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A CASE OF HERMAPHRODITISM IN THE EUROPEAN ANCHOVY *Engraulis encrasicolus* IN THE GULF OF CÁDIZ (NE ATLANTIC)

SHORT NOTE

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ABSTRACT

An hermaphroditic specimen of European anchovy *Engraulis encrasicolus* was caught during a Spanish Institute of Oceanography (IEO) survey carried out in waters of the Gulf of Cadiz (NE Atlantic Ocean). The gonad was clearly formed by one ovary and one testis. The histological study revealed that both lobules were active and functional.

Key words: *Engraulis encrasicolus*, European anchovy, hermaphroditism, Gulf of Cádiz

RESUMEN

En el transcurso de una campaña oceanográfica llevada a cabo por el instituto español de oceanografía (IEO) en aguas del Golfo de Cádiz (NE Océano Atlántico), se capturó un individuo hermafrodita de boquerón *Engraulis encrasicolus*. La gónada estaba claramente formada por un ovario y un testículo. El estudio histológico reveló que ambos lóbulos eran activos y funcionales.

Palabras clave: *Engraulis encrasicolus,* boquerón, hermafroditismo, Golfo de Cádiz.

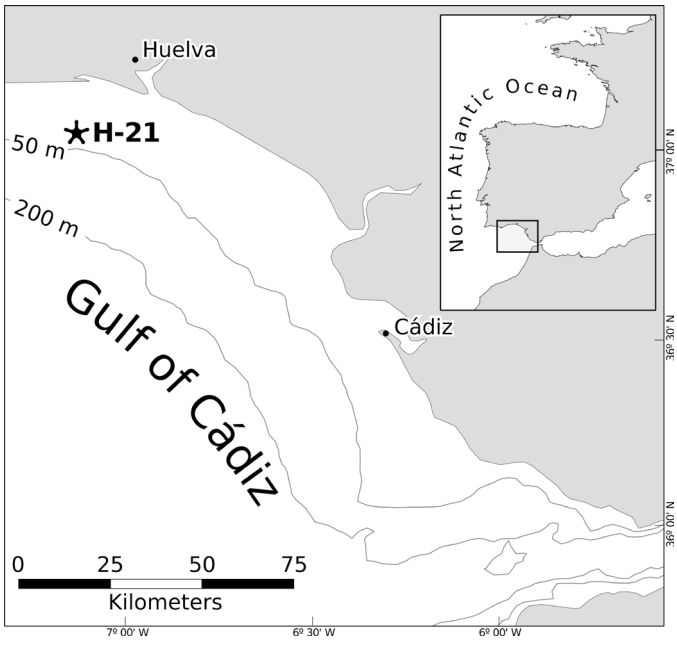

Figure 1:
Map showing the location of the haul 21 from BOCADEVA0711 survey.

Spanish Institute of Oceanography (IEO) carries out, on a triennial basis, the BOCADEVA Daily Egg Production Method (DEPM) survey series in waters of the Gulf of Cadiz (NE Atlantic Ocean, Fig.1). The main goal of BOCADEVA series surveys is the estimation of the spawning stock biomass (SSB) of European anchovy *Engraulis encrasicolus* L. 1758, in the scope of IEO's project ICITIOEVA (Egg Production Methods. Estimation of the stock biomass of important commercial pelagic species: sardine, mackerel, anchovy and Atlantic horse mackerel). During the survey BOCADEVA0711 carried out from July, 30 2011 through August, 1 2011, a hermaphrodite individual of *E. encrasicolus* was found during a biological sampling on haul 21 (37 º 3' 53.5'' N, 7º 7' 31'' W) at a depth of 39 m, 16 km off coast.

Specimen total length (TL, 123 mm), total weight (W_t, 10.60 g), eviscerated weight (W_e, 9.20 g) and gonad weight (W_g, 0.60) were recorded. The gonad was clearly formed by one ovary (Ov, left lobule) and one testis (Ts, right lobule) (Fig. 2). Macroscopic maturity stage was assigned, following the key proposed by ICES (2008). According to this stage key, the presence of yolked and opaque eggs indicated that the ovary was in stage 3 (active, imminent spawning), despite its size was smaller than expected for this stage. Testis was classified into stage 3 due to its size, whitish-creamy color and the absence of free expelled sperm when slightly pressed.

The gonad was removed from specimen's body, fixed and preserved in 4% phosphate buffered formaldehyde. Tissue samples from the central region of both female and male gonads were taken, embedded in Technovit 7100 GMA resin and 3 µm thick slices where cut in a rotary microtome, mounted in standard microscope slides and stained with hematoxiline and eosin counterstain. Histological examination of the ovary revealed the presence of oocytes in different developmental stages, some of them showing cortical alveoli. Post-ovullatory follicles (POF's) and some signs of atresia were observed as well (Fig. 3A). These facts suggested that ovary was in the regressing phase (Brown-Peterson *et al*. 2007), despite macroscopical aspect suggested a spawning capable specimen. In any case, ovary could be considered as active and functional. Regarding the testis, its histological study revealed an anastomosing tubular testis type (Grier and Uribe, 2009) where spermatocysts with developing germ cells, and free spermatozoa in the lumen of the tubules, could be observed (Fig. 3B). According to Brown-Peterson *et al*. (2007) the testis was on spawning capable or actively spawning phase and was also active and functional.

This is the first record of a case of hermaphroditsm in this species, *E. encrasicolus*. A large number of gonochoristic species of teleosts have been also identified that have produced rare or highly unusual

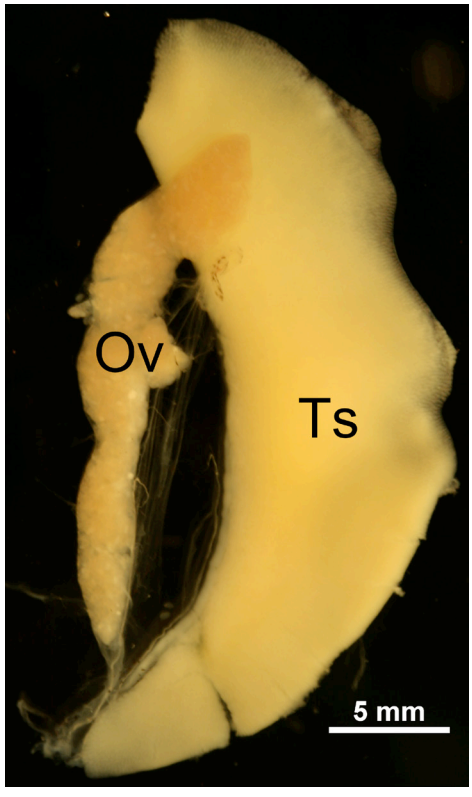

Figure 2:
Macroscopic view of gonad showing ovarian (Ov) and testis (T).

morphologically bisexual individuals, e.g. *Salmo trutta* (O'Farrell and Pierce, 1989) or *Sardinops sagax* (Herrera *et al*., 1991). Such exceptional cases are also termed as abnormal hermaphrodites or intersexes to distinguish an aberrant phenomenon in a normally gonochoristic species from true hermaphroditism, and are often observed by chance in field or laboratory surveys (Kinnison *et al*., 2000; Devlin and Nagahama, 2002), as it was our case. These species are clearly not normally and functionally hermaphroditic, and sometimes it is related with polluted or otherwise abnormally-stressed conditions as Fraser (1997) reported in his study about a hermaphroditic individual of Artic charr *Salvelinus alpinus*.

Literature cites different cases of abnormal hermaphroditism. In some species, ovarian regions seemed to be dominant, as it was the case of *Menida beryllina* where the 10% of the gonad was testis in a female (Yan, 1984), or *Heterandria formosa* with a gonad showing signs of vitellogenic oocytes and spermatozoa (Riehl, 1991). Kinnison *et al*. (2000) described two macroscopic types of gonads in intersexual salmonids, depending on the distribution of ovarian and testicular tissue: lobular (sections of ovarian and testicular tissue along the supporting structure of one or both gonads) and mosaic (superficial patches of ovarian tissue on the surface of testicular tissue or scattered and embedded oocytes in the testicular tissue). The lobular form includes intersexual individuals of *Oncorhynchus tshawytscha* and *Oncorhynchus kisutch* founded in New Zealand and Chile, respectively. Our case could be identified as an extreme case of the lobular type since the female lobule was totally separate from the masculine lobule. Finally, and taking into account that both gonads were in an active spawning phase, our specimen could also be classify as a case of simultaneous hermaphroditism (Sadovy and Shapiro, 1987).

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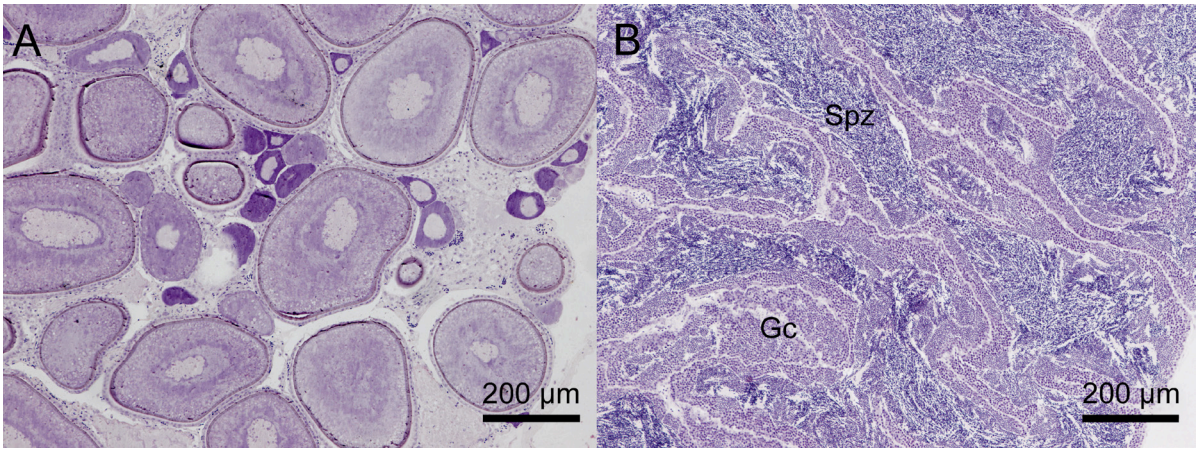

Figure 3:

A. Histological section of the ovary: Oocytes of differente sizes, signs of atresia and POF's are observed. B. Histological section of the testis: The lumen of the tubules is filled with spermatozoa (Spz), and at the periphery of the lumen there are spermatocysts with developing germ cells (Gc).

REFERENCES

Brown-Peterson N, Lowere-Barbieri S, Macewicz B, Saborido-Rey F, Tomkiewicz J, Wyanski, D (2007). An improved and simplified terminology for reproductive classification in fishes. Joint Meeting of ichthyologists and herpetologists conference, St. Louis (Missouri, USA).

Devlin RH, Nagahama Y (2002). Sex determination and sex differentiation in fish: an overview of genetic, physiological, and environmental influences. Aquaculture, 208: 191-364.

Fraser D (1997) A hermaphroditic Artic charr from Loch Rannoch, Scotland. Journal of Fish Biology, 50:1358-1359.

Grier HJ, Uribe MC (2009) Chapter 4: Male reproductive system: testis, spermatogenesis and testicular cycles. In: Jamieson B, ed, Reproductive biology and phylogeny of fish (agnatha and bony fishes), Inc Enfield. NH, USA; Plymouth, UK: Science Publishers, pages 119-142.

Herrera G, Padilla C, Claramunt G, Pizarro P, Garland D (1991). Synchronous hermaphroditism of the intersex type in the spanish sardine *Sardinops sagax* Jenyns 1842. Revista de Biología Marina y Oceanografía, 26: 81–89

ICES (2008). Report of the Workshop on Small Pelagics (*Sardina pilchardus, Engraulis encrasicolus*) maturity stages (WKSPMAT). 10-14 November 2008, Mazara del Vallo (Italy). Available at http://www.ices.dk/reports/ACOM/2008/WKSPMAT/wkspmat_2008.pdf

Kinnison MT, Unwin, MJ, Jara F (2000). Macroscopic intersexuality in salmonid fishes. New Zealand Journal of Marine and Freshwater Research, 34: 125-134.

O'Farrell MM, Pierce RE (1989). The occurrence of a gynandromorphic migratory trout, *Salmo trutta* L. Journal of Fish Biology, 34: 327.

Riehl R (1991). Masculinization in a hermaphroditic female of the mosquitofish *Heterandria formosa*. Japanese Journal of Ichthyology, 37: 374– 380.

Sadovy YD, Shapiro Y (1987). Criteria for the diagnosis of hermaphroditism in fishes. Copeia, 1: 136-156.

Yan HY (1984). Occurrence of spermatozoa and eggs in the gonad of tidewater silverside, *Menidia beryllina*. Copeia, 544–545.