individuals with at least one anomaly) (white bar = wild group).

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