http://www.egejfas.org
Ege Journal of Fisheries and Aquatic Sciences, 41(1), 63-68 (2024)

Su Ürünleri Dergisi (2024)
DOI: 10.12714/egejfas.41.1.09

RESEARCH ARTICLE ARAŞTIRMA MAKALESİ

Prebosphoric occurrence of Korean rockfish, *Sebastes schlegelii* Hilgendorf, 1880 in southwestern Black Sea with notes on its morphometry and dispersal potential

Güneybatı Karadeniz'in boğaz önü sularında görülen Kore iskorpiti, *Sebastes schlegelii* Hilgendorf, 1880'in morfometrisi ve yayılma potansiyeli

Uğur Uzer[1] ● **Firdes Saadet Karakulak**[1] ● **Hakan Kabasakal**[2,3*]

[1]İstanbul University, Faculty of Aquatic Sciences, Department of Fisheries Technologies and Management, Vezneciler, İstanbul, Türkiye
[2]İstanbul University, Institute of Science, Fisheries Technologies and Management Program, İstanbul, Türkiye
[3]WWF Türkiye, Asmalı Mescit, İstiklal Cd. No:136, 34430, Beyoğlu, İstanbul, Türkiye

*Corresponding author: kabasakal.hakan@gmail.com
Received date: 21.01.2024 Accepted date: 07.03.2024

How to cite this paper:
Uzer, U., Karakulak, F.S., & Kabasakal, H. (2024). Prebosphoric occurrence of Korean rockfish, *Sebastes schlegelii* Hilgendorf, 1880 in southwestern Black Sea with notes on its morphometry and dispersal potential. *Ege Journal of Fisheries and Aquatic Sciences, 41*(1), 63-68. https://doi.org/10.12714/egejfas.41.1.09

Abstract: On 21 December 2023 one specimen of *Sebastes schlegelii* Hilgendorf, 1880 have been captured by means of a commercial bottom trawler towed at a depth of 30 m off Şile coast. Following its first occurrence in Turkish Black Sea waters off Giresun coast on 6 March 2023, it has recently reported from the Sea of Marmara (Gulf of İzmit) on 7 January 2024, exhibiting a noteworthy dispersal speed which required less than one year to migrate across nearly a 1,000 km. Therefore, the dispersal and potential interactions with indigenous species of this invasive teleostean along theTurkish coast should be monitored carefully. In the present article, authors provide full morphometric and meristic characters of *S. schlegelii*, as well.

Keywords: Sebastidae, invasive alien species, prebosphoric, dispersal

Öz: 21 Aralık 2023 tarihinde Şile açıklarında 30 m derinlikte çekilen ticari dip trolü ile avcılık sırasında *Sebastes schlegelii* Hilgendorf, 1880 türünün bir bireyi elde edilmiştir. *S. schlegelii* Türkiye sularında ilk kez görüldüğü (Giresun, güneydoğu Karadeniz) 6 Mart 2023 tarihi ile Marmara Denizi'nde (İzmit Körfezi) ilk kez kaydedildiği 7 Ocak 2024 arasında dikkate değer bir yayılım başarısı sergilemiştir ki bir yıldan az bir sürede 1,000 km'ye yakın bir mesafeyi aştığı görülmektedir. Bu nedenle, bu istilacı türün gerekTürkiye kıyısı boyunca güney yönünde yayılımı gerekse yerel türlerle olası etkileşimleri dikkatle izlenmelidir. Bu makalede incelenen *S. schlegelii* bireyinin eksiksiz morfometrisi de verilmektedir.

Anahtar kelimeler: Sebastidae, istilacı yabancı tür, boğaz önü, yayılma

INTRODUCTION

The Korean rockfish, *Sebastes schlegelii* Hilgendorf, 1880 (Perciformes: Scorpaenoidei), is a member of the teleostean family Sebastidae, which is represented by 7 genera and 133 species worldwide (Froese and Pauly, 2023). *S. schlegelii* is a livebearing (ovoviviparous), demersal fish occurring near shore and over rocky bottoms at the depths between 3 and 100 m in temperate waters of northwest Pacific off the coasts off Japan, Korean peninsula and China (Froese and Pauly, 2023).

In a recently published checklist of Mediterranean marine fishes, which is based on evidence approach criteria for the definition of "confirmed occurrence", Kovačić et al. (2021) emphasized that no representatives of genera *Sebastes* have been reported to occur in any parts of the region. So, the dispersal of *Sebastes* into the Black Sea can be assumed as a very remote possibility in the light of its absence in the Mediterranean Sea. However, after it was realized that a record of a teleostean captured off the Crimean coast misidentified as dogtooth grouper (*Epinephelus caninus*) (Boltachev and Karpova, 2013), was actually a Korean rockfish, of which further specimens from the region were caught thereafter, confirmed the first record and the presence of an established population in the Black Sea (Karpova et al., 2021). *S. schlegelii* is a boreal species, of which the natural distribution range extends in very limited area in northwest Pacific (Froese and Pauly, 2023); therefore, its introduction in the region assumed may because of random introduction with ship ballast waters or during acclimatization of the giant oyster (*Crassostrea gigas*) (Karpova et al., 2021).

S. schlegelii reported from Turkish Black Sea coast for first time by Bilecenoğlu et al. (2023) based on specimens previously sighted (and photographed) or captured from several localities in the region, which followed by another recent capture of the species off the coast of Akçakoca (southwestern Black Sea; Yağlıoğlu et al., 2023) and the first record of the Korean rockfish in the Sea of Marmara (Karadurmuş et al., 2024). In the present article authors report on a prebosphoric capture of *S. schlegelii*, provide detailed morphometric and meristic characteristics of the examined

specimen, as well as make a projection of its dispersal potential along Turkish coasts.

MATERIAL AND METHODS

Study area

The area of investigation of the present study is located in the southwestern Black Sea and in accordance with GFCM's definition of geographical subareas (GSAs) of the Mediterranean Sea, Black Sea is defined as GSA29 (Carpentieri et al., 2021).

Examined specimens have been captured, almost 8,3 kilometers away to the west from northern entrance of the Bosphorus Strait, which measured as a point-to-point distance by means of Google Maps measure distance function (Figure 1).

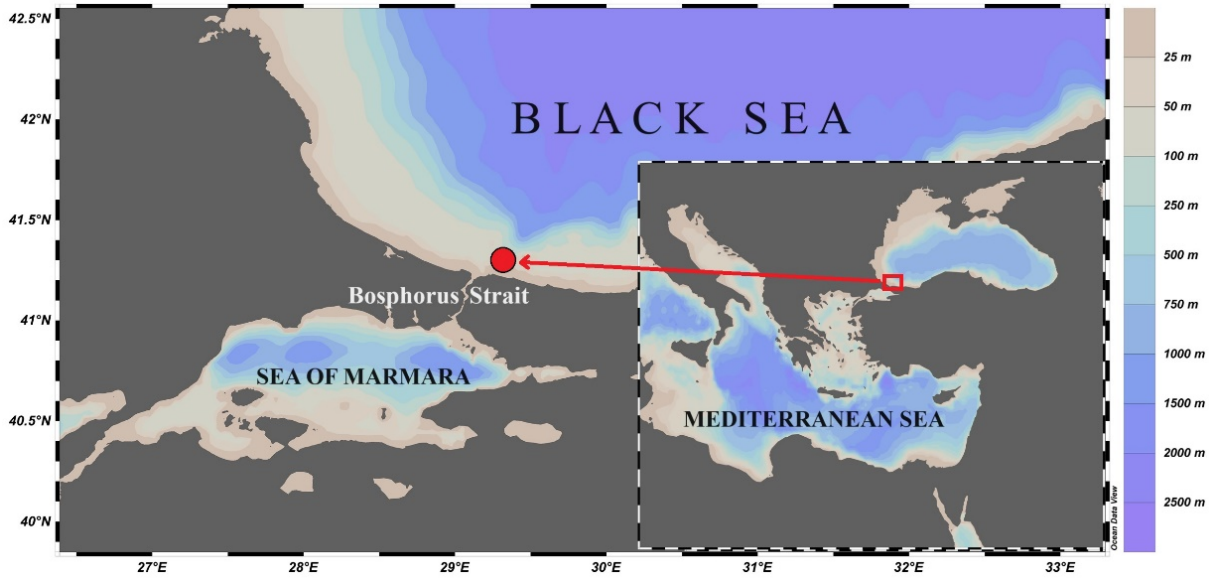

Figure 1. Map shows the approximate locality (red dot) of capture of the examined specimen of *Sebastes schlegelii* in prebosphoric Black Sea

Examined specimen

On 21 December 2023, one specimen of *S. schlegelii* (Figure 2) has been captured by means of a commercial bottom trawler towed at a depth of 50 m off Şile coast (41º16.69'N - 29º13.53'E). Following the capture, the present specimen was stored in a deep freezer at minus 18ºC on board of the fishing trawler, then transferred to İstanbul University, Faculty of Aquatic Sciences, Department of Fisheries Technologies, and Management laboratories. Since the *Sebastes* species occurring in the Atlantic Ocean have 14-16 spiny rays in the dorsal fin, and one or two lachrymal (also called as preorbital) spines (Hureau and Litvinenko, 1986), identification of *S. schlegelii* was based on the following descriptive characters (Karpova et al., 2021): 13 spiny rays in the dorsal fin and three lachrymal spines on the head. Taxonomic nomenclature follows Froese and Pauly (2023). Morphometric measurements and meristic counts were performed in accordance with the procedure adopted from Kai and Nakabo (2002) and Bilecenoğlu et al. (2023). Morphometric distances were measured either with a measurement tape to the nearest 0.5 mm (for distances >10 cm) or with a digital vernier caliper to the nearest 0.05 mm (for distances ≤10 cm) on fresh specimen to avoid affecting shape variations or changing of the distances because of fixation (Martinez et al., 2013). Definitions of body depths 1 and 2 are the distances between the anterior origin of the 13th dorsal spine and that of the 1st anal spine, and body depth 2 is the distance between the anterior origin of the 1st dorsal spine and that of the pelvic spine, respectively (Kai and Nakabo, 2002). Body proportions were expressed as percentages of standard length (SL) and head length (HL). Terminology of head spines follows Orr et al. (2000). Total weight (TW) of the examined specimen was weighed on a precision balance to the nearest 0.05 g. The best practice approach for the first record notes that proposed by (Bello et al., 2014), which requires depositing of evidence specimens preserved in curated collection, photographs of the examined specimen, and morphometric measurements and meristic counts, was strictly followed. The examined specimen was fixed in 10% formalin and 90% distilled water buffered with borax and deposited in the Istanbul University Faculty of Aquatic Sciences laboratory with the barcode number PSC20230114-120.

RESULTS

The examined specimen has a slightly laterally compressed and robust body, and a large head with prominent spines (Figures. 2 and 3). Three lachrymal spines are present, one of which is quite separated from the other two (Figure 3). Strong nasal, preopercular and postocular spines are present (Figure 3), with weakly developed superior cranial spines and suborbital ridge. On the preopercle five spines, of which the second one is the longest, are developed (Figure 3). On the upper corner of the opercle, two flattened and posteriorly

directed spines, of which the upper one is the larger, are visible. A single dorsal fin with 13 spines and 13 soft rays (XIII-13), of which the 13th spine, providing anterior support to soft part of the dorsal fin, is longer than the 12th one. Formulae of pelvic and anal fins I-5 and III-8, respectively. Caudal fin rounded. Ctenoid scales covering the body and 46 pored scales were counted along the lateral line. 25 gill rakers were counted on the first gill arch on the left side of the head. A large and oblique mouth with a maxilla extending the posterior rim of eye. The main color of the body is brown with darker fades on dorsal surfaces and become paler ventrally, blotched with dark spots scattered with an irregular pattern; ventral surface is light grayish with brownish spots; a dark brown stripe on the maxilla; two dark bands, of which the front one is more prominent, are extending radially from the eye. Morphometric measurements of the present specimen is presented in Table 1.

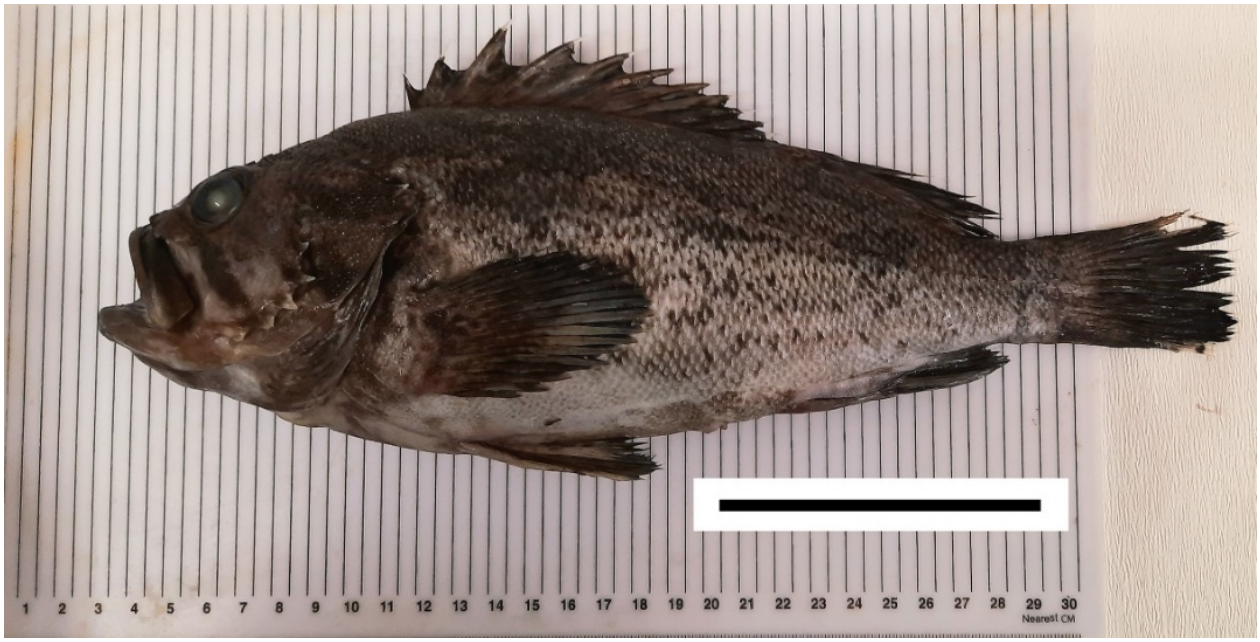

Figure 2. Examined specimen of *S. schlegelii*. Scale bar = 90 mm

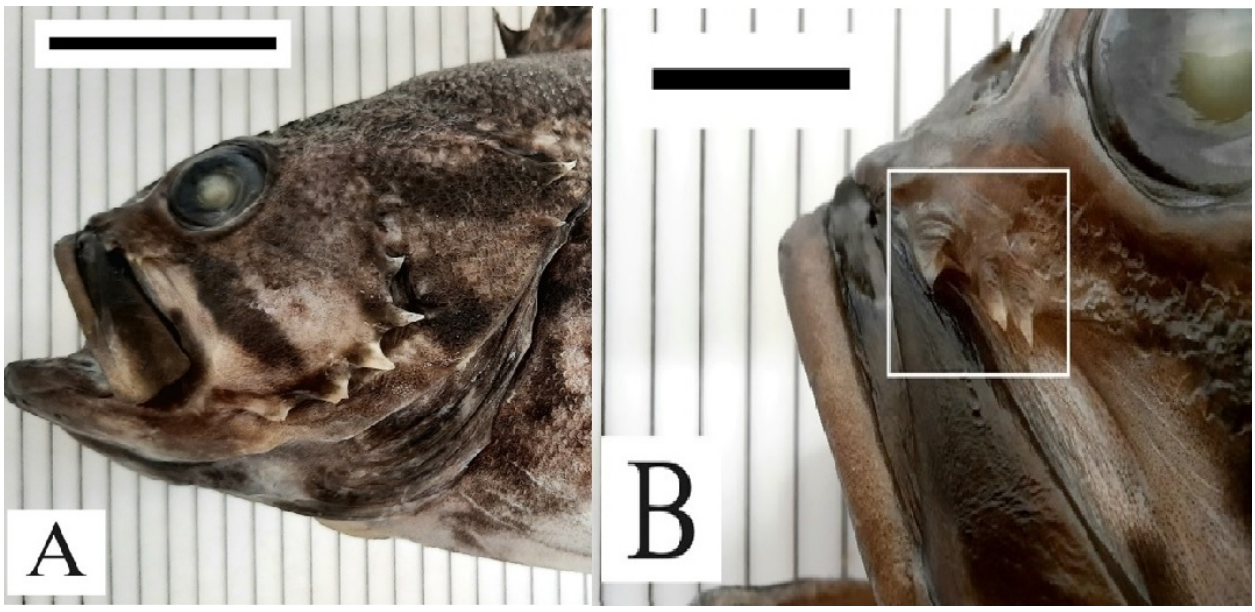

Figure 3. (A) Side view of the head of *S. schlegelii*. Scale bar = 40 mm. (B) Close-up view of three lachrymal spines denoted by the white rectangle. Scale bar = 20 mm

Table 1. Morphometric measurements of the examined and published specimens of *S. schlegelii* recorded from the Marmara (*) and Black Seas

Measurements (mm)	Present Specimen		Karpova et al. (2021)	Bilecenoğlu et al. (2023)	Yağlıoğlu et al. (2023)	Karadurmuş et al. (2024)*
TL	311		325-391	245	350	275
SL	263.5		277-331	206	299.3	240
	(mm)	(% of SL)	(% of SL)	(% of SL)	(% of SL)	
Body depth 1	89.98	34.15	-	36.5	34.0	38.3
Body depth 2	73.95	28.06	-	30.1	-	-
Caudal peduncle depth	25.87	9.82	10.2-10.5	9.7	10.2	9.2
Predorsal length	77.47	29.40	33.0-35.8	27.1	31.1	33.3
Postdorsal length	10.01	3.80	12.5-13.1	13.3	-	
Prepelvic length	103.45	39.26	37.4-38.9	39	34.0	41.3
Preanal length	178.57	67.77	67.8-69.2	66.7	-	68.8
Prepectoral length	88.22	33.48	33.6-35.5	29.8	-	37.1
Distance between pelvic and pectoral fins	15.15	5.75	4.7-5.2	4.7	-	
Distance between pelvic and anal fins	60.62	23.01	18.8-30.2	22.4	-	-
Dorsal fin base length	154.92	58.79	62.5-62.7	60.8	15.8	63.8
Anal fin base length	43.72	16.59	15.5-16.4	15.9	17.8	
Pectoral fin length	59.25	22.49	21.2-22.9	25.2	20.1	24.2
Pelvic fin length	49.21	18.68	20.3-20.6	22.7	34.0	-
Pelvic spine length	26.98	10.24	-	-	-	-
Caudal fin length	52.9	20.08	21.1-21.2	13.4	17.0	-
1st dorsal fin spine	12.99	4.93	-	-	-	-
2nd dorsal fin spine	22.06	8.37	-	-	-	-
3rd dorsal fin spine	29.26	11.10	-	-	-	-
4th dorsal fin spine	34.62	13.14	-	-	-	-
5th dorsal fin spine	36.36	13.80	-	-	-	-
12th dorsal fin spine	18.72	7.10	-	-	-	-
13th dorsal fin spine	24.36	9.24	-	-	-	-
1st anal fin spine	13.04	4.95	-	-	-	-
2nd anal fin spine	27.08	10.28	-	-	-	-
3rd anal fin spine	26.53	10.07	-	-	-	-
Pelvic fin spine	26.97	10.24	-	-	-	-
Head length	90.36	34.29	35.5-40.1	34	30.5	36.7
		% of HL	% of HL	% of HL	% of HL	% of HL
Snout length	20.9	23.13	29.7-32.0	19.8	30.6	-
Orbit length	15.49	17.14	18.3-21.1	18.7	18.9	20.4
Postorbital length	56.55	62.58	52.5-52.5	61.5	-	-
Interorbital width	38.04	42.10	-	-	30.9	-
Upper jaw length	32.29	35.73	47.2-49.4	45.5	-	-

DISCUSSION

The above description of the examined specimen is coincided with those given in Karpova et al. (2021), Froese and Pauly (2023), Bilecenoğlu et al. (2023), Yağlıoğlu et al. (2023 and Karadurmuş et al. (2024). The morphometric distances of the examined specimen of *S. schlegelii* are also coincided with those reported in the literature (Karpova et al., 2021; Bilecenoğlu et al., 2023; Yağlıoğlu et al., 2023; Karadurmuş et al., 2024), and the slight differences between the examined and published ratios (as % SL), all of which are in the safe limits for the Korean rockfish, may be arised because of intraspecific allopatry (Moyle and Cech Jr., 1988). The number of observed lachrymal spines (3) in the examined specimen, one of the main descriptive characteristic of *S. schlegelii*, as well as the number preopercular (5) and opercular (2) spines are also coincided with the numbers reported by Karpova et al. (2021), Bilecenoğlu et al. (2023) and Yağlıoğlu et al. (2023), also confirm the identification of the examined specimen.

According to Froese and Pauly (2023), maximum total length (TL) of *S. schlegelii* is 650 mm and the published maximum total weight (TW) is 3100 g. With a reported maximum age of 20 years, Korean rockfish attain sexual maturity between a TL range of 260 to 280 mm (Froese and Pauly, 2023). Although the present specimen is larger (TL 311 mm) than the reported size range of maturity, its dissection revealed that it is female and bearing ovaries (total weight of both ovaries were 1.25 g) at 2c stage that described in the MEDITS maturity scale for bony fish (Follesa and Carbonara,

2019). To date, reproductive biology of *S. schlegelii* from the Black Sea has not been investigated and available information was not allowed to evaluate the reason of the occurrence of such nonmatured ovaries due to recent spawning or the Korean rockfish attains maturity at a larger size in the Black Sea. Further research is required to clarify this uncertainty.

In the past 10 years between the first record date of *S. schlegelii* in the Black Sea (26 May 2013; Boltachev and Karpova, 2013) and date of capture of present specimen (21 December 2023), Korean rockfish distributed from the Crimean coast (northern Black Sea) to prebosphoric waters. During this time, chronological order of records of *S. schlegelii* has begun off southwestern coast of Crimean peninsula (Boltachev and Karpova, 2013), then further specimens reported from the Russian waters along the eastern coast of the Black Sea (Karpova et al., 2021), of which followed by the sighting records of Korean rockfish off Giresun (6 March 2023), Ordu (27 April 2023) and Kastamonu (13 June 2023) coasts along the Turkish coast of eastern and central Black Sea (Bilecenoğlu et al., 2023). With the capture of a specimen off Fatsa coast on 16 June 2023, first physical evidence of *S. schlegelii* from Turkish Black Sea waters has been obtained (Bilecenoğlu et al., 2023), which was followed by the capture of a single specimen off Akçakoca coast (southwestern Black Sea; Yağlıoğlu et al., 2023). According to (Bilecenoğlu et al., 2023) Korean rockfish is captured regularly but with few numbers off the coast of Ordu (southeastern Black Sea).

Based on Google Maps measure distance function result, the distance between Giresun (southeastern Black Sea), where *S. schlegelii* sighted in Turkish waters for first time on 6 March 2023, and Şile (prebosphoric Black Sea), where the present specimen captured on 21 December 2023, is about 833 km and just a few weeks later, on 7 March 2024 the Korean rockfish finally occurred in the Gulf of İzmit, where it has been reported for the first time in the Sea of Marmara (Karadurmuş et al., 2024). Regarding the above mentioned dates, dispersal of *S. schlegelii* along this distance just took 10 months, suggesting a remarkable dispersal speed (83.3 km per month) from east to west, from southeastern Black Sea to the Sea of Marmara. Marine environment is a dynamic realm, and the distribution of species in the marine environment can be deeply affected and changed under the influence of changing conditions (Chen et al., 2021). The Black Sea is one of the marine areas where the species composition of marine life has changed, either due to natural processes (e.g. Mediterrannization; Azzurro et al., 2011), or due to anthropogenic factors (e.g. transportation with ballast waters; Öztürk, 2021). As emphasized in a recent FAO publication, the number of non-native species in the fauna of the Black Sea is gradually increasing (Öztürk, 2021), and among these species there are fish that are not native to the region (Yankova et al., 2013). Although the number of alien fish species in the Black Sea was reported to be 2 a decade ago (Yankova et al., 2013), new species are being added to this number with changing conditions, and one of them is *S. schlegelii* (Karpova et al., 2021; Bilecenoğlu et al., 2023; Yağlıoğlu et al., 2023).

The chronology of the distribution direction of *S. schlegelii*, which has been occurring in the Black Sea since the early 2010s (Karpova et al., 2021; Bilecenoğlu et al., 2023; Yağlıoğlu et al., 2023), reminds the dispersal history of the invasive gastropod *Rapana venosa* (Öztürk, 2021). The rapa whelk has been first recorded in the Black Sea in 1947 near Novorossiysk (northeastern Black Sea) and followed by the records of *R. venosa* off the coast of Sinop (central south Black Sea) in 1955, in the Sea of Marmara in 1966 and in the Aegean Sea in 1969 (Öztürk, 2021). *R. venosa*, which was initially tried to be eradicated due to the damage it caused to mussel (*Mytilus* sp.) and oyster (*Ostrea* sp.) beds, is now considered an important economic resource in the Black Sea (Öztürk, 2021). Based on our previous ecological experience with *R. venosa* in the Black Sea, Sea of Marmara and Aegean Sea, the occurrence and dispersal of *S. schlegelii* far from its natural distribution range (nortwestern Pacific), arise several questions, such as whether the Korean rockfish brings with ecological problems or economic opportunities as it moves towards the Sea of Marmara, where it has been recently reported (Karadurmuş et al., 2024). Although *Sebastes* species were previously classified in the same family with closely related species of scorpion fish (Scorpaenidae) in the past (Hureau and Litvinenko, 1986), are today divided into the Sebastidae family (Froese and Pauly, 2023). Therefore, *S. schlegelii* can be assumed to compete with *Scorpaena notata*, *S. porcus* and *S. scrofa*, which are indigenous species of the fish fauna of Sea of Marmara (Bilecenoğlu et al., 2014), can not be ruled out. Since Korean rockfish is an economically valuable aquaculture species in its natural distribution area, just like in the case of the rapa whelk, *S. schlegelii* can induce its own economy in the future.

CONCLUSION

According to Chen et al. (2021), who emphasize that changing climatic conditions will negatively affect the distribution patterns of *S. schlegelii* in the northwest Pacific, if the conditions do not change, it is predicted that the species will experience a 45% habitat loss in its natural distribution area by the end of this century. The most important environmental parameter affecting the distribution of *S. schlegelii* is bottom water temperature, and the species can be expected to be occur in regions with bottom water temperatures between 3ºC and 13ºC (Chen et al., 2021). Considering the fact that the annual average sea water temperature in the Sea of Marmara is increasing year-by-year (Turkish State Meteorological Service, 2022), the southward dispersal of this relatively cold-water inhabitant species may not extend further than Sea of Marmara. Documenting the species' southerly dispersal and possible colonizations is necessary to achieve an in-depth understanding of the persistence and potential impacts of *S. schlegelii* in its new habitat.

ACKNOWLEDGMENTS

Authors thank to the crews of commercial fishing trawler (Ömer Halis Demir) and the fisherman Sefer GÜZEY for generously sharing the specimen of *S. schlegelii* examined in the present study. Authors also thank to anonymous reviewers for their valuable comments, which improved the content and quality of the article.

FUNDING

No additional grants to carry out or direct this particular research were obtained.

AUTHORSHIP CONTRIBUTIONS

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Hakan Kabasakal and Uğur Uzer. The first draft of the manuscript was written by Hakan Kabasakal and all authors commented on previous versions of the manuscript. All authors approved the final manuscript.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

ETHICS APPROVAL

Specimen of *Sebastes schlegelii* examined in the present study was consisted of a bycatch fish captured in commercial fisheries. Live fishes were never euthanized and their wellfare were never violated. Since the present sample was only consisted of already death animal, no approval of ethical committe required.

DATA AVAILABILITY

Raw data, including excel tables, figures, etc. are available on request from corresponding author for further inspection.

REFERENCES

Azzurro, E., Moschella, P., & Maynou, F. (2011). Tracking Signals of Change in Mediterranean Fish Diversity Based on Local Ecological Knowledge. *PLoS ONE*, *6*(9), e24885. https://doi.org/10.1371/journal.pone.0024885

Bello, G., Causse, R., Lipej, L., & Dulčić, J. (2014). A proposed best practice approach to overcome unverified and unverifiable "first records" in ichthyology. *Cybium*, *38*(1), 9-14.

Bilecenoğlu, M., Kaya, M., Cihangir B., & Çiçek, E. (2014). An updated checklist of the marine fishes of Turkey. *Turkish Journal of Zoology*, *38*(6), 901-929. https://doi.org/10.3906/zoo-1405-60

Bilecenoğlu, M., Yokeş, M.B., & Aydın, M. (2023). First record of *Sebastes schlegelii* Hilgendorf, 1880 along the Turkish Black Sea coast-new addition to the alien species inventory. *Turkish Journal of Maritime and Marine Sciences*, *9*(2), 119-128. https://doi.org/10.52998/trjmms.1358814

Boltachev, A., & Karpova, E. (2013). First record of dogtooth grouper *Epinephelus caninus* (Valenciennes, 1834), Perciformes, Serranidae, in the Black Sea. *BioInvasions Records*, *2*(3), 257–261. https://dx.doi.org/10.3391/bir.2013.2.3.14

Carpentieri, P., Nastasi, A., Sessa, M., & Srour, A. (Eds.) (2021). *Incidental catch of vulnerable species in Mediterranean and Black Sea fisheries-A review*. Studies and Reviews no. 101 (General Fisheries Commission for the Mediterranean). Rome: FAO. https://doi.org/10.4060/cb5405en

Chen, Y., Shan, X., Ovando, D., Yang, T., Dai, F., & Jin, X. (2021). Predicting current and future global distribution of black rockfish (*Sebastes schlegelii*) under changing climate. *Ecological Indicators*, *128*, 107799. https://doi.org/10.1016/j.ecolind.2021.107799

Froese, R., & Pauly, D. (2023). *FishBase. World Wide Web electronic publication*. https://fishbase.se/summary/Sebastes-schlegelii.html (last accession: 18 January 2024)

Follesa, M.C., & Carbonara, P. (2019). *Atlas of the maturity stages of Mediterranean fishery resources*. Studies and Reviews n. 99. Rome, FAO.

Hureau, J.-C., & Litvinenko, N.I. (1986). Scorpaenidae. In P.J.P. Whitehead, M.L. Bauchot, J.C. Hureau, J. Nielsen & E. Tortonese (Eds.), *Fishes of the north-eastern Atlantic and the Mediterranean* (pp. 1211-1229). Paris, UNESCO.

Kai, Y., & Nakabo, T. (2002). Morphological differences among three color morphotypes of *Sebastes inermis* (Scorpaenidae). *Ichthyological Research*, *49*(3), 260-266. https://doi.org/10.1007/s102280200037

Karadurmuş, U., Güner, A., & Aydın, M. (2024). First Record and Geographic Expansion of the *Sebastes schlegelii* (Hilgendorf, 1880) in the Sea of Marmara (Türkiye). *Journal of Anatolian Environmental and Animal Sciences*, *9*(1), 82-86. https://doi.org/10.35229/jaes.1431890

Karpova, E.P., Tamoykin, I.Y., & Kuleshov, V.S. (2021). Findings of the Korean Rockfish *Sebastes schlegelii* Hilgendorf, 1880 in the Black Sea. *Russian Journal of Marine Biology*, *47*(1), 29-34. https://doi.org/10.1134/S1063074021010003X

Kovačić, M., Lipej, L., Dulčić, J., Iglesias, S.P., & Goren, M. (2021). Evidence-based checklist of the Mediterranean Sea fishes. *Zootaxa*, *4998*(1), 1-115. https://doi.org/10.11646/zootaxa.4998.1.1

Martinez, P.A., Berbel-Filho, W.M., & Jacobina, U.P. (2013). Is formalin fixation and ethanol preservation able to influence in geometric morphometric analysis? Fishes as a case study. *Zoomorphology*, *132*(1), 87–93.

Moyle, P.B., & Cech Jr., J.J. (1988). *Fishes. An Introduction to Ichthyology*. Englewood Cliffs, Prentice Hall.

Orr, J.W., Brown, M.A., & Baker, D.C. (2000). Guide to rockfishes (Scorpaenidae) of the genera *Sebastes*, *Sebastolobus*, and *Adelosebastes* of the Northeast Pacific Ocean, second edition. *U.S. Department of Commerce, NOAA Technical Memorandum*, NMFS-AFSC-117.

Öztürk, B. (2021). *Non-indigenous species in the Mediterranean and the Black Sea*. Studies and Reviews No. 87 (General Fisheries Commission for the Mediterranean). Rome, FAO. https://doi.org/10.4060/cb5949en

Turkish State Meteorological Service (2022). available at: https://www.mgm.gov.tr/FILES/resmi-istatistikler/denizSuyu/Marmara-Deniz-Suyu-Sicakligi-Analizi-2022.pdf (last accession: 7 March 2024).

Yankova, M., Pavlov, D., Ivanova, P., Karpova, E., Boltachev, A., Bat, L., Oral, M., & Mgeladze, M. (2013). Annotated check list of the non–native fish species (Pisces) of the Black Sea. *Journal of Black Sea and Mediterranean Environment*, *19*(2), 247-255.

Yağlıoğlu, D., Doğdu, S.A., & Turan, C. (2023). First Morphological and Genetic Record and Confirmation of Korean Rockfish *Sebastes schlegelii* Hilgendorf, 1880 in the Black Sea Coast of Türkiye. *NESciences*, *8*(3), 140-150. https://doi.org/10.28978/nesciences.1363941