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NEW RECORDS OF THE PARROT FISH, *SPARISOMA CRETENSE*, AND THE CLEAVER WRASSE, *XYRICHTYS NOVACULA*, BY VISUAL CENSUS IN THE SOUTHERN ADRIATIC

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ABSTRACT

In this publication, we will report on new records for two fish species Sparisoma cretense and Xyrichtys novacula in the Southern Adriatic Sea (Croatia), found in August 2011. Both species are potential indicators for tropicalization. All specimens were visually detected and identified over the course of a long term fish survey (dating back to 2009) involving a lure assisted visual census. S. cretense has been observed at locations in the Molunat and Cavtat areas while the X. novacula specimens have been observed at a SE location at Korčula Island. The 2009-2011 survey has so far covered a total of 100 sites representing a broad geographical range from the southernmost locations of the Croatian Adriatic (Prevlaka) to northern locations in the Gulf of Trieste and from the main coast of Croatia to islands as distant from the main shore as Lastovo Island.

Key words: tropicalization, lure assisted visual census, Adriatic, *Sparisoma cretense*, *Xyrichtys novacula*

NUOVI AVVISTAMENTI DI PESCE PAPPAGALLO, *SPARISOMA CRETENSE*, E DI PESCE PETTINE, *XYRICHTYS NOVACULA*, COL CENSIMENTO VISIVO IN ADRIATICO MERIDIONALE

SINTESI

L'articolo riporta nuove segnalazioni di due specie ittiche, Sparisoma cretense e Xyrichtys novacula, in acque croate dell'Adriatico meridionale, nell'agosto del 2011. Entrambe le specie sono potenziali indicatori di tropicalizzazione. Tutti gli individui sono stati osservati e identificati durante una lunga indagine della fauna ittica (avviata nel 2009), con il metodo del censimento visivo con l'ausilio di esche. Esemplari di S. cretense sono stati osservati in prossimità di Molonta (Molunat) e Ragusavecchia (Cavtat), mentre individui di X. novacula sono stati avvistati nella parte sud-orientale dell'isola di Curzola (Korčula). Negli anni 2009-2011, la ricerca ha compreso 100 siti di campionamento, coprendo un'ampia distanza geografica che va dalle località più meridionali dell'Adriatico croato (Vittaglina o Prevlaka) alle località più settentrionali nel Golfo di Trieste, nonché dalla linea di costa alle isole che distano dalla terraferma al pari dell'isola di Lastovo.

Parole chiave: tropicalizzazione, censimento visivo con l'ausilio di esche, Adriatico, *Sparisoma cretense*, *Xyrichtys novacula*

INTRODUCTION

The marine biodiversity of the Mediterranean is undergoing changes which can be described as a process towards tropicalization, the increased occurrence of warm-water biota (Bianchi & Morri, 2003). This process has two major components, the introduction of exotic species novel to the Mediterranean, and the northward spread of Mediterranean native species with subtropical affinities which were, until recently, confined to the southern parts of the basin (Bianchi & Morri, 1993, 1994, 2004). The occurrence and spread of thermophilic species in the Mediterranean Sea results from four distinct processes: Atlantic influx, lessepsian migration, introductions by humans, and present-day sea warming. While the first three facilitate the physical occurrence of warm water fish outside their usual range, the fourth constitutes the conditions under which the northward spread of such fish species is possible. Sea warming has been, despite large cyclic fluctuations, a positive trend in the Mediterranean since the mid 1980s (Bianchi & Morri, 1994; Astraldi et al., 1995; Vacchi et al., 2001; Bianchi, 2007).

Most indications for the northward spread of thermophilic species come from chance observations. To test the hypothesis on the occurrence of biogeographical expansions and on the establishment of a new population, more targeted field work is needed. Here, we report on results from a survey designed to investigate and monitor demersal fish community structure and fish-habitat associations in the eastern Adriatic (Croatia). This long term survey assures accurate revisits of fixed sites spread over a large geographical range. While not primarily established for the study of northward spreading species, this method does give the opportunity to systematically investigate the geographical distribution of individual species, the changes thereof and in addition, their associations with habitats and other fish species as well as various aspects of fish behaviour.

One possibly northward spreading species once restricted to the warmer eastern Mediterranean but now crossing temperature divides is the parrotfish, *Sparisoma cretense* (Linnaeus, 1758) (Bianchi, 2007; Abecasis et al., 2008). It is a reef-associated omnivorous fish occurring in the Eastern Atlantic: Portugal, Azores and Madeira south to the Canary Islands and Senegal. While still more common along the eastern and southern Mediterranean coasts, it has also been found in the Tyrrhenian Sea since the summer of 1991 (Bianchi & Morri, 1994), the southern Italian Adriatic (Reiner, 1996; Guidetti & Boero, 2001, 2002), and the Croatian part of the Adriatic. Two specimens caught in 1925 near Komiža, Vis Island, are kept in the Ichthyological collection of the Institute of Oceanography and Fisheries in Split (Pallaoro & Jardas, 1996) while more recent observations were reported by Mušin (1989) in the Dubrovnik area and Dulčić & Pallaoro (2001) near the Vrhovnjaci archipel-

ago near the Lastovo Island as well as in the Palagruža archipelago.

Another potentially northward spreading species is the cleaver wrasse (or pearly razorfish), *Xyrichtys novacula* (Linnaeus, 1758), an invertebrate feeder native to the Western Atlantic: North Carolina, the USA, the northern Gulf of Mexico, and the Caribbean to Brazil, but also present in the Eastern Atlantic: the southern coast of Spain to south of Cape Lopez, Gabon, Azores, Madeira, the Canary Islands, Cape Verde and Sao Tome Island, as well as in the Western and Central Mediterranean (Tortonese, 1975; Robins & Ray, 1986; Cardinale et al., 1997; Candi et al., 2004). A specimen caught in 1932 at Korčula Island, Croatia, is kept in the Croatian Natural History Museum in Zagreb and Šoljan (1975) reported repeated records of this species from the Adriatic Sea. Onofri (1982, 1987) reported and studied *X. novacula* from a SE location on Korčula Island, Croatia. A single specimen, caught in 1988 near Lumbarda, Korčula Island, is kept in the Ichthyological collection of the Institute of Oceanography and Fisheries in Split (Pallaoro & Jardas, 1996), while the only later sighting for the Croatian Adriatic recorded in the literature was in Jelsa, Hvar island and dates back to 2000 (Dulčić & Pallaoro, 2001).

MATERIALS AND METHODS

Our observations were made during a fish survey in August 2011, targeting a total of 28 locations during which the lure assisted visual census method was used. This method was described in detail and validated in Schultz & Kruschel (2010), Kruschel & Schultz (2010), and Kruschel & Schultz (2012). This was the latest of a series of surveys since 2009 increasing the total number of sites to 100 (Fig. 1), approximately half of which are revisited every year, and a third of which are visited twice every year.

At each visited location, a total observation time ranging from 45-90 minutes per site was applied. Fish were observed along 50-100 logistically identical snorkel transects as well as outside such transects, and also by a second observer not involved in transect-based visual census loosely following the first. The depth range covered was 0–20 m, with maximum depth depending on water transparency and steepness of the bottom profile. The lead snorkeler swam at the surface holding the lure line. The lure consisted of a piece of double conical lead (3 x 0.5 cm) attached to a monofilament fishing line wrapped around a Styrofoam board. At random intervals, the lure was lowered to within approximately 5 cm of the substrate's surface and moved at approximately 0.3 m s⁻¹ for 10 seconds (approximately 3 m distance). The snorkeler observed and identified all fish 1 m to both sides of the lure line's path and in the entire water column up to the surface.

Habitat characteristics along the entire transect were quantified and recorded as well. In between lure pre-

sentations, the snorkeler moved randomly to determine the starting point for the next lure presentation. Fish observed during such in-between-transect periods were

recorded along with their habitat occupancy at the time of observation if they constituted a species not yet encountered at the actual site or a species of special interest.

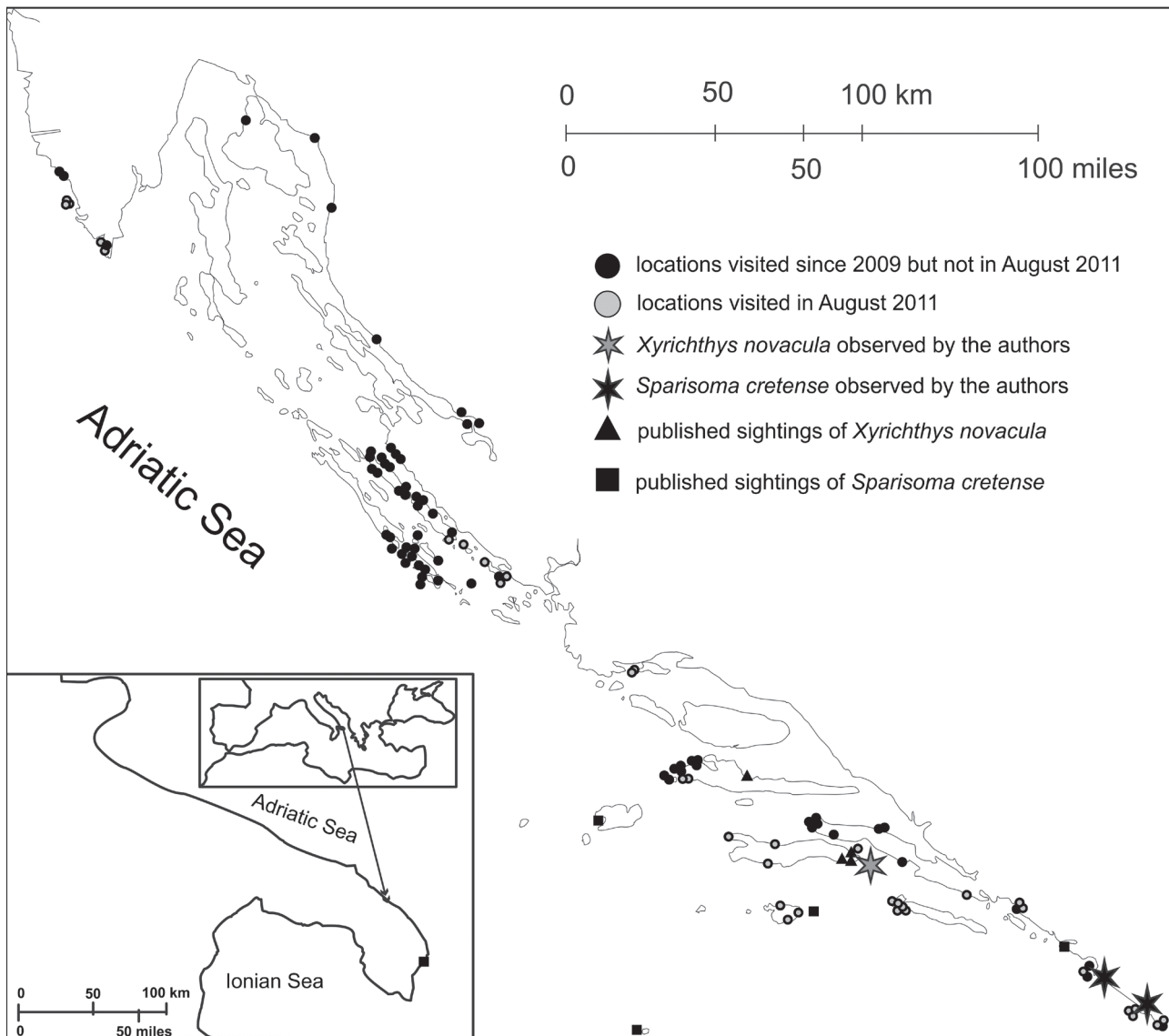


Fig. 1: Map locations representing the total of 100 sites visited since 2009 and sites representing published sightings of *Sparisoma cretense* (full squares) and *Xyrichtys novacula* (full triangles), including those from the southwestern Adriatic (Italy) as indicated in the additional map in the lower left. Grey circles indicate locations representing the 28 eastern Adriatic (Croatia) sites visited in August 2011 (many for the first time), full black circles indicate locations representing sites that had been visited once or multiple times since 2009 but not in August 2011. Black stars indicate August 2011 site-locations at which *S. cretense* have been sighted, grey star indicates August 2011 site-locations of *X. novacula*.

Sl. 1: Zemljevid, ki prikazuje 100 lokacij, ki smo jih začeli obiskovati leta 2009, ter lokacije, kjer je so doslej zabeležili vrsti *Sparisoma cretense* (črni kvadrat) in *Xyrichtys novacula* (črni trikotnik), vključno z lokacijami v jugozahodnem Jadranu (Italija), kot je prikazano na pomanjšanem zemljevidu v spodnjem levem kotu. S sivimi krogi je označenih 20 lokacij v vzhodnem Jadranu (Hrvaška), ki smo jih obiskali avgusta 2011 (mnoge prvič); s črnimi krogi so označene lokacije, ki smo jih od leta 2009 naprej obiskali enkrat ali večkrat, vendar ne v avgustu 2011. S črno zvezdico so označene lokacije, na katerih smo avgusta 2011 opazili vrsto *S. cretense*, s sivo zvezdico pa lokacije, na kateri smo avgusta 2011 opazili vrsto *X. novacula*.

In addition, a second snorkeler, acting as photographer, followed behind the lure-presenting snorkeler to photographically record habitat types and to generate evidence for species of special interest.

RESULTS

Sparisoma cretense

One specimen of *S. cretense* in grayish terminal phase coloration and approximately 15 cm long was encountered on August 17, 2011, at 17:00, by the photographer (S. Dahlke) in an embayment near the town of Cavtat (Tab. 1). The specimen was alone and was, for the duration of the 7 minute observation, swimming very actively back and forth across a group of smaller boulders neighboring the upper edge of a *Posidonia oceanica* meadow, often picking food (apparently epiphytes) from the rocky surface but not from the nearby seagrass blades.

The other specimen of *S. cretense*, also terminal phase, and also approximately 15 cm long, was encountered by the lure-trolling diver (C. Kruschel) on August 18, 2011, at 15:00, between two lure presentations within the north-west facing embayment near the village of Molunat (Tab.1). The specimen was alone at a depth of approximately 6 m and was observed remaining, for the duration of the 5 minute observation, at one boulder located within a patch of *P. oceanica* where it was picking food off the rocky surface and off the neighbouring seagrass blades.

Xyrichtys novacula

Two specimens, the sex of which were not determined, approximately 15 cm long, were encountered by the lure-trolling snorkeler (C. Kruschel) on August 23, 2011, 14:00 while presenting the lure at a depth of 3 m over a patch of unconsolidated sand in between the upper edge of a sparse *Cymodocea nodosa* bed and the lower edge of a boulder-fringing *P. oceanica* patch in an outer coast embayment near the village of Lumbarda, in the SE of Korčula Island (Tab. 1). The specimens remained, for the 5 min observation, spatially close to

each other (less than 50 cm apart) and both interacted with the lure by following it while it was still presented along the lure transect and later by repeatedly visiting it for visual inspection, while it was resting on the ground as the snorkeler spent additional observation time following the completion of the transect. Both specimens were pale pinkish with darker sprinkles spread over their dorsal area giving the impression of a pearly sheen. The specimens were not observed feeding; they did, however, frequently assume a vertical, head-down position with the head within a few centimetres from the bottom. Neither specimen showed any attraction or adverse reaction to the snorkeler who remained on the surface.

Within the same location but ca. 300 m from the place described above, another specimen, the sex of which was not determined and which was approximately 15 cm in length, was encountered by the photographer (S. Dahlke) at a depth of 3 m on August 18, 2011, at 14:30, within a patch of unconsolidated sand not immediately neighbouring any structured habitat. In response to the observer diving down closer to the specimen in order to obtain photographs, it took notice of the approach and quickly buried itself into the sand thereby preventing any subsequent imaging.

DISCUSSION

The parrotfish, *S. cretense*, inhabits rocky reefs and sea grass beds in shallow waters to a depth of about 50 m and is, aside from some very sporadic records around the basin (Bini, 1968; Tortonese, 1975; Parenzan, 1983; Bianchi & Morri, 1994; Otero & Galeote, 1996 and references therein; Guidetti & Boero, 2001, 2002), established along the Mediterranean southern and eastern coasts (e.g., North Africa, Sicily and the Aegean Sea) (Tortonese, 1975; Bernardi et al., 2000). This distribution suggests that *S. cretense* is one of the Mediterranean thermophilic southern species. Guidetti & Boero (2001, 2002) studied this species in SE Apulia, south-western Adriatic (Fig. 1), and concluded that while the species is relatively rare there, it could constitute an established and stable population outside its typical distribution. This may support the hypothesis that *S. cretense*

Tab. 1: GPS position (decimal degrees), depth, and number of individuals of *Sparisoma cretense* (S) and *Xyrichtys novacula* (X).

Tab. 1: Položaj GPS (decimalni zapis), globina in število primerkov vrst *Sparisoma cretense* (S) in *Xyrichtys novacula* (X).

Location name	Latitude (N)	Longitude (E)	Depth (m)	Species	Number of individuals
Cavtat	42.58282	18.209492	3	S	1
Molunat	42.456138	18.426035	6	S	1
Lumbarda 1	42.914470	17.186978	3	X	2
Lumbarda 2	42.916673	17.184583	3	X	1

is expanding northwards in response to climate change driven warming of Mediterranean waters. In the eastern Adriatic, two specimens caught in 1925 in Komiža and kept in the Ichthyological collection of the Institute of Oceanography and Fisheries in Split represent the most northward record published so far. From 2000 to date, the most recent published reports of *S. cretense* from the eastern Adriatic (Dulčić & Pallaoro, 2001) where one specimen was caught near the Vrhovnjaci archipelago (42.763 N, 17.115 E) and two more specimens were recorded by visual census in the Palagruža archipelago (42.385 N, 16.254 E) in September 2000. The first location is further north than the sightings reported here (Cavtat and Molunat, Tab. 1) while the latter is further south. Another record of *S. cretense* in the Dubrovnik area (Mušin, 1989) represents a location approximately at the same latitude as the sightings reported here. Therefore our encounters with *S. cretense* do not seem to indicate a more northward distribution of this species now as compared to 10, 20 or even 85 years ago. Also, sightings from this survey represent exclusively main coast locations, while the published locations include the Palagruža Islands which constitute a mid Adriatic location and the Vis and Vrhovnjaci Islands which are off the main coast locations. Both are more exposed and also more western than any sites visited during this survey and may therefore be more likely to be encountered by *S. cretense* provided the source population was the nearest known established population in the south-western Adriatic (Guidetti & Boero, 2001). Considering that we have not detected *S. cretense* during any of the earlier, previous fish surveys (spanning the entire Croatian coast) which we have regularly conducted since 2009 (twice a year in spring and summer/fall) may suggest that this species remains very rare in the Croatian Adriatic and may not have established stable populations, a hypothesis that can only be tested by additional research. One reason for the lack of encounter via our survey method may be that in locations with low water transparency, we are limited to depths less than 10 m. The 0-10 m depth range does not, according to Guidetti & Boero (2001, 2002), represent the preferred depth range of adult *S. cretense* which was determined in their study as being between 12-15 m. A depth range of 0-10 m is, however, suitable for encountering juveniles which would be plausible indicators of establishing populations and which were recorded by Guidetti & Boero (2001) exclusively between 5 and 15 m.

Published information on the cleaver wrasse, *X. novacula*, in the Mediterranean comes primarily from the Tyrrhenian Sea, where the species inhabits sandy bays and prefers well-sorted fine bottoms over rocky and ve-

getated (*P. oceanica*) grounds (Cardinale *et al.*, 1997). There the species is heavily exploited, primarily via trawl netting. As it prefers shallower waters in the summer but retreats deeper when the surface waters cool, lower winter catches result (Candi *et al.*, 2004). Considering the frequency with which the coastal sediments in the eastern Adriatic (down to 80 m) are trawled, one would expect regular and more frequent fisheries related sightings of this species provided it was indeed undergoing a northward expansion by establishing stable populations. In contrast, the species has been only sporadically reported from the eastern Adriatic, with reports, however, dating as far back as 1932. The most recent published report of *X. novacula* along the eastern Adriatic comes from a location near Jelsa (Hvar Island, 43.17 N, 16.69 E) and remains, to the best of our knowledge, the northernmost record of this particular species in the Adriatic Sea (Dulčić & Pallaoro, 2001). It is surprising that only now, in 2011, we encountered this species for the first time considering that we have been surveying the shallow water (0-20 m) benthos at 100 locations, including sandy bays, along the entire Croatian Coast since 2009, with one third of these sites visited twice a year. The only location at which we did detect the species (Korčula Island, Tab. 1) is more southern than the most recent previous reported locations (Dulčić & Pallaoro, 2001) and roughly identical with those reported by Onofri (1982, 1987) and with the location at which a specimen kept in the Ichthyological collection of the Institute of Oceanography and Fisheries in Split, was caught in 1988 and also with the location of the specimen kept in the Croatian Natural History Museum, Zagreb caught in 1932. Therefore we are reluctant to interpret our sightings of *X. novacula* as an indication of an ongoing northward spread of the species. Our sightings, however, may indicate the possibility that SE Korčula Island is occupied by a small established population, a hypothesis that can be tested only by additional research.

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NOVI ZAPISI O POJAVLJANJU PAPAGAJKE, *SPARISOMA CRETENSE* IN VRSTE
XYRICHTYS NOVACULA, NASTALI NA PODLAGI VIZUALNEGA POPISA
V JUŽNEM JADRANU

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POVZETEK

V članku poročamo o novih zapisih o pojavljanju dveh ribjih vrst in sicer papagajke, *Sparisoma cretense* in *Xyrichtys novacula*, na jugu hrvaškega dela Jadranskega morja avgusta 2011. Obe vrsti sta potencialna indikatorja tropikalizacije. Vse primerke smo vizualno opazili in identificirali v sklopu daljšega preučevanja ribjih vrst (začelo se je leta 2009), ki je vključevalo vizualni popis s pomočjo vabe. Vrsto *S. cretense* smo opazili na več lokacijah na območju Molunata in Cavtata, primerke vrste *X. novacula* pa na lokaciji jugovzhodno od Korčule. V raziskavo, ki je potekala med letoma 2009 in 2011, smo skupno vključili 100 lokacij v širokem geografskem obsegu. Raztezajo se vse od najjužnejših predelov hrvaškega Jadrana (Prevlaka) do severnih lokacij v Tržaškem zalivu ter od hrvaške obale pa do najbolj oddaljenih otokov, kot je Lastovo.

Ključne besede: tropikalizacija, vizualni popis s pomočjo vabe, Jadran, *Sparisoma cretense*, *Xyrichtys novacula*

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