BioInvasions Records (2019) Volume 8, Issue 1: 167–174

Rapid Communication

Westward range expansion of the Indo-Pacific nakedband gaper *Champsodon nudivittis* (Ogilby, 1895) in Saronikos Gulf, Greece

Vasiliki Kousteni* and George Christidis

Institute of Marine Biological Resources and Inland Waters, Hellenic Centre for Marine Research,46.7 km Athens Sounio ave., P.O. Box 712, 19013 Anavyssos Attiki, Greece

Author e-mails: *kousteni@hcmr.gr (VK), gorge@hcmr.gr (GC)*

**Corresponding author*

Citation: Kousteni V, Christidis G (2019) Westward range expansion of the Indo-Pacific nakedband gaper *Champsodon nudivittis* (Ogilby, 1895) in Saronikos Gulf, Greece. *BioInvasions Records* 8(1): 167–174, https://doi.org/10.3391/bir.2019.8.1.18

Received: 6 December 2017
Accepted: 9 October 2018
Published: 18 February 2019

Thematic editor: Cynthia McKenzie

Abstract

The Indo-West Pacific nakedband gaper, *Champsodon nudivittis*, was recorded for the first time in Saronikos Gulf (central Aegean Sea, Greece) on the basis of a single specimen collected by bottom trawl on 13 October 2017 at 89 m mean depth. DNA barcoding was used as a complementary tool to standard taxonomic features description for species identification. The present record corresponds to the western-most expansion of this Lessepsian migrant, whose transition from the Levantine basin to the west was clearly associated with a deceleration in dispersal rate.

Key words: Champsodontidae, eastern Mediterranean Sea, Lessepsian migration, dispersal rate

Introduction

The nakedband gaper *Champsodon nudivittis* (Ogilby, 1895) belongs to the monogeneric family of Champsodontidae with 13 valid species confined to the Indo-Pacific region (Nemeth 1994). Similarly to its co-generic species, *C. nudivittis* is a small-sized species, having an elongated body covered with small, rough, non-overlapping denticulate scales, a large oblique mouth, a posterior-ventrally located preopercular spine and a complex acoustico-lateralis system consisting of two lateral lines interconnected by vertical rows of sensory papillae (Nemeth 2001). *Champsodon nudivittis* is native to the entire Indo-Pacific at depths down to 355 m (Nemeth 1994). In the Mediterranean Sea, Çiçek and Bilecenoğlu (2009) first reported the presence of *C. nudivittis*, from a trawl at 50 m depth in Iskenderun Bay, while to date all reported captures of the species in the Mediterranean Sea occurred in the eastern part of this basin including: the Gulf of Antalya (Gökoğlu et al. 2011), Finike Bay (Ergüden and Turan 2011), off Ashdod (Israel) (Goren et al. 2011), off Rhodes Island (Kalogirou and Corsini-Foka 2012), Fethiye and Ekincik Bays (Filiz et al. 2014), Gökova Bay (Akyol and Ünal 2015), Iskenderun Bay (Çiçek and Bilecenoğlu 2009; Demirci et al. 2016), and off the Syrian coast (Ali et al. 2017).

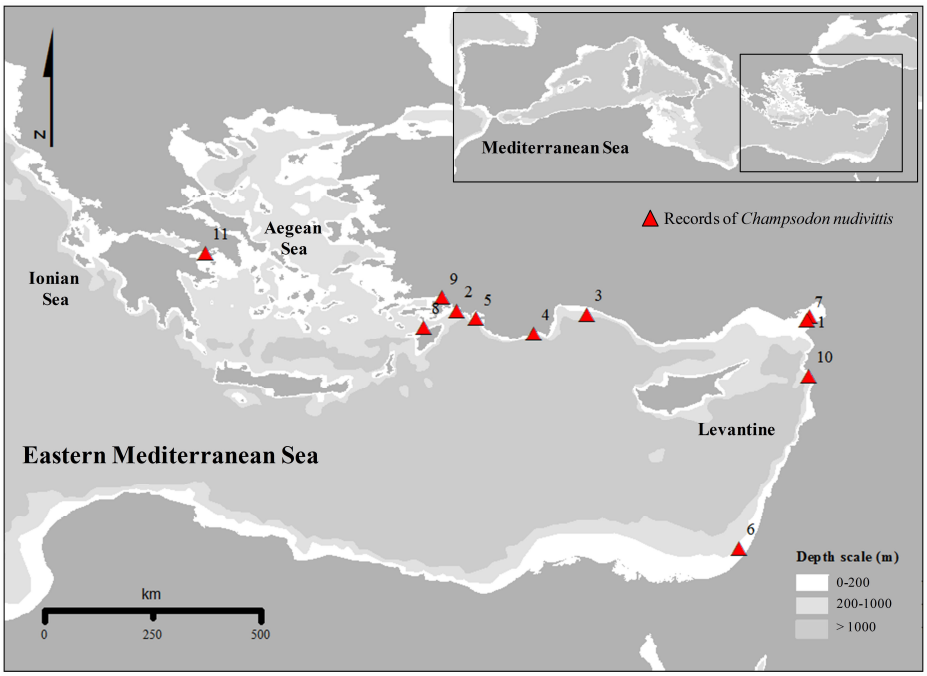

Figure 1. Distribution map of *Champsodon nudivittis* records in ascending chronological order (see Supplementary material Table S1) in the Mediterranean Sea.The map was prepared in ArcMap v10.4.

In the present paper, we report the first record of *C. nudivittis* in Saronikos Gulf (central Aegean Sea, Greece) corresponding to the westernmost expansion of the species in the Mediterranean Sea. The spread of the nakedband gaper in the Mediterranean Sea is discussed to assess the actual status of the species in this area.

Materials and methods

On 13 October 2017, one specimen of *Champsodon nudivittis* was captured on the trawl route between 37°56′27.6″N; 23°20′31.2″E and 37°56′16.8″N; 23°19′12″E in Saronikos Gulf, at depths between 86 and 92 m (Figure 1). The field sampling was conducted in the frame of a research programme (MINOUW) using the experimental bottom trawling vessel R/V Filia (HCMR) equipped with a bottom trawl net of 22 mm square-mesh codend size. The haul duration was 33 min and the haul speed was set at 2.3 knots. Species identification followed Nemeth (1994, 2001) and was confirmed by using DNA barcoding to amplify a 738 bp fragment of the mitochondrial DNA cytochrome *c* oxidase subunit I (COI) gene using polymerase chain reaction (PCR) (GenBank accession number: MH807253). Morphometrics (total length, TL; fork length; FL, standard length, SL e.t.c.), meristics (counts of fin rays and gill rakers) and total weight (TW) were recorded. For describing the scale patterns, "chin" refers to the ventral region between the dentaries and "breast" refers to the triangular area anterior to the pelvic fin bases (Nemeth 1994). Sagittal otoliths were removed, photographed using a stereoscope connected to the image analysis system

of HCMR, and used for age determination. The specimen was eventually preserved in 4% formalin and deposited in the Institute of Marine Biological Resources and Inland Waters (HCMR, Athens, Greece).

All records of *Champsodon nudivittis* in the Mediterranean Sea between 2008 and 2017 were mapped using the Geographical Information System (GIS) software ArcView v10.4. Using this application, the distance covered by the species along the coastline over the aforementioned period of time was measured in direct lines and following the isobath of 200 m, considering the maximum depth of the species' distribution recorded in the Mediterranean Sea (Supplementary material Table S1). Based on the generated data and following the method suggested by Ben Rais Lasram et al. (2008), the propagation speed between the first record and that furthest from the Suez Canal was calculated and expressed in km yr^{-1}. Further, the chronological series of the dispersal speed per record interval was reconstructed. Given that the chronological order of *C. nudivittis* records in the Mediterranean Sea were not analogous to their geographical distance from the Suez Canal, the chronological series of the dispersal speed was calculated for four records only (6^{th}, 7^{th}, 8^{th} and 11^{th} in Table S1) where this assumption was fulfilled. These four records represented also the main wide areas (E and NE Mediterranean Sea, SE and C Aegean Sea, respectively) where the species has been recorded in the Mediterranean Sea. Finally, as suggested by Ben Rais Lasram et al. (2008), in order to provide a trend for the dispersal rate, the distance crossed by the species was plotted against time.

Results

Champsodon nudivittis reached 116 mm in TL (FL = 109 mm, SL = 99 mm) and weighed 10.66 g in TW. One clear growth increment was recognized at the otolith periphery (Figure 2a). Morphometric and meristic characteristics are given in Table 1. The specimen had elongated and slightly compressed laterally body (Figure 2a). Mouth was large and oblique with maxilla extending posteriorly to below eye (Figure 2b). The sensory papillae between eyes were not arranged in a semicircle, but located between parallel bony ridges on the upper part of head (Figure 2c). Eyes were large with diameter less than snout length and the ventral margin of pupil was indented by flap of iris (Figure 2d). The lacrimal bone possessed two spines projecting anterior-ventrally (Figure 2c). A characteristic preopercular spine was located posterior-ventrally (Figure 2e). Scales were small, spinulose and did not overlap. A small patch of scales was observed on the breast (Figure 2f). No scales were found on the chin, the base of dorsal and anal fins, the space between pectoral and pelvic fins (Figure 2e), and the space from the abdomen as far as to the anus (Figure 2g). The body was silver in colour with dark spots on sides.

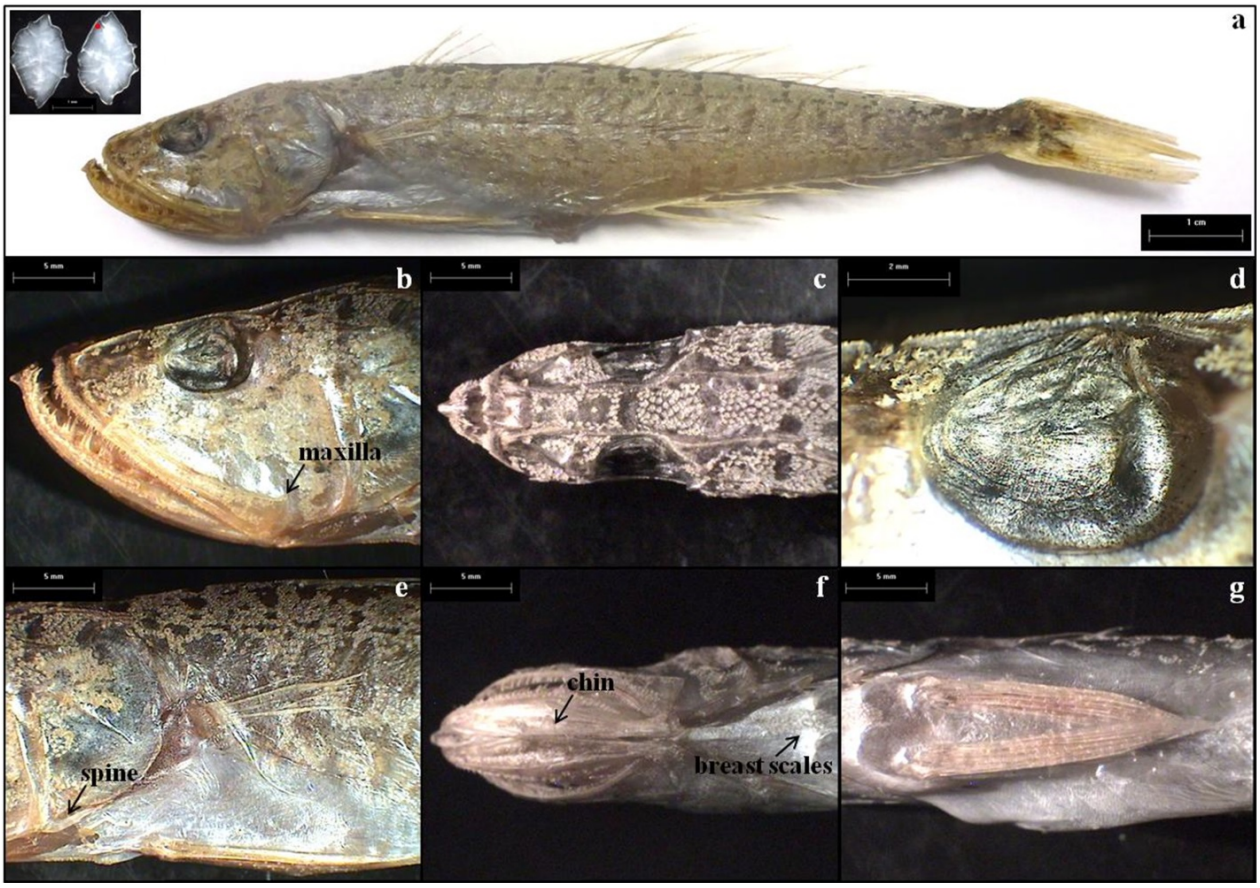

Figure 2. *Champsodon nudivittis* individual (SL = 99 mm) caught in Saronikos Gulf (central Aegean Sea): (a) general view and pair of sagittal otoliths with the growth increment marked; (b) profile view of head; (c) dorsal view of head; (d) view of iris; (e) preopercular spine; (f) scale pattern in breast region; (g) view of abdomen. Photo by Vasiliki Kousteni.

The upper part was darker, the abdomen was shiny silver, and the chin was spotted with small melanophores. The dorsal fins were pale with dark spots in their upper parts. The pectoral, ventral and anal fins were pale as well as the central rays of the caudal fin. The upper and lower caudal lobes showed sparse dark spots and dark pigmentation was obvious at the caudal fin base.

The propagation speed of *C. nudivittis* between the first Mediterranean record in 2008 and that furthest from the Suez Canal (record 11th, Table S1) equaled 146.48 km yr^{-1}. The dispersal rate appeared to decrease over time for *C. nudivittis* that spread beyond the limits of the Levantine basin towards the northern side of the Mediterranean Sea. Specifically, the dispersal rate was 560.0 km yr^{-1} until the species reached the Iskenderum Bay (Turkey) from the Ashdod coast (Israel), increased to 826.8 km yr^{-1} until the species reached Rhodes Island (eastern Aegean Sea, Greece) from Iskenderum Bay (Turkey), and dropped to 94.6 km yr^{-1} between Rhodes Island and Saronikos Gulf (present record) while crossing the Aegean Sea. The distance crossed by the species from Suez Canal appeared to increase over time (Figure 3).

Table 1. Morphometric (in mm and ratios) and meristic characteristics (in counts) of *Champsodon nudivittis* individual caught in Saronikos Gulf.

Morphometric characteristics	mm	Ratios	
Head			
Head length (HDL)	27.25	SL/HDL	3.63
Snout length (SNL)	6.76	HDL/SNL	4.03
Preopercular spine length (POSL)	3.54	HDL/POSL	7.70
Interorbital distance (INO)	3.67	HDL/INO	7.43
Eye diameter (EYD)	5.80	HDL/EYD	4.70
Eye height (EYH)	4.42	HDL/EYH	6.17
Upper jaw (maxilla) length (UJL)	16.11	HDL/UJL	1.69
Lower jaw length (LJL)	18.76	HDL/LJL	1.45
Least eye and maxilla distance (LEMD)	5.25	HDL/LEMD	5.19
Mouth width (MOW)	6.16	HDL/MOW	4.42
Preorbital length (POB1)	8.46	HDL/POB1	3.22
Postorbital length (POB2)	15.99	HDL/POB2	1.70
Fins			
First dorsal fin length (D1L)	11.62	SL/D1L	8.52
First dorsal fin base (D1B)	8.73	SL/D1B	11.34
Second dorsal fin length (D2L)	49.88	SL/D2L	1.98
Second dorsal fin base (D2B)	42.16	SL/D2B	2.35
Pectoral fin length (P1L)	11.03	SL/P1L	8.98
Pectoral fin base (P1B)	4.95	SL/P1B	20.00
Pelvic fin length (P2L)	18.58	SL/P2L	5.33
Pelvic fin base (P2B)	5.43	SL/P2B	18.23
Anal fin length (ANL)	43.48	SL/ANL	2.28
Anal fin base (ANB)	36.36	SL/ANB	2.72
Body			
Pre-first dorsal length (PD1)	34.28	SL/PD1	2.89
Pre-second dorsal length (PD2)	48.85	SL/PP2	2.03
Interdorsal space (IDS)	10.33	SL/IDS	9.58
Caudal peduncle length (CPL)	5.53	SL/CPL	17.90
Prepectoral length (PP1)	24.87	SL/PP1	3.98
Prepelvic length (PP2)	28.28	SL/PP2	3.50
Preanal length (PAL)	53.25	SL/PAL	1.86
Pelvic-anal space (PAS)	24.97	SL/PAS	3.96
Maximum body width (BW)	10.78	SL/BW	9.18
Maximum body depth (BD)	19.97	SL/BD	4.96
Body depth over the posterior angle of the mouth (BDM)	15.51	SL/BDM	6.38
Body depth over pelvic fin origin (BDP)	15.00	SL/BDP	6.60
Body depth over anal fin origin (BDA)	16.39	SL/BDA	6.04
Caudal peduncle depth (CPD)	5.51	SL/CPD	17.97
Meristic characteristics		**Counts**	
First dorsal fin rays		5	
Second dorsal fin rays		20	
Pectoral fin rays		12	
Anal fin rays		18	
Ventral fin rays		5	
Caudal fin rays		18	
Gill rakers on upper arch		1	
Gill rakers on lower arch		10	

Discussion

Champsodon nudivittis is nominally distributed in the Indo-West Pacific Ocean (Nemeth 1994). The introduction of the species in the Mediterranean Sea is quite recent (Çiçek and Bilecenoğlu 2009), not ship-mediated, as suggested by Çiçek and Bilecenoğlu (2009), and has been

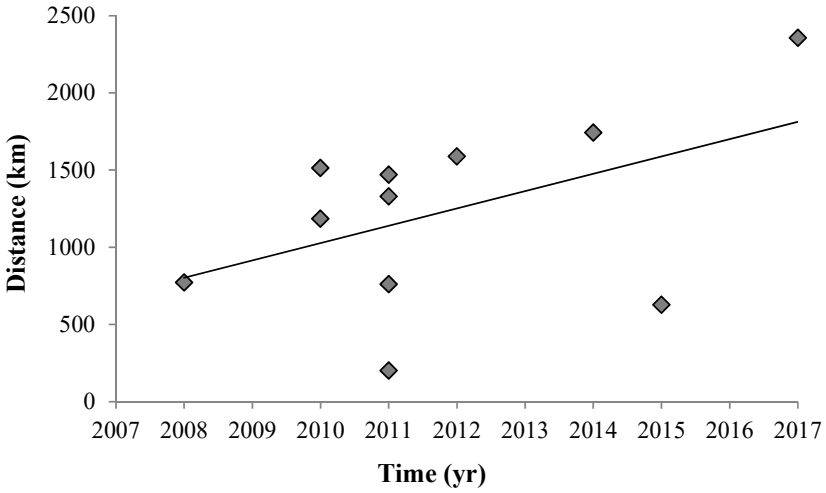

Figure 3. Correlation between time and distance crossed by *Champsodon nudivittis* in the Mediterranean Sea from the Suez Canal.

occurred through the Suez Canal, namely Lessepsian migration (Por 1978). This view is supported by the presence of *C. nudivittis* in the Red Sea (Goren et al. 2011). Additionally, two other chamsodontid fishes have been reported later in the Mediterranean Sea: *Champsodon vorax* (Günther, 1867) was firstly recorded off Lebanon in 2010 (Bariche 2010) and *Champsodon capensis* (Regan, 1908) first record has been reported in the Iskenderun Bay in 2010 (Dalyan et al. 2012); the later one has also been recorded in the Red Sea (Goren and Dor 1994). The western-most record of *C. nudivittis* in the Mediterranean Sea was recorded in the present study.

All morphometric measurements, meristic counts and colour description of the Saronikos Gulf *C. nudivittis* specimen were well in accordance with Nemeth (1994, 2001) and previous studies (e.g. Kalogirou and Corsini-Foka 2012). The estimated age of the captured individual (1 yr) seemed to be in accordance with the length-age key of 296 individuals produced by Yaglioglu et al. (2014). The main diagnostic features that distinguished this specimen from the other two co-generic Mediterranean species included the combination of the following characteristics: the presence of a small patch of scales on the breast, an unscaled chin and mid-belly area, a single gill raker on the upper limb of the first gill, sensory papillae between eyes not arranged in a semicircle, ventral margin of pupil indented by flap of iris, and maxilla extending to below rear margin of eye. Species identification was further confirmed with DNA barcoding. Given the taxonomical uncertainties of previous records of *Champsodon* species raised by Goren et al. (2011), genetics is proposed to be used as a complementary tool to morphometrics in both past and future *Champsodon* specimens to verify their identity and reassess accurately the range expansion of the genus in the Mediterranean Sea.

The occurrence of *C. nudivittis* in the Saronikos Gulf, central Aegean Sea, indicates the rapid westward expansion of the species in the

Mediterranean (distance of range expansion from the Suez Canal = 2355 km), supporting a probable establishment of a population in this area. According to the categorical variable summarizing the species ability to spread over the Mediterranean Sea proposed by Ben Rais Lasram et al. (2008), *C. nudivittis* is considered a species of strong dispersal potential that is able to spread beyond the biogeographical boundaries of the Levantine basin. The species also exhibited a high propagation speed, exceeding the average Lessepsian species spread at a rate of 122 km yr^{-1} that has been estimated on the northern side of the Mediterranean Sea (Ben Rais Lasram et al. 2008).

The transition of *C. nudivittis* from the Levantine basin to the west was clearly associated with a deceleration in dispersal rate, similarly with other Lessepsian migrants. For instance, the dispersal rate of the slipmouth *Equulites klunzingeri* (Steindachner, 1898) was 207.8 km yr^{-1} until the species reached Rhodes Island, and dropped to 31.6 km yr^{-1} between Rhodes and the eastern coast of Greece. A similar pattern was observed for the dusky spinefoot *Siganus luridus* (Rüppell, 1829) during its transition from the Aegean Sea to the Adriatic Sea, where the dispersal rate decelerated to less than a 7^{th} of its previous value (Ben Rais Lasram et al. 2008). Ben Rais Lasram et al. (2008) attributed this phenomenon to the fact that the transition between different water bodies acts as a geographical barrier.

As most of the species follow a positive dispersal range-abundance relationship (Gaston 2003), a rapid geographical expansion of *C. nudivittis* along the western coast of the Mediterranean is very likely, a phenomenon that may accelerate with further sea surface warming. Therefore, the role of this newly-established species within the coastal ecosystem and its impact on the indigenous communities needs to be further monitored.

Acknowledgements

The field sampling was funded by the European Commission's Horizon 2020 Research and Innovation Programme under Grant Agreement No. 634495 for the project Science, Technology, and Society Initiative to minimize Unwanted Catches in European Fisheries (MINOUW). Dr. Mehmet Baki Yokeş (AMBRD Laboratories Istanbul Turkey) is acknowledged for conducting the genetic analysis and the reviewers' contribution in improving the quality of the manuscript is much appreciated.

References

Akyol O, Ünal V (2015) Occurrence of the Indo-Pacific *Champsodon nudivittis* (Perciformes, Champsodontidae) in the Bay of Gökova (Southern Aegean Sea, Turkey), *Turkish Journal of Fisheries and Aquatic Sciences* 15: 187–190, https://doi.org/10.4194/1303-2712-v15_1_21

Ali M, Saad A, Jabour R, Rafrafi-Nouira S, Capapé C (2017) First record of nakedband gaper *Champsodon nudivittis* (Osteichthyes: Champsodontidae) off the Syrian Coast (Eastern Mediterranean). *Journal of Ichthyology* 57: 161–163, https://doi.org/10.1134/S0032945217010015

Bariche M (2010) *Champsodon vorax* (Teleostei: Champsodontidae), a new alien fish in the Mediterranean. *Aqua International Journal of Ichthyology* 16(4): 197–200

Ben Rais Lasram F, Tomasini JA, Guilhaumon F, Romdhane MS, Do Chi T, Mouillot D (2008) Ecological correlates of dispersal success in Lessepsian fishes. *Marine Ecology Progress Series* 363: 273–286, https://doi.org/10.3354/meps07474

Çiçek E, Bilecenoğlu M (2009) A new alien fish in the Mediterranean Sea: *Champsodon nudivittis* (Actinopterygii: Perciformes: Champsodontidae). *Acta Ichthyologica et Piscatoria* 39: 67–69, https://doi.org/10.3750/AIP2009.39.1.14

Dalyan C, Yemişken E, Eryılmaz L (2012) A new record of gaper (*Champsodon capensis* Regan, 1908) in the Mediterranean Sea. *Journal of Applied Ichthyology* 28: 834–835, https://doi.org/10.1111/j.1439-0426.2012.02019.x

Demirci S, Şimşek E, Demirci A (2016) Assessment of age and growth parameters of the nakedband gaper *Champsodon nudivittis* (Ogilby, 1895) with different models in the Eastern Mediterranean. *Pakistan Journal of Zoology* 48(3): 891–894

Ergüden D, Turan C (2011) Occurrence of the nakedband gaper, *Champsodon nudivittis* (Ogilby, 1895) (Osteichthyes: Champsodontidae), in Finike Bay, eastern Mediterranean, Turkey. *Journal of Applied Ichthyology* 27: 1397–1398, https://doi.org/10.1111/j.1439-0426.2011.01824.x

Filiz H, Akçimar SC, Irmak E (2014) Occurrence, length-weight and length-length relationships of *Champsodon nudivittis* (Ogilby, 1895) in the Aegean Sea. *Journal of Applied Ichthyology* 30: 415–417, https://doi.org/10.1111/jai.12216

Gaston KJ (2003) The structure and dynamics of geographic ranges. Oxford University Press, Oxford, 278 pp

Gökoğlu M, Ünlüsayın M, Balcı BA, Özvarol Y, Çolak H (2011) Two alien fish in the Gulf of Antalya: *Apogon queketti* Gilchrist, 1903 (Apogonidae) and *Champsodon nudivittis* (Ogilby, 1895) (Champsodontidae). *Zoology in the Middle East* 54: 138–140, https://doi.org/10.1080/09397140.2011.10648888

Goren M, Dor M (1994) An updated checklist of the fishes of the Red Sea. CLOFRES II, The Israel Academy of Sciences and Humanities, Jerusalem, 120 pp

Goren M, Stern N, Galil BS, Diamant A (2011) On the occurrence of the Indo-Pacific *Champsodon nudivittis* (Ogilby, 1985) (Perciformes, Champsodontidae) from the Mediterranean coast of Israel, and the presence of the species in the Red Sea. *Aquatic Invasions* 6: 115–117, https://doi.org/10.3391/ai.2011.6.S1.026

Kalogirou S, Corsini-Foka M (2012) First record of the Indo-Pacific *Champsodon nudivittis* (Ogilby, 1895) (Perciformes, Champsodontidae) in the Aegean waters (eastern Mediterranean Sea). *BioInvasions Records* 1: 229–233, https://doi.org/10.3391/bir.2012.1.3.10

Nemeth D (1994) Systematics and distribution of fishes of the family Champsodontidae (Teleostei: Perciformes), with descriptions of three new species. *Copeia* 2: 347–371, https://doi.org/10.2307/1446983

Nemeth D (2001) Champsodontidae. In: Carpenter KE, Niem VH (eds), FAO Species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles, sea turtles, sea snakes and marine mammals. FAO, Rome, pp 3497–3499

Por FD (1978) Lessepsian migration - the influx of Red Sea biota into the Mediterranean by way of the Suez Canal. *Ecological Studies* 23: 1–238, https://doi.org/10.1007/978-3-642-66728-2_1

Yaglioglu D, Deniz T, Erguden D, Gurlek M, Turan C (2014) Age and growth of the nakedband gaper, *Champsodon nudivittis* (Ogilby, 1895), from the Iskenderun Bay, northeastern Mediterranean. *Cahiers de Biologie Marine* 55(3): 347–351

Supplementary material

The following supplementary material is available for this article:

Table S1. Records of *Champsodon nudivittis* in the Mediterranean Sea.

This material is available as part of online article from:
http://www.reabic.net/journals/bir/2019/Supplements/BIR_2019_Kousteni_Christidis_Table_S1.xlsx