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Occurrence of the scalloped ribbonfish *Zu cristatus* (Lampridiformes) in coastal waters of the central Tyrrhenian Sea, Italy

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The occurrence of two individuals of *Zu cristatus* at 2 m depth in coastal waters of the Gulf of Castellamare (Tyrrhenian Sea, Italy) together with records of this rare pan-Oceanic mesopelagic species is reported. Analyses of two mitochondrial genes (12 s and 16 s; 936 bp) revealed a 2·6% sequence divergence between Mediterranean and Pacific (Japanese) samples of the species.

Key words: littoral record; mitochondrial DNA; *Zu cristatus*.

The scalloped ribbonfish *Zu cristatus* (Bonelli) is one of the two species included in the genus *Zu* Walters & Fitch, 1960. It is mostly mesopelagic and shows a pan-Oceanic distribution (Aguiar & Quero, 1990; Froese & Pauly, 2004). Records of this species are relatively rare, especially in coastal areas, as summarized in Table I. Two young specimens of *Z. cristatus* (150 and 180 mm standard length, L_S) were found at *c.* 2 m depth at the Santa Croce Bank, Gulf of Castellamare, central Tyrrhenian Sea (13° 54′ 47 E; 40° 44′ 92 N). The fish were swimming slowly in shallow water and were easily collected by a diver with a hand-net. The Santa Croce Bank is a protected area known to host high levels of biodiversity as compared to adjacent zones (Bussotti *et al.*, 1999; Zupo, 2002). The functional role of biological refugia, possibly with suitable trophic and hydrographic conditions, might explain the occasional presence, in this area, of fish species usually living in deeper waters.

One fish, which was moribund at capture, was preserved in ethyl alcohol (Fig. 1) and it is now conserved in the collection of the Zoological Department

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TABLE I. Most important pan-Oceanic records of *Zu cristatus*. The holotype of the species (type locality Lerici, Gulf of La Spezia) is in the Regional Museum of Natural History, Turin, Italy (MZUT 1119) (Tortonese, 1940). In addition, *c.* 12 specimens from the Tyrrhenian Sea are in the Genoa Museum of Natural History (Tortonese, 1940)

Region	Marine zone	Stage	Years	Notes	Reference
Mediterranean					
Middle Adriatic Sea	Epipelagic	Eggs	2002	First record of eggs	Dulcic (2002)
Adriatic Sea	Littoral	Juveniles	1979	Unusual record	Jardas (1980)
Ionian-Aegean Sea	Mesopelagic	Adult	1985–2002	Two fish	C. Papacostantinou (pers. comm.)
Tyrrhenian Sea	Mesopelagic	Adult	1980–2002	Two fish	G.D. Ardizzone (pers. comm.)
Tyrrhenian Sea	Littoral	Juveniles	1998	Shallow water (2 m)	This contribution
Ligurian Sea	Epipelagic	Adult	1976	Shallow water (20 m)	Gavagnin (1976)
Sardinian Sea	Mesopelagic	Adult	1979	First record	Cau (1980)
Balearic Islands	Mesopelagic	Adult	1980	Occasional record	Oliver (1981)
Catalonian Sea	Littoral	Adult (1·12 m)	1978	First record	Roig & Demestre (1980)
Spain	Mesopelagic	Adult	1969	New record	Ibáñez & Gállego (1974)
Spain	Mesopelagic	Adult	1982–2002	One fish	J.C. Quero (pers. comm.)
Atlantic					
Middle Atlantic	Epipelagic	Eggs	1980	Occasional record	Olney & Naplin (1980)
Gulf of Mexico	Bathypelagic	Adult	1978	New record	Eckmayer (1982)
Indo-Pacific					
Tasmanian Sea	Mesopelagic	Adult	1983	Occasional record	Scott (1984)
Seto Inland Sea, Japan	Epipelagic	Adult	1991–1998	New record	Shimizu (2001)
China Sea, Taiwan	Epipelagic	Larvae, Adult	1993	New record	Young *et al.* (1994)
Western Indian Ocean, Kenya	Mesopelagic	Adult	1984	Occasional record	Heemstra & Kannemeyer (1984)
Indian Ocean, South Africa	Bathypelagic	Adult	1984	*Zu elongatus n.sp.*	Heemstra & Kannemeyer (1984)
Pacific Ocean, Baja California	Mesopelagic	Adult	1978	First record	Fitch & Schultz (1978)
Pacific Ocean, Peru	Mesopelagic	Adult	1977	First record	Chirichigno (1978)

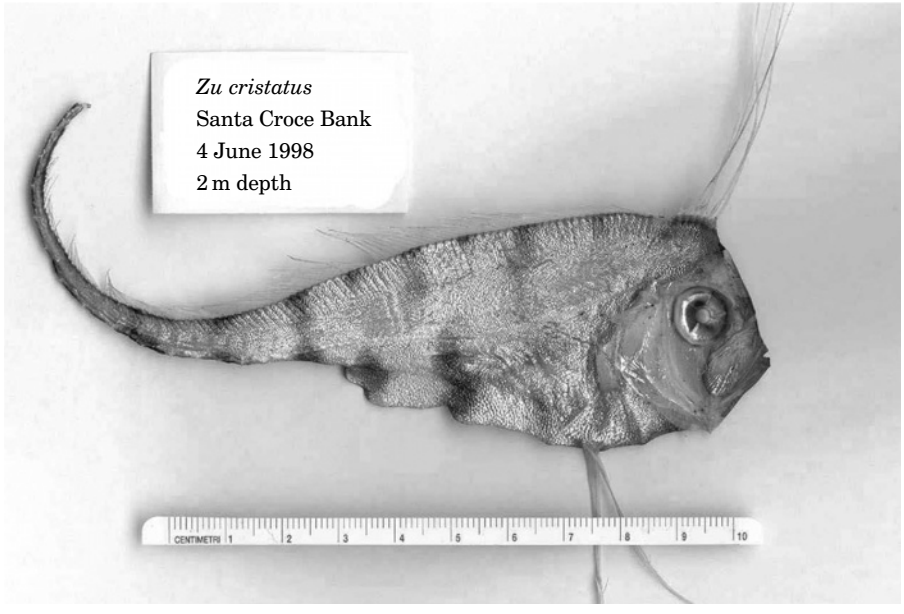

FIG. 1. *Zu cristatus*: the specimen collected at Santa Croce Bank, central Tyrrhenian Sea, Italy

of the University of Naples, Italy (catalogue number, IZA 041). The other specimen was in better conditions and immediately released, while still alive.

The morphology of the preserved specimen is as follows: *c*. 180 mm L_S (from tip of snout to the last hypural vertebra; caudal fin is missing); sharp and lobate keel from insertion of the pectoral fins to the anus; body covered with cycloid scales; *c*. 107+ scales on the lateral line, each with a sharp central spine, except the anterior ones; all rays of fins are unbranched; dorsal fin with 5 very elongate rays, followed by one reduced ray and 114 complete rays; anal fin absent; pectoral fins with 12 and 11 rays on left and right side respectively; pelvic fin with 9 rays; 11 total gill rakers (8 on the ceratobranchial, and 3 on the epibranchial of the first left gill arch). Head length, from the tip of snout to the posteriormost margin of left opercular bone, opercular marginal membranae included, 38 mm; head depth, taken from the vertical crossing the mental spine to the outer margin of dorsal crest, 41 mm; eye diameter, taken horizontally, 10 mm; depth of body, taken at vertical crossing the insertion of pelvic fins, 41 mm.

The morphology of this specimen agrees with the descriptions given by Masuda *et al*. (1984) for Japanese specimens and by Tortonese (1970) and Palmer (1986) for Atlantic-Mediterranean ones, namely: 110–120 scales on lateral line; 11 gill rakers; 3–6 (mostly 5–6) very elongate dorsal rays; 10–12 rays in the pectoral fin. Maximum size recorded for the species is 1·12 m total length (L_T) for a specimen caught in the Iberian Sea (Roig & Demestre, 1980).

Table I summarizes the most important records for the species at the pan-Oceanic level. A record is considered as 'important' when it reports for the first time the presence of the species in a given geographic area along with additional ecological information (*e.g*. stage and marine zone). The habitats are mostly mesopelagic (52·4% of cases), and rarely bathypelagic (9·5%). Eggs and

juveniles, however, are epipelagic and they can also be found in littoral areas (Jardas, 1980; Olney & Naplin, 1980; Young *et al*., 1994; Dulcic, 2002) The very occasional records of adults of this species and the lack of records from shelf waters are also confirmed by marine researchers with 30 years of experience of fish catches by trawling in the Mediterranean and European Atlantic areas (J.C. Quero, G. Ardizzone & C. Papacostantinou, pers. comm.).

Using the complete sequence of the mitochondrial genome of *Z. cristatus* from Japan deposited in GenBank (Table II) a very preliminary evaluation of the degree of intraspecific genetic divergence on a macro-geographical scale was carried out. Fragments of two mitochondrial genes (12 s and 16 s rRNAs) were sequenced from the specimen collected from Santa Croce Bank; these two genes were selected because orthologous sequences for another 5 genera and 7 species of Lampridiformes are deposited in GenBank. This allowed us to determine levels of sequence divergence from the species to the genus level and thus to place the comparison between Mediterranean and Japanese samples in a taxonomically well-defined context. A list of the species included in the study and the relative GenBank accession numbers are presented in Table II.

Genomic DNA was extracted from scales following standard protocols (Bianco & Ketmaier, 2001). PCR amplifications were carried out using the primers 12 and 16 sa/b (Simon *et al*., 1994). Sequences were determined with an ABI 373A automated sequencer (Applied Biosystems) following the manufacturer's protocols. 393 bp of the 12 s and 570 bp of the 16 s were sequenced in both directions, edited with the programme Sequencer 3.1.1.1 (Gene Codes Corporation) and aligned by eye. Sequences have been submitted to GenBank (Accession numbers AY652748–AY652749).

Three different levels of sequence divergence (uncorrected *p* distances) were found for the lampridiform nucleotide sequence data available from GenBank: 20·33 ± 7·04% among genera, 8·33 ± 0·58% within genera and 5·67 ± 5·27%

TABLE II. Species used for comparison and GenBank accession numbers for the two mitochondrial genes used in the study

Species	GenBank accession number	
	12 s	16 s
Lophotus capellei Temminck & Schlegel	AY036619[1]; AF049727[2]	AY036617[1]; AF049737[2]
Lophotus lacepede Giorna	AY036616[3]	AY036618[3]
Lampris guttatus (Brünnich)	NC 003165*[4]	
	AF049726[2]	AF049736[2]
Regalecus glesne Ascanius	AF092184[5]; AF049728[2]	AF221865[5]; AF049738[2]
Trachipterus jacksoniensis (Ramsay)	AF049729[2]	AF049739[2]
Trachipterus trachipterus (Gmelin)	NC003166*[4]	
Metavelifer multiradiatus (Regan)	AF049725[2]	AF049735[2]
Zu cristatus (Bonelli)	NC003167*[4]	

* Complete mitochondrial genome.

Data from: [1]M. Craig & I.I. Pondella (unpubl.); [2]Wiley *et al*. (1998); [3]Craig *et al*. (2004); [4]Miya *et al*. (2001); [5]Colgan *et al*. (2000).

within species (means ± S.D.). There was a 2·6% of sequence divergence between the Japanese and Mediterranean samples of *Z. cristatus* analysed in the study. This value is lower than the value found between two Australian populations of the king of herrings *Regalecus glesne* Ascanius (6·4%), and between one Mexican and one Japanese population of the opah *Lampris guttatus* (Brünnich) (12·8%). On the other hand, the sequence divergence between the two samples of *Z. cristatus* is higher than the value present between North and South Pacific samples (California and Tasman Sea, respectively) of the unicornfish *Lophotus capellei* Temminck & Schlegel (0·9%) (Wiley *et al.*, 1998; M.T. Craig & D.J. Pondella, unpubl. data). The moderate level of mtDNA differentiation between geographically distant samples suggests that extant populations of *Z. cristatus* may have diverged relatively recently. The number of specimens of *Z. cristatus* used in the present study, however is too low to derive any firm conclusions. Further analyses, based on much larger numbers of individuals and populations, and on more variable (and bi-parentally inherited) molecular markers are needed to shed light on the genetic aspects of the ecology and population biology of *Z. cristatus*, and to define the current ranges of the different populations.

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References

Aguiar, A. & Quero, J. C. (1990). Trachipteridae. In *Check-List of the Fishes of the Eastern Tropical Atlantic*, Vol. 1 (Quero, J. C., Hureau, J. C., Karrer, C., Post, A. & Saldanha, L., eds), pp. 647–649. Paris: Unesco.

Bianco, P. G. & Ketmaier, V. (2001). Anthropogenic changes in the freshwater fish fauna of Italy, with reference to the central region and *Barbus graellsii*, a newly established alien species of Iberian origin. *Journal of Fish Biology* **59** (Suppl. A), 190–208. doi: 10.1006/jfbi.2001.1766

Bussotti, S., Buia, M. C., Di Capua, I., Gambi, M. C., Lorenti, M., Scipione, M. B., Terlizzi, A. & Zupo, V. (1999). Preliminary biocenotic characterization of the protected area "Banco di Santa Croce" (Gulf of Naples, Italy). *Biologia Marina Mediterranea* **6,** 133–135.

Cau, A. (1980). Second note on the bathyal ichthyofauna of the seas around southern Sardinia. *Quaderni della Civica Stazione Idrobiologia di Milano* **8,** 39–44.

Chirichigno, F. N. (1978). Nuevas adiciones a la ictiofauna marina del Peru. *Instituto Del Mar Del Peru (Callao)* **46,** 1–109.

Colgan, D. J., Zhang, C. G. & Paxton, J. R. (2000). Phylogenetic investigations of the Stephanoberyciformes and Beryciformes, particularly whalefishes (Euteleostei: Cetomimidae), based on partial 12s rDNA and 16s rDNA sequences. *Molecular Phylogenetics and Evolution* **17,** 15–25.

Craig, M., Hastings, P. A., Pondella, I. I. & Daniel, J. (2004). Notes on the systematics of the crestfish genus *Lophotus* (Lampridiformes: Lophotidae), with a new record for California. *Bulletin Southern California Academy of Sciences* **103,** 57–65.

Dulcic, J. (2002). First record of scalloped ribbonfish, *Zu cristatus* (Pisces, Trachipteridae), eggs in Adriatic Sea. *Journal of Plankton Research* **24,** 1245–1246.

Eckmayer, W. J. (1982). First Gulf of Mexico record of *Zu cristatus* (Bonnelli) (Pisces: Trachipteridae). *Northeast Gulf Science* **5,** 51–52.

Fitch, J. E. & Schultz, S. A. (1978). Some rare and unusual occurrences of fishes off California and Baja California. *California Fish and Game* **64,** 74–92.

Gavagnin, E. P. (1976). Considerazioni sulla cattura di uno *Zu cristatus* (Bonelli) a San Remo (Osteichthyes Trachipteridae). *Natura Milano* **67,** 258–261.
Heemstra, P. C. & Kannemeyer, S. X. (1984). The families Trachipteridae and Radiicephalidae (Pisces, Lampriformes) and a new species of *Zu* from South Africa. *Annals of the South African Museum* **94,** 1–27.
Ibáñez, M. & Gállego, L. (1974). A new record of a *Zu cristatus* (Trachipteridae, Pisces) off the coast of Blanes (Spain). *Vie et Milieu* **26,** 523–526.
Jardas, I. (1980). Contribution a la connaissance des trachipteres dans la mer Adriatique. 2. *Zu cristatus* (Bonelli, 1820). *Acta Adriatica* **21,** 469–478.
Masuda H., Amaoka, K., Araga C., Yyeno T. & Yoshino, T. (1984). *The Fishes of the Japanese Archipelago*. Tokyo: Tokay University Press.
Miya, M., Kawaguchi, A. & Nishida, M. (2001). Mitogenomic exploration of higher teleostean phylogenies: a case study for moderate-scale evolutionary genomics with 38 newly determined complete mitochondrial DNA sequences. *Molecular Biology and Evolution* **18,** 1993–2009.
Oliver, P. (1981). Sobre la aparicion de algunos peces raros en las Islas Baleares. *Bollettin Instituto Español de Oceanografia* **6,** 59–64.
Olney, J. E. & Naplin, A. (1980). Eggs of the scalloped ribbonfish *Zu cristatus* (Pisces Trachipteridae) in the western North Atlantic. *Copeia* **1980,** 165–166.
Palmer, G. (1986). Trachipteridae. In *Fishes of the North-Eastern Atlantic and the Mediterranean* (Whitehead, P. J. P., Bauchot, M. L., Hureau, J. C., Nielsen, J. & Tortonese, E., eds), pp. 729–732. Paris: Unesco.
Roig, A. & Demestre, M. (1980). Sobre la captura de dos *Zu cristatus* (Bonelli, 1820) en aguas del litoral catalan (Pisces, Trachipteridae). *Miscelanea Zoologica* **6,** 152–154.
Scott, E. O. G. (1984). Observations on some Tasmanian Australia fishes, 29. *Proceedings of Royal Society of Tasmania* **117,** 167–202.
Shimizu, T. (2001). An annotated list of the coastal fishes from Iyo City, Ehime Prefecture, Japan. *Bulletin of the Tokushima Prefectural Museum* **11,** 17–99.
Simon, C., Frati, F., Beckenbach, A., Crespi, B., Liu, H. & Flook, P. (1994). Evolution, weighting and phylogenetic utility of mitochondrial gene sequences and a compilation of conserved polymerase chain reaction primers. *Annals of the Entomological Society of America* **86,** 651–701.
Tortonese E. (1940). Elenco dei tipi esistenti nella collezione ittiologica del R. Museo di Torino. *Bollettino dei Musei di Zoologia e Anatomia Comparata, Torino* **48,** 133–144.
Tortonese, E. (1970). *Fauna d'Italia*, Vol. X. Bologna: Calderini.
Wiley, E. O., Johnson, G. D. & Dimmick, W. W. (1998). The phylogenetic relationships of lampridiformes fishes (Lampridiformes, Acanthomorpha), based on a total evidence analysis of morphological and molecular data. *Molecular Phylogenetics and Evolution* **10,** 417–425.
Young, S. S., Shen, S. C. & Chiu, T. S. (1994). First record of trachipterid larvae with description of different stages and adult forms from Taiwan. *Acta Zoologica Taiwan* **5,** 85–93.
Zupo, V. (2002). Biodiversity of the Banco di Santa Croce, a marine protected area in the Gulf of Naples. *Biomare Newsletter* **3,** 15.

Electronic References

Froese, R. & Pauly, D. (Eds) (2004). *FishBase*. Available at http://www.fishbase.org (version 08/2004).