Epipsammic diatom fauna of Karabey Creek in Türkiye

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Abstract

This researching includes investigations of monthly changes in the population size and density of the diatoms in the Epipsammic samples taken from Karabey Creek in Bingöl, Türkiye between March-November 2020. Throughout the research, 31 taxa belonging to Bacillariophyta was recorded in the first station and 37 taxa were recorded in the second station. Navicula and Nitzschia was the diatom species that were represented by 5 taxa, the highest number in the first station, in the second station, Cymbella, Navicula and Nitzschia were the diatom species that were represented by the most taxa with 5 taxa. In March, the first station's highest relative density (10.63%) belonged to Ulnaria ulna species while the lowest density (0.73%) belonged to Encyonema ventricosum, *Fragilaria tenera* and *Surirella minuta* species in May. In the second station, the highest relative density (8.73%) belonged to *Ulnaria ulna* species in March while the lowest density (1.09%) belonged to *Pinnularia nobilis*, *Surirella ovalis* and *Encyonema elginense* species in April. Measurements concerning temperature, dissolved oxygen and pH were also conducted for the water samples taken from the stations. The measured variables are found to be positive for the development of diatoms in epiliton. Relative density of the diatoms found in the Epipsammic flora was recorded.

Keywords: Karabey Creek, Epipsammic, Diatom

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Introduction

The streams of earth have great importance since its involvement in industry and agriculture, consumption by humans as drinking water and as well as being a source that feeds lakes, ponds and dams. The organisms living in the streams maintain a stable relationship with each other as well as its surroundings, thereby creating an ecosystem. In order to maintain and develop the aquaculture population in our inland waters, detection of algae and its importance must be acknowledged. First, algae found in phytoplankton shows vital importance for aquatic life since they produce organic molecules from inorganic ones and supply oxygen while so doing. Naturally, the changes in the quantity and the kind of organisms on this level of the food chain directly affect the upper levels of the food chain (Atıcı and Ahıska, 2005).

Nowadays 70% of freshwater in the arctic area is in the form of either glaciers or snow and the other 30% is composed of ground water and surface water. Surface waters such as lake, rivers are calculated to be 0.3% of the total water. The fact that the amount of freshwater that can be directly used is so low shows the significance of the freshwater ecosystem (UNEP, 2002).

Streams are the vessels of the countries. The importance of the aquatic ecosystems that are separate habitats on their own are still not acknowledged. Protection, proper management and proper usage of water that bear such a great importance for life on earth matter crucially. The changes in water's physical, chemical and biological properties give valuable clues about the aquatic ecosystems (Hutchinson, 1967; Horne and Goldman, 1944; Çelekli, 2006).

Phytoplankton that form more complex carbon molecules than high plants are used as indicators for changes in water quality because of their reaction to changes in the environment. After water framework directive became valid, phytoplankton became accepted as a part of quality component for determining the ecological quality status of surface water that houses hydrological activity (EC, 2009).

Algae that is in the first level of the food chain lives by holding on to different substrates in the benthic area of the ecosystems. These creatures are called phytobenthos. Phytobenthos group is mainly composed of diatoms (Toudjani *et al*., 2017). Diatoms are also known as siliceous algae are used as reliable environmental indicator species for a long time (Lowe and McCullough, 1974). These also have an important function among phytoplankton for primary production.

Since there are diatoms living on the water surface, the biggest environmental reason for changes in the composition of diatoms is movement of water. Movement of water affects susceptibility to hanging on water surface with respect to species's adhesion capacity (de Jonge, 1985). Diatoms are sensitive to physicochemical changes in the environment and they react quickly. Because of this and their being primary autotroph, they are more sensitive

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microorganisms to food salts. All their make diatoms crucial for both aquatic ecosystems and identifying the ecological status of the ecosystems (Steinberg and Schiefele, 1988; Descy and Coste, 1991; Toudjani *et al*., 2017). Diatoms that are densely found in most of the aquatic ecosystems reflect the ecological changes in their environment very well. They are used in tracking the water quality and especially eutrophication processes often because of these abilities (Admiraal *et al*., 1982).

European water framework directive has required 5 different ecological quality factors, such as phytobenthos, phytoplankton, macrophyte, fish and benthic invertebrates in order to evaluate the ecological quality of bodies of water since 2000 (EC, 2009). Diatoms make up a big part of one of the quality parameters, which is phytobenthos (Della Bella *et al*., 2007). Usage of diatoms for determining the water quality is not new, actually it has been used since the 1900s (Kolkwitz and Marsson, 1908).

The advantage of using benthic diatoms in order to determine the water quality refers to the fact that it can be found anytime and anywhere. These organisms are used for determining the ecological quality of streams of the earth (Kelly *et al*., 1998; Potapova *et al*., 2004; Della Bella *et al*., 2007; Taylar *et al*., 2007). For this reason, the identification of algae in the benthic of Karabey Stream and the determination of their relationship with the environment increase the importance of the study. Therefore, in this study, it is aimed to examine the epipsammic diatoms and monthly changes of Karabey stream.

Materials and methods

In this study, Epipsammic of Karabey Creek in Yedisu district in Bingöl, Türkiye has been investigated. The coordinates of the stations are listed in the table below (Table 1) and sampling stations of Karabey Creek showed in the Figure 1.

Table 1: Coordinates of Sampling Stations of Karabey Creek.

Station	Coordinates
1	39º 25′ 18.72“K 40º 35 ′17.10 “D
2	39º 24′ 36.33“K 40º 34′.22.50“ D

Collection of the samples is conducted between March-November 2020. The second station is near the residential area, and the first station is far from the residential area. Karabey creek is surrounded by Kiği and Adaklı district of Bingöl in south, Karlıova district of Bingol in southeast, Çat district of Erzurum in northeast, Tercan district of Erzincan in north, Pulumur district of Tunceli in west. The distance between Karabey creek and Bingöl city center is approximately 133 km and the distance between Karabey creek and Yedisu is 4 km combining with Fas creek from the Çorik Mountain in borders of Kigı and in the south Cobi water and Kalman creek, the Karabey creek mixes with Fırat Rriver.

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Figure 1: Sampling Stations of Karabey Creek

When collecting the Epipsammic algae the method developed by Round (1953) was used. For this purpose, a glass rod with a diameter of 1 cm and a length of 100 cm was used. Permanent preparations were made from the epipsammic samples in order to be able to diagnose the diatoms accurately. A Nikon branded microscope was used for species identification and counting of the diatoms, whose permanent preparations were made. The counting in the permanent preparations was based on relative density and the results are given as “organism %”.

Relative density (Rd) = N_A/N x100

Where, N_A=Total number of A species individuals, N=Number of all species individuals (Kocatas, 1999).

The study draws on Patrick and Reimer (1966, 1975); Germain (1981), and Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b) for the species identification of the diatoms found in the Karabey Creek. The temperature of the water at the stations was measured by using 1^{o}C graduated mercury thermometer, and oxygen and electrical conductivity were measured in situ by using portable YSI 55 DO digital oxygen meter.

Results

The recorded temperature (^{o}C) values during the study of Karabey creek are shown in Table 2. The highest temperature recorded in Karabey creek is (18^{o}C) in August and the lowest one is (9.6^{o}C) in March (Table 2). The temperature of water has risen in parallel with the temperature of air.

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Table 2: The recorded temperatures (ºC) of Karabey Creek.

Parameter	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Temperatures (ºC)	9.6	10.5	14,2	15,8	17.0	18.1	16.2	17.0	14.1

The recorded oxygen (mg-O_2/L) values during the study of Karabey creek are shown in Table 3. The highest oxygen level recorded in Karabey creek is (8.2 mg-O_2/L) in March and the lowest one is (6.9 mg-O_2/L) in August (Table 3).

Table 3: The recorded oxygen (mg-O_2/L) values of Karabey Creek.

Parameter	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Oxygen (mgO_2/L)	8.2	8.0	7.9	7.2	7.0	6.9	7.2	7.2	7.4

The recorded pH values during the study of Karabey creek are shown in Table 4. The highest pH value recorded in Karabey creek is (7.4) in November and the lowest one is (7.0) in March (Table 4).

Table 4: The recorded pH values of Karabey Creek.

Parameter	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
pH	7.0	7.0	7.1	7.1	7.2	7.2	7.3	7.3	7.4

Relative densities of the Epipsammic diatoms recorded in the first station by months are listed in Table 5. In the first station, a total of 31 taxa belonging to epipsammic diatoms are recorded. Most taxa (5 Taxons) belong to Navicula and Nitzschia species. The highest relative density (10.63%) in this station is recorded in March and belongs to *Ulnaria ulna*; the lowest relative density (0.73%) is recorded in May and belongs to *Encyonema ventricosum*, *Fragilaria tenera*, and *Surirella minuta* species. In this study, Amphora (1 taxa), Cocconeis (1 taxa), Cymbella (4 taxa), Cymbopleura (1 taxa), Diatoma (1 taxa), Encyonema (1 taxa), Epithemia (2 taxa), Fragilaria (1 taxa), Gomphonema (3 taxa), Navicula (5 taxa), Nitzschia (5 taxa), Pinnularia (2 taxa), Surirella (3 taxa), Ulnaria (1 taxa) belonging to diatoms are recorded in total of 31 taxa. During the study, relative density of Ulnaria has not decreased under approximately 4% in the first station (Table 5).

Table 5: Monthly changes in relative densities of the Epipsammic diatoms recorded in the first station of Karabey Creek

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Amphora ovalis (Kütz.) Kütz.	4.25	4.87	3.67	3.88	4.18	4.41	4.54	5.88	2.94
Cocconeis placentula Ehr.	-	-	1.47	1.69	2.61	2.20	2.27	1.96	-
Cymbella affinis Kützing	6.38	6.09	4.41	3.95	4.18	4.41	4.54	5.88	5.88

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Table 5 (continued):

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Cymbella cistula (Ehrenberg) O.Kirchner	8.51	7.31	5.88	3.38	3.66	3.67	3.40	3.92	2.94
Cymbella parva (W.Smith) Kirchner	6.38	4.87	5.14	4.51	3.66	2.94	4.54	5.88	5.88
Cymbella prostrata (W.Smith) Cleve	4.25	3.65	3.67	3.95	4.18	4.41	3.40	3.92	5.88
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	8.51	6.09	4.41	4.51	3.66	3.67	4.54	5.88	5.88
Diatoma vulgaris Bory	-	-	2.20	3.95	3.14	2.94	2.27	3.92	5.88
Encyonema ventricosum (C.Agardh) Grunow	-	-	0.73	1.69	2.61	2.94	3.40	-	-
Epithemia turgida (Ehr) Kütz	-	-	1.47	1.12	2.09	3.67	2.27	1.96	-
Epithemia sorex Kütz.	-	1.21	2.20	2.25	3.14	2.94	2.27	-	-
Fragilaria tenera (W.Smith) Lange-Bertalot	-	-	0.73	1.69	2.09	2.20	1.13	-	-
Gomphonema angustatum (Kützing) Rabenhorst	-	2.43	2.20	2.25	2.61	1.47	1.13	-	-
Gomphonema olivaceum (Hornemann) Brébisson	4.25	3.65	3.67	3.38	3.14	2.94	3.40	3.92	2.94
Gomphonema parvulum (Kütz.) Kütz.	2.12	2.43	2.20	2.82	2.61	2.20	2.27	1.96	2.94
Navicula cryptocephala Kützing	4.25	6.09	5.14	4.51	3.66	4.41	4.54	5.88	5.88
Navicula gregaria Donkin	6.38	3.65	2.94	3.38	3.14	2.94	3.40	3.92	2.94
Navicula lanceolata Ehr.	2.12	2.43	2.20	2.25	2.61	2.20	2.27	1.96	2.94
Navicula radiosa Kützing	6.38	6.09	4.41	4.51	3.66	3.67	4.54	5.88	5.88
Navicula tripunctata (O.F.Müller) Bory	6.38	6.09	5.14	4.51	3.66	3.67	4.54	3.92	5.88
Nitzschia palea (Kützing) W.Smith	4.25	3.65	3.67	3.95	3.14	2.94	2.27	3.92	2.94
Nitzschia sigma (Kützing) W.Smith	2.12	2.43	4.41	3.38	2.61	2.94	3.40	3.92	5.88
Nitzschia tenuis W.Smith	2.12	3.65	2.94	2.82	2.09	3.67	3.40	1.96	2.94

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Table 5 (continued):

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Nitzschia terrestris (J.B.Petersen) Hustedt	4.25	4.87	3.67	3.95	3.66	4.41	4.54	5.88	5.88
Nitzschia tryblionella Hantzsch	2.12	3.65	2.94	3.38	3.66	2.94	2.27	1.96	2.94
Pinnularia nobilis (Ehrenberg) Ehrenberg	-	-	2.20	2.25	2.61	1.47	2.27	1.96	-
Pinnularia divergens W.Smith	4.25	4.87	4.41	3.95	3.14	3.67	3.40	3.92	5.88
Surirella angusta Kützing	-	-	1.47	1.96	2.61	2.94	2.27	-	-
Surirella minuta Brébisson ex Kützing	-	-	0.73	1.12	2.09	2.20	2.27	-	-
Surirella ovalis Brébisson	-	-	1.47	1.12	2.09	1.47	1.13	-	-
Ulnaria ulna (Nitzsch) Compère	10.63	8.53	6.61	5.64	4.71	5.14	6.81	7.84	8.82

Relative densities of the Epipsammic diatoms recorded in the second station by months are listed in Table 6. In the second station, 37 taxa has been recorded in total Amphora (1 taxa), Cocconeis (1 taxa), Cyclotella (1 taxa), Cymbella (5 taxa), Cymbopleura (1 taxa), Diatoma (1 taxa), Encyonema (2 taxa), Epithemia (2 taxa), Fragilaria (1 taxa), Gomphonema (3 taxa), Lindavia (1 taxa), Navicula (5 taxa), Nitzschia 5 taxa), Pinnularia (3 taxa), Stephanodiscus (1 taxa), Surirella (3 taxa), Ulnaria (1 taxa). The highest number of taxa (5) belongs to Cymbella, Navicula and Nitzschia. The highest relative density (8.73%) belongs to *Ulnaria ulna* and is recorded in March, the lowest one (1.09%) belongs to *Encyonema elginense*, *Surirella ovalis* and *Pinnularia nobilis* in April (Table 6).

Table 6: Monthly changes in relative densities of the Epipsammic diatoms recorded in the second station of Karabey Creek.

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Amphora ovalis (Kütz.) Kütz.	3.88	3.29	2.94	3.15	3.43	3.87	3.47	3.70	3.31
Cocconeis placentula Ehr.	-	-	1.47	1.89	1.58	1.80	1.57	1.23	1.32
Cyclotella glomerata (H. Bachmann) Houk & Klee	-	1.64	1.83	1.89	2.11	2.06	1.89	2.05	1.98
Cymbella affinis Kützing	4.85	3.84	3.30	3.47	3.16	3.61	3.15	3.29	3.31

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Table 6 (continued):

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Cymbella cistula (Ehrenberg) O.Kirchner	5.82	3.29	2.94	3.78	3.69	4.13	4.10	4.11	5.29
Cymbella leptoceros (Ehr.) Kütz	3.88	3.29	3.30	3.15	2.90	3.35	3.15	3.70	3.97
Cymbella parva (W.Smith) Kirchner	4.85	3.84	3.67	3.78	3.43	3.10	2.83	3.29	3.31
Cymbella prostrata (W.Smith) Cleve	3.88	3.29	2.94	3.15	2.90	2.58	2.52	2.88	2.64
Cymbopleura amphicephala (Nägeli ex Kützing) Krammer	4.85	3.84	2.20	2.83	2.90	2.84	2.83	3.29	3.31
Diatoma vulgaris Bory	-	1.64	1.83	1.26	2.11	2.32	1.89	1.64	1.32
Encyonema elginense (Krammer) D.G.Mann	-	1.09	1.47	2.20	2.37	2.06	2.20	2.05	1.98
Encyonema ventricosum (C.Agardh) Grunow	-	-	1.10	1.57	2.11	1.80	2.20	1.64	-
Epithemia turgida (Ehr) Kütz	-	2.19	2.20	1.57	2.63	2.32	2.83	2.46	1.98
Epithemia sorex Kütz.	-	1.64	1.83	1.57	2.37	1.80	1.89	1.64	1.32
Fragilaria tenera (W.Smith) Lange-Bertalot	1.94	2.19	1.83	2.20	1.84	1.55	1.57	1.23	1.32
Gomphonema angustatum (Kützing) Rabenhorst	2.91	4.39	3.30	3.15	3.16	3.35	3.15	3.70	3.31
Gomphonema olivaceum (Hornemann) Brébisson	3.88	3.29	3.67	3.15	2.90	2.58	2.20	2.46	3.31
Gomphonema parvulum (Kütz.) Kütz.	2.91	3.84	3.30	3.15	2.90	2.84	2.83	2.88	3.31
Lindavia comta (Kützing) Nakov, Gullory, Julius, Theriot & Alverson	-	-	1.47	1.89	2.11	1.80	1.57	1.23	-
Navicula cryptocephala Kützing	4.85	3.84	3.67	2.83	2.90	3.35	3.15	3.70	3.97
Navicula gregaria Donkin	3.88	3.29	3.30	2.83	2.63	2.84	2.83	2.88	3.31
Navicula lanceolata Ehr.	2.91	3.29	2.94	2.20	2.37	2.58	2.83	2.46	2.64
Navicula radiosa Kützing	4.85	4.39	3.67	3.15	3.43	3.61	3.47	3.70	3.97
Navicula tripunctata (O.F.Müller) Bory	5.82	4.39	4.00	3.78	3.69	3.87	4.10	4.11	4.63

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Table 6 (continued):

	Marc.	Apr.	May.	Jun.	Jul.	Agu.	Sep.	Oct.	Nov.
Nitzschia palea (Kützing) W.Smith	4.85	3.84	3.30	3.47	3.43	3.10	4.10	2.29	3.97
Nitzschia sigma (Kützing) W.Smith	3.88	3.29	3.67	3.15	3.16	2.84	3.15	2.88	3.31
Nitzschia tenuis W.Smith	2.91	2.74	3.30	3.15	2.37	2.32	2.52	2.46	1.98
Nitzschia terrestris (J.B.Petersen) Hustedt	3.88	3.84	2.57	2.83	2.11	2.58	2.52	2.46	2.64
Nitzschia tryblionella Hantzsch	2.91	3.29	3.30	3.15	3.43	2.84	2.52	2.88	2.64
Pinnularia divergens W.Smith	3.88	3.84	3.67	3.15	3.16	3.35	2.52	2.46	2.64
Pinnularia nobilis (Ehrenberg) Ehrenberg	-	1.09	1.16	1.26	1.58	1.80	1.57	1.64	1.32
Pinnularia viridis (Nitzsch) Ehrenberg	-	1.64	1.47	1.89	1.35	1.55	1.89	2.05	1.98
Stephanodiscus astrea(Kützing)Grunow	-	-	1.47	2.20	2.37	2.58	2.83	2.88	2.64
Surirella angusta Kützing	-	-	1.47	1.57	1.84	2.32	2.52	1.64	1.32
Surirella minuta Brébisson ex Kützing	-	-	1.10	1.89	1.35	1.55	2.20	2.05	1.98
Surirella ovalis Brébisson	-	1.09	1.10	1.57	1.58	1.29	1.26	1.64	1.32
Ulnaria ulna (Nitzsch) Compère	8.73	6.59	5.14	4.73	4.22	3.61	4.10	4.11	5.29

Discussion

In this study, which is conducted between March and November 2020 by taking the benthic samples, some physical and chemical parameters have been analysed monthly in order to determine the epipsammic diatoms. The sampling could not be conducted in winter because of environmental conditions. Throughout the study, 31 taxa in the first station and 37 taxa in the second station belongs to Bacillariophyta were determined.

Both Epipsammic and epiphytic diatoms, *Cymbella cistula* and *Ulnaria ulna*, were observed. These species adapt better to environmental conditions when compared to others. In the first and second stations of Karabey creek, Cocconeis placentula was observed. This species was often observed in the studies which are conducted in streams of Germany, where organic pollution is present (Lange-Bertalot, 1979).

Mumcu *et al.* (2009) stated that the species which belongs to the dominant

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taxa in bottomless depths of China streamlet are Nitzschia, Cymbelle, Navicula. Ateş and Ertan (2017) mentioned Cymbella, Gomphonema, Navicula in the study that took place in Pınargözü source. In our study, Cymbella, Navicula and Ulnaria were the dominant species.

The benthic diatom that has the most tolerance for organic pollution is Nitzschia as a genus and Nitzschia palea as a species (Palmer, 1969). Nitzschia with high tolerance for organic pollution can be commonly found in freshwater; it houses cosmopolitan species and lives in water that has high nutrient and low oxygen value (Van dam *et al*., 1994). Chessman (1986) stated that Navicula and Nitzschia are cosmopolitan species. This study also supports this claim because Navicula and Nitzschia are found every month and they have many taxa. Many ecological factors play a role in the survival and genesis of the benthic algae community. Temperature, pH, diffused gas, dissolved organic and inorganic substances, and type of substrate are the most important abiotic factors that affect algae communities. Diffused oxygen levels differ between 7.0 and 8.2 mg- O_2/L, temperature levels differ between 9.6 and 18.1, pH levels differ between 7.4 and 7.0 in the Karabey Creek. The average values for diffused oxygen is 7.4, for temperature is 14.7 and for pH levels is 7.17. Diatoms (Bacillariophyta) are the most important algae in the Karabey Creek due to their taxa count, frequency of occurrence and number of individuals. Other algae are also neglected because of their low occurrence frequency and number of individuals.

Oxygen is not the only necessity for the creatures living in aquatic ecosystems. Food salts in water, pH of water, temperature, conductivity etc. are also ecological factors that affect aquatic biota (Yüksek, 2004). Temperature affects biological, physical and chemical activities in water and changes concentration of some variables. With rise in temperature, respiration and metabolic speed of organisms also rise, which leads to an increase in oxygen consumption. Since the temperature and sunlight are low in winter, algae reproduce less and its biomass decreases. Phytoplankton start to reproduce as the spring comes, with increase in temperature and the inorganic molecules that have been created by bacterial activity. The optimum temperature for the algae to grow is 25°C (Reynolds, 1993). But some algae prefer lower and some prefer higher temperatures. Usually temperature between 10-30°C is tolerable for algae. According to Reynolds (1993), the optimum temperature of water for algae growth is under (25°C). This prevented the taxa count of diatoms to be more. While Cox (1984) suggested that light is the most important factor for the seasonal spread of the diatoms. Round (1973) suggested that diatoms develop better than phytoplankton in spring and summer and they develop less in autumn.

As a result, being the first algological research in Karabey Creek (Bingöl), this

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is thought to be helpful for determining the freshwater algae flora.

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