Egyptian Journal of Aquatic Biology & Fisheries
Zoology Department, Faculty of Science,
Ain Shams University, Cairo, Egypt.
ISSN 1110 – 6131
Vol. 23(3): 321 –328 (2019)
www.ejabf.journals.ekb.eg

Study of the benthic macrofauna and application of AMBI index in the coastal waters of Algeria

Benkhedda Belhaouari*[1, 2], Fethi Si-hamdi[1] and Ahmed Belguermi[3]
1-Département Eau, Environnement et Développement Durable, Université de Chlef - *Hassiba* Benbouali
2- Ecole supérieure d'agronomie de Mostaganem
3- Laboratoire Réseau de Surveillance Environnementale, Université d'Oran 1 - Ahmed Ben Bella
*Corresponding author: belhaouaribio@hotmail.fr

ARTICLE INFO
Article History:
Received: March 3, 2019
Accepted: Aug.18, 2019
Online: Aug. 22, 2019

Keywords:
Marine pollution
Monitoring,
Coastal waters
Algerian coastal
Benthic macrofauna
AMBI index

ABSTRACT
The aim of this of study was to examine the state of the benthic macrofauna community at six different sites in coastal waters of Algeria. The diversity of benthic macrofauna was studied and the AZTI marine biotic index (AMBI) was applied. Sampling was carried out during March and April 2018. Thus, 31 species were recorded. Higher species richness (13 species) was recorded in two sites. The highest density was estimated at 56.6 in / 0.1 m². Taxonomic analysis has shown the prevalence of Gastopoda, Bivalvia and Scaphopoda. Sediment analysis showed a low concentration of organic matter in the six sites. The AMBI index used in this study has been used extensively in Europe as indicador of marine pollution, but rarely used in Algeria. The AMBI values were quite homogeneous over all the sites, and generally correspond to undisturbed states except for one site, which is slightly disturbed.

INTRODUCTION

The Algerian coastal is 1622 km long and occupies a good part of the Mediterranean basin. The Algerian population estimated at 41 million inhabitants is concentrated at nearly 40% in coastal cities (ONS, 2017). The littoral zones are subjected to a strong anthropic pressure and consequently many species are victims of bad adaptation. Natural or anthropogenic disturbances result in a functional and structural modification of ecosystems (Fernandez and Boudouresque, 1997; Thibaut and Blanfune, 2014). The present study is focused on the Algerianwesterncoast; at 200 km from the capital. The sustainable use of coastal waters implies a good knowledge of their states. Therefore, we performed this study.

Benthic macroinvertebrates of soft bottom habitat are excellent indicators of the general state of the environment and may, through the presence or absence of some sensitive organisms, be a control for natural and anthropic disturbances (Augier, 2010; Eleftheriou, 2013; Belhaouari *et al*., 2014).

Research works about biological quality of Algerian coastal waters are very limited (Belhaouari *et al*., 2018 ; Traich *et al*., 2018), therefore, the aim of the present study is to determine the benthic macroinvertebrates characterizing the soft bottom of Algerian western coast and evaluate the ecological status using the AMBI index

(AZTI Marine Biotic Index) (Borja *et al*., 2000 ; Borja *et al.*, 2003), that will contribute to the sustainable management of marine biodiversity.

MATERIALS AND METHODS

Sampling

Sampling was carried out at six sites on the coast of Tenes during March and April 2018 (Figure 1). The sampling points are located in the sediment at a depth of approximately 20 m (Table 1). At each of these sites, three replicates of benthos were collected with a Van Veen grab (1200 cm^2). The samples were used for sediment characterization and for the study of benthic macrofauna.The samples were filtered immediately, using a sieve of mesh size of 1 mm and fixed in a solution of 4% formalin (Borja, 2000).

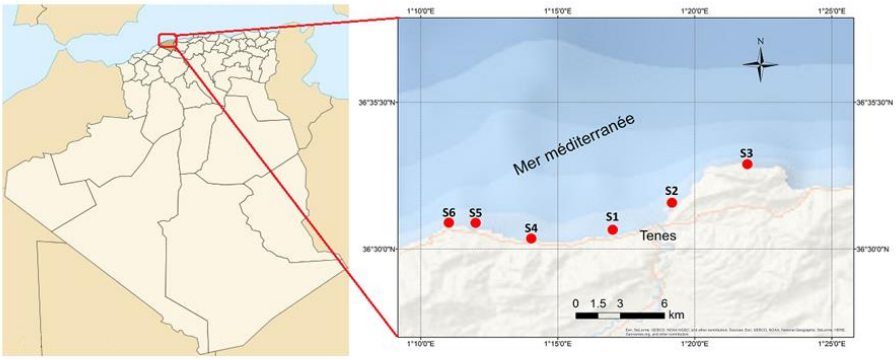

Fig. 1: Location of sampling sites

Table 1: Characteristics of sampling sites

Sites	Sample location	Depth (m)	Longitude	Latitude
Site 1	Aïn El kadi	19,7	1°17’2.56’’E	36°31’14.30’’N
Site 2	Phare	19,4	1°19’37.49’’	36°32’59.89’’N
Site 3	Sidimerwan	22,9	1°22’2.15’’E	36°33’8.26’’N
Site 4	Maïnis	22,1	1°14’22.06’’E	36°30’49.74’’N
Site 5	Oued El ksab	18,1	1°12’48.52’’E	36°31’7.72’’N
Site 6	Kaf kala	18,1	1°11’6.66’’E	36°31’7.46’’N

Sediment data

At each station, a sediment sample was obtained to determine texture of the sediment and organic matter. The particle size of the sediment was determined by sieving (Rzasa and Owczarzak, 2013). The organic matter content was calculated by the loss on ignition method: drying at 105°C, 24 h ; then combusting at 520°C, 6 h (Kristensen and Anderson, 1993).

Biological data

The identification of the species was carried out in the laboratory by a binocular microscope (4±40). To study the macrobenthic community structure, we used the following parameters: richness (number of identified taxa); abundance (N: ind /0,1m^2); indices of Shannon Weaver (H’).

AMBI AZTI’s Marine Biotic Index

AMBI AZTI’s Marine Biotic Index, also called benthic coefficient (CB) is a biotic index developed in Spain by Borja *et al*. (2000) to identify the ecological quality of soft bottom benthos in the Mediterranean region.

The macrofauna of the soft bottom benthos can be divided into 5 groups:
Group I. Species very sensitive to organic enrichment and present under unpolluted conditions (initial state).
Group II. Species indifferent to enrichment, always present in low densities with non-significant variations with time (from initial state, to slight unbalance).
Group III. Species tolerant to excess organic matter enrichment.
Group IV. Second-order opportunistic species (slight to pronounced unbalanced situations).
Group V. First-order opportunistic species (pronounced unbalanced situations). Starting from these bases, a simple formula has been proposed. This is based on the abundance percentages of each ecological group in each sample to obtain a continuous index, the Biotic Coefficient (BC):

$$BC = \{(0 \times \%GI) + (1.5 \times \%GII) + (3 \times \%GIII) + (4.5 \times \%GIV) + (6 \times \%GV)\}/100$$

The AMBI index is produced for the first time in Ténès. The final calculation is done using the AMBI index software (Version 5.0).

Table 2: Summary of the AMBI values and their equivalences (Borja, 2000)

Site pollution classification	Biotic Coeffcient	Biotic index	Dominating ecological group	Benthic community health
Unpolluted	$0.0<BC\leq0.2$	0	I	Normal
Unpolluted	$0.2<BC\leq1.2$	1		Impoverished
Slightly polluted	$1.2<BC\leq3.3$	2	III	Unbalanced
Meanly polluted	$3.3<BC\leq4.3$	3		Transitional to pollution
Meanly polluted	$4.3<BC\leq5.0$	4	IV-V	Polluted
Heavily polluted	$5.0<BC\leq5.5$	5		Transitional to heavy pollution
Heavily polluted	$5.5<BC\leq6.0$	6	V	Heavy polluted
Extremely polluted	Azoic	7	Azoic	Azoic

RESULTS AND DISCUSSION

Sediment Characterization

The results of analyzes of the granulometric composition of the sediment and the organic matter content are shown in Table 3.

Table 3: Sediment texture and organic matter content

	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Sediment texture	Fine sand	Fine sand	Coarse gravel	Fine gravel	Fine sand	Mediun sand
% Organic matter	0,35	0,35	0,31	2,076	0,59	1,28

The sedimentary parameters measured on the 06 stations indicate the presence of two granular classes (sand and gravel).Our results show that sediments have variable sand contents on most stations (Table 3), with 3 stations with fine sands and one with medium sands.Our results show that only two stations have a gravel fraction (Site 3 and Site 4).
Organic matter contents are relatively equal and low. The rate of organic matter in the sediment did not exceed 1% in four sites. The highest rate (2.07%) was recorded in Site 4, whose sediment corresponds to fine gravel.
The results of this study show that the dominant sedimentary facies is sand. The soft bottoms of the coast of the study area, located at about 20 m depth are weakly enriched in organic matter. Most of the studied sites are open and subjected to

a strong hydrodynamism. The trapping of fine particles is limited in this type of open environment (Alzieu,2003 ; Augier, 2010).

Faunistic analysis and ecological index

The abundance of taxa (in / 0.1 m²) and species richness (S) for the sampled stations are presented in Table 04.

Table 4: Abundance of the benthic macrofauna

Classe	Species	S1	S2	S3	S4	S5	S6	All sites
Gasteropoda	*Bolinusbrandaris*	1,7						1,7
	Nassa cooper	10,3						10,3
	Turritellacommunis	1,7		1,7	8,6			12
	*Naticarius*sp.	1,7					1,7	3,4
	Nassariusreticulatus	3,4			6,9			10,3
	Calyptraeachinensis				10,3			10,3
	Cerithiumvulgatum			1,7				1,7
	Gibberulamiliaria				1,7		8,6	10,3
	Bulla sp.					3,4	1,7	5,1
	Turbonillaacuta				1,7			1,7
	Nassariusincrassatus	3,4				8,6		12
	Pseudomelatomapenicillata				1,7			1,7
	Bittiumreticulatum				6,9	8,6	13,8	29,3
	*Donax*sp.	1,7						1,7
Scaphopoda	*Dentalium*sp.	20,4	25,9		3,4			49,7
Bivalvia	*Callistachione*	1,7						1,7
	Glycymerisglycymeris					1,7		1,7
	*Tellina*sp.				1,7	3,4		5,1
	Venus verrucosa			1,7				1,7
	Paphiaaurea				1,7			1,7
	Chameleagallina				1,7			1,7
	Pitarrudis				1,7			1,7
Ophiuroidea	*Ophiuratexturata*	1,7						1,7
Anthozoa	*Adamsiacarciniopados*	3,4						3,4
Polychaeta	*Otopsis*sp.	3,4						3,4
Asteroidea	*Astropectenirregularis*		1,7					1,7
Enopla	*Nematonereis*sp.		1,7					1,7
Malacostraca	*Gammarus*sp.		1,7					1,7
	Medorippelanata	1,7						1,7
	Macropipus depurator			1,7				1,7
Ascidiacea	*Styela*sp.				8,6			8,6
		∑= 56,2 S = 13	∑ = 31 S = 4	∑= 6,8 S = 4	∑= 56,6 S = 13	∑= 25,7 S = 5	∑= 25,8 S = 4	S = 31

The total species diversityof the study area is 31 taxa, it is variable in the six stations. The taxonomic analysis of sites shows the big representation of Gasteropoda, Bivalvia, Scaphopoda and Malacostraca. The other classes are less represented on the sites. However, they contribute to the overall diversity of these habitats. The most represented class is Gastopoda, it is present on 5 stations. The main species identified are *Nassa cooperi*, *Nassarius reticulates*, *Calyptrae achinensis*, *Gibberula miliaria*, *Nassarius incrassatus*, *Bittium reticulatum*, *Dentalium* sp. and *Styela* sp. The most abundant taxon is *Dentalium*sp (49.7 in / 0.1 m²), it belongs to the class of Scaphopoda. The highest abundance was recorded at site 1 and site 4 where it reached 56.2 in / 0.1 m² and 56.6 in / 0.1 m², respectively. Site 3 is characterized by the lowest abundance 6.8 in / 0.1 m².

The species diversityis higher in sites 1 and 4 (13 taxa), these two sites are less subject to sedimentary rearrangements and more stable. This kind of site is favorable for the development of benthic macrofauna (Augier, 2010). The most abundant taxa is *Dentalium sp* has been recorded in sites characterized by high species diversityand in sites marked by low species diversity, it is a burrowing mollusc that burrow sediment with its muscular cylindrical foot (Hayward *et al*., 1998; Muller *et al*., 2004). In the current state of knowledge, it is difficult to compare the values of species diversitywith previous studies, no study of this type having been carried out in our study area. Compared to other sectors of the Algerian coast, the species diversity is very comparable between several sites. In Bou Ismail bay (100 km east of Ténès), the species diversity is estimated at 42 species. In Algiers bay (200 km east of Ténès), it is estimated at 35 species (Grimes, 2010).

The results of the Shannon Weaver diversity index represented in (Figure 2) show that the H' indices corresponding to the six sites are globally low, ranging from 0.62 in site 2 to 2.21 in site 4.

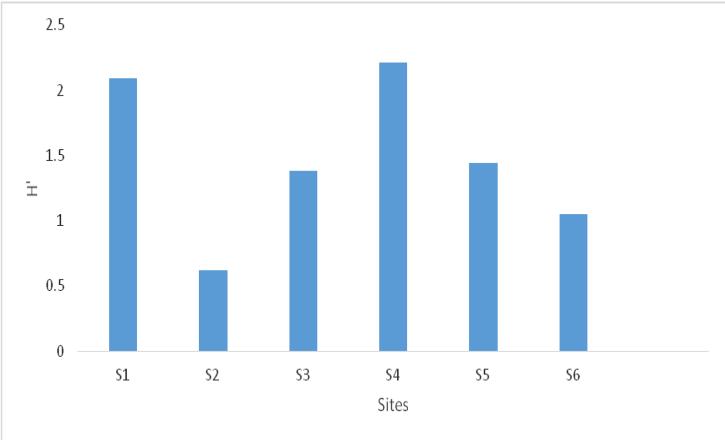

Fig. 2: Shannon Weaver H 'Index Results

Regarding the index H', it should be noted that the index H' explains the species diversity of a community according to the number of species harvested and the number of individuals of each species (Frontier *et al*., 2008), it is not appropriate for detecting environments subjected to disturbance or pollution (Dauvin *et al*., 2013). Concerning the S2 site, the low value of the H' index (0.62) indicates that there are predominant species. This site is characterized by the presence of four species, Table 4 shows a very broad dominance of *Dentalium*sp. (83.54%). For the S3 site, it is characterized by the presence of four species, the individuals are distributed equally (25%), but the index H 'is not high (1.38), this may be related to the low species richness.This index is too sensitive to species richness and total abundance in the samples (Simboura and Zenetos, 2002; Grall and Coïc, 2006). Sites S1 and S4 have the highest index values H '2.09 and 2.21 respectively. They are marked by the highest species richness (13 species), but their index H 'remains below 3. These sites cannot be considered as reference sites. In fact, for sites to be used as a reference, they must be characterized by a high specific richness and big Shannon index (H'≥3) (Grimes *et al*., 2010).

AMBI Index: The percentage of ecological groups and the results of the AMBI index calculated on the six sites are presented in Figures 3 and 4.

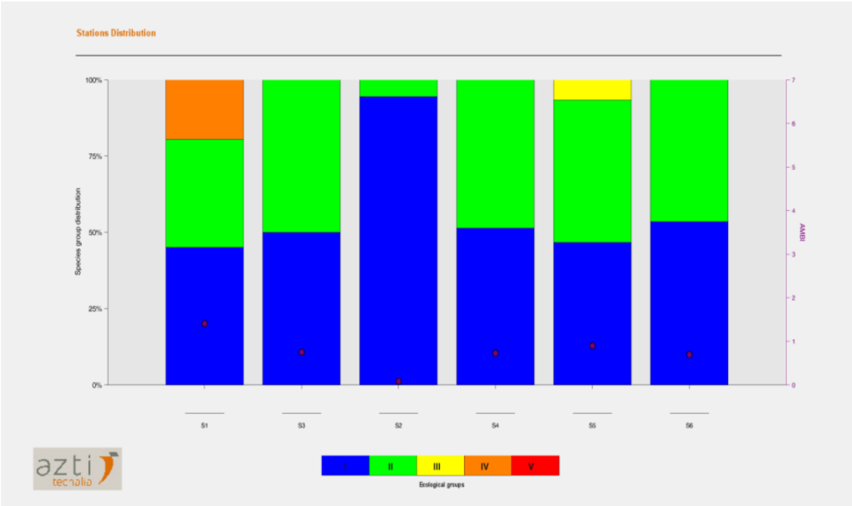

Fig. 3: Percentage of ecological groups by station

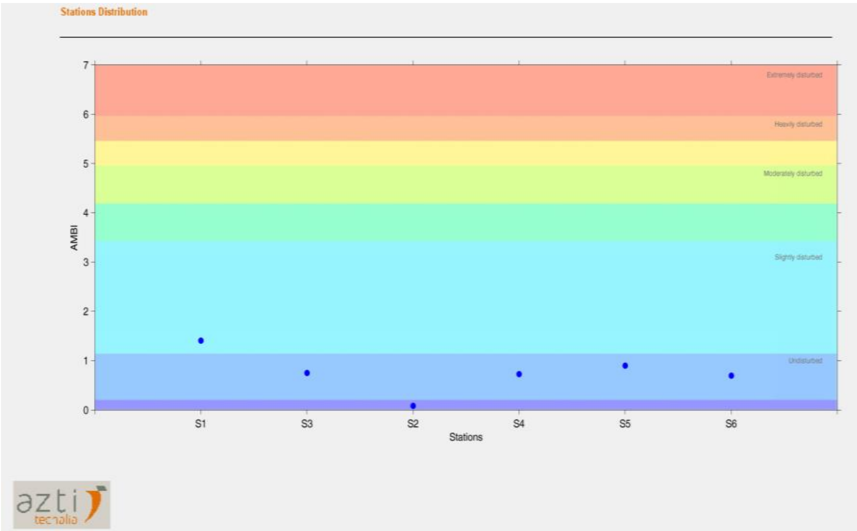

Fig. 4: AMBI index calculated on the six stations

The AMBI index calculated as part of this initial state study are generally quite homogeneous (Figure 4). The index computation revealed that the sites studied are undisturbed with the exception of site 1 which is slightly disturbed.

In terms of functional groups, the majority of the sites have a high proportion of species belonging to group I (species very sensitive to disturbances) and group II (species insensitive to disturbances, always present in low densities and without seasonal variations) (Figure 4). Site 1 is characterized by species belonging to group VI (second-order opportunistic species), represented by Gasteropoda *Nassa cooperi* (19.5%). Site 5 has a low proportion of species belonging to group III (species tolerant to organic matter enrichment), represented by bivalvia *Glycymeris glycymeris* (6.6%).

For the marine biotic index (AMBI), the result of site 1 is remarkable, this site is slightly disturbed. In fact, this site is located in the center of the coast of Tenes would be one of the most popular sites of the coast. Although it has a high Shannon Weaver H' index value compared to other sites, it is characterized by the worst AMBI index. In another study performed at the Algerian coast Grimes (2010) have reported similar results. This analysis makes it possible to relativize the current environmental situation of the studied sites compared to states of disturbance more important present on some Algerian waters (Rouane-Hacene *et al*., 2017; Belhaouari *et al*., 2017; Khadidja *et al*., 2018).

CONCLUSION

This benthos study of the soft substrates on six sites distributed on the algerian coastal waters allowed the acquirement coherent and informative data.

The used of AMBI prove the efficiently of this index with regard to the Mediterranean-Algerian context. The AMBI results confirm that the coastal waters of our study area are generally qualified as a good ecological state. Biological parameters (species richness and abundance of taxa) and sediment parameters such as sediment texture and concentration of organic matter represent an important tool for describing the benthic fauna state.

At the end of this study, we recommend the use of the AMBI index as part of the biomonitoring and sustainable management of the Algerian coastal.

REFERENCES

Alzieu, C. (2003). Bioévaluation de la qualité environnementale des sédiments portuaires et des zones d'immersion. Ifremer, 247 p.

Augier, H. (2010). Guide des fonds marins de Méditerranée. Delachauxet Niestle, 456 p.

Belhaouari, B.**;** Belguermi, A.; Achour, T.; Bendaha, A.; Deham, F. and Mokhtari, Y. (2014). Organic Pollution Assessment and Biological Quality of the River OuedRhiou (Algeria). Inter. J. Sci: Basic & Appl. Res., 18(1): 33-44.

Belhaouari, B.; Setti, M.; Kawther, A. (2017). Monitoring of phytoplankton on coast of Ténès (Algeria). J. Water Sci. Environ. Technol, 02(1): 159-163.

Belhaouari, B. (2018). Assessment of the state of littoral waters in Algeria: Guidelines and recommendations. EWASH & TI. J., 2(1): 41- 44.

Borja, A.; Franco, J.; Pérez, V. (2000). A Marine Biotic Index to Establish the Ecological Quality of Soft-Bottom Benthos within European Estuarine and Coastal Environments. Mar. Pollut. Bull., 40: 1100–1114.

Borja, A.; Muxika, I.; Franko, J., (2003). The application of a Marine Biotic Index to different impact sources affecting soft-bottom benthic communities along European coasts. Mar. Pollut. Bull., 46: 835–845.

Eleftheriou, A. (2013). Methods for the study of marine benthos. John Wiley & Sons, 496 p.

Fernandez, C.; Boudouresque, C.F. (1997). Phenotypic plasticity of Paracentr-otuslividus (*Echinodermata: Echinoidea*) in a lagoonal environment. Mar. Ecol. Prog. Ser., 152: 145–154.

Frontier, S.; Pichod-Viale, D.; Leprêtre, A.; Davoult, D.; Luczak, C. (2008). Ecosystèmes: Structure, fonctionnement, évolution. Dunod, 576 p.

Grall, J.; Coïc, N. (2006). Synthèse des méthodes d'évaluation de la qualité du benthos en milieu côtier. Ifremer, 91 p.

Grimes, S.; Ruellet, T.; Dauvin, J.D.; Boutiba, Z. (2010). Ecological quality status of the soft-bottom communities on the Algerian coast: general patterns and diagnosis. Mar. Pollut. Bull., 60: 1969-1977

Hayward, P.J.; Nelson-Smith, T.; Shields, C. (1998). Guide des bords de mer, Mer du Nord, Manche, Atlantique, Mediterranee. Delachaux & Niestlé, 351p.

Dauvin, J.; Grimes, S.; Bakalem, A. (2013). Marine biodiversity on the Algerian Continental Shelf (Mediterranean Sea). J. Nat. Hist, Taylor & Francis, 47 (25–28):1745–1765.

Khadidja, C.; Lamia, B.; Halima, S. (2018). Ecological Quality Status of the Algiers coastal waters by using macroalgae assemblages as bioindicators (Algeria, Mediterranean Sea. Mediterr. Mar. Sci., 19(2): 305–315.

Kristensen, E.; Andersen, F.O. (1993). Determination of organic carbon in marine sediments: a comparison of two CHN-analyzer methods. J. Exp. Mar. Biol. Ecol., 109: 15–23.

Muller, Y. (2004). Faune et flore du Littoral du Nord, du Pas-de-calais et de la Belgique, Commission régionale de biologie région Nord Pas-de-Calais, 308 p.

Office National des Statistiques (ONS). (2017). Démographie algérienne 2016 : Donnée statistique N° 779. ONS, 24 p.

Rouane-Hacene, O.; Boutiba, Z.; Benaissa, M., Belhaouari, B.; Francour, P.; Guibbolini-Sabatier, M.E.; Risso-De Faverney, C. (2017). Seasonal assessment of biological indices, bioaccumulation, and bioavailability of heavy metals in sea urchins *Paracentrotuslividus* from Algerian west coast, applied to environmental monitoring. Environ. Sci. Pollut. Res. Int., 25 (12): 11238–11251.

Rzasa, S.; Owczarzak, W. (2013). Methods for the granulometric analysis of soil for science and practice. Pol. J. Soil. Sci., 46(01): 01–50.

Simboura, N.; Zenetos, A. 2002. Benthic indicators to use in ecological quality classification of Mediterranean soft bottom marine ecosystems, including a new biotic index.Mediterr. Mar. Sci. 3(2): 77–111.

Thibaut, T.; Blanfuné, A. (2004). Evaluation écologique du littoral rocheux de l’Air Marine Protégée de Karaburun-Sazani. Intiative PIM, 22p.

Traiche, A.; Belhaouari, B.; Rouen-Hacen, O. (2018). Study of macroalgae biodiversity in the western algerian coast, Ténès. Curr. Bot., 9: 28–32.