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Invertebrate Infestation of *Caretta caretta* Nests at Fethiye Beaches, Turkey

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Abstract: In this study, the impact of invertebrate groups on the *Caretta caretta* hatchlings and eggs on Fethiye beaches, Turkey between the 1999 and 2003 nesting seasons were compared and precautions required to be taken to minimize the impact of invertebrates were suggested. Prevalence of invertebrate animal groups (Tenebrionidae, Acarina, Diptera and Oligochaeta) were detected almost 70% of the nests. Tenebrionidae larvae as an important predator due to the fact that this larvae causes destruction in 265 (56.98%) of the 465 nests and caused a greater damage to eggs (8.22%, 1847 of 22444 eggs in 265 infested nests). Invertebrates were observed most destructive on the Yanıklar beach, followed by Akgöl and Çalış beaches with respect to nest sites. Only Tenebrionidae and Dipteran larvae were detected in the hatchlings, while all of the invertebrate groups were found on the eggs. Thanks to protective measurements taken in 2002 and 2003 breeding seasons, invertebrate infestation on eggs and hatchlings of *Caretta caretta* was reduced.

Key words: Invertebrate infestation, sea turtle, ecological factors, conservation, Turkey

INTRODUCTION

The first report concerning the invertebrates causing damage in the nests of marine turtles in Turkey was related to Coleopteran larvae that bored holes on the eggs found on the Fethiye beaches (Türkozan and Baran, 1996). In his study, Türkozan (2000) reported that Coleopteran larvae were observed on the Kızılot beach and destroyed eggs in this area. Baran *et al.* (2001) reported in their study that they had detected invertebrate groups such as Tenebrionidae, Muscidae, Scarabaeidae, Elateridae, Myrmeleonidae, Acarina and Nematoda in the nests along the Fethiye beaches. In the same study, it was also observed that Tenebrionidae larvae bored holes on the eggs, as a result of which the eggs and the hatchlings were damaged, and that these larvae were frequently found in nests close to low vegetation (weeds and grassy vegetation) and in fine sand (<2 mm). Dipteran larvae were found to be harmful effect on the coasts of Northern Cyprus as stated in two different studies conducted in the area and 9, 3.3 and 20.7% of green turtle nests and 23, 13.4 and 17.4% of loggerhead turtle nests were infested in 1995, 1996 and 1997, respectively (Broderick and Hancock, 1997; McGowan *et al*., 2001a). Dipteran larvae were also detected in studies carried out in Costa Rica (Fowler, 1979; Bjorndal *et al*., 1985) and in Mexico (Lopes, 1982; Andrade *et al*., 1992). Another study carried out on the nests of leatherback turtles (*Dermochelys coriacea*) at Michoacán, revealed that larvae of *Eusenotaina rufiventris* were living on live, as well as dead, hatchlings (Vásquez, 1994). Vásquez (1994) considered the location of hatcheries with respect to high water mark, the number of nests in a hatchery, and the density of nests and concluded that these had no effect on the levels of infestation of leatherback turtle clutches. The major relationship between the depth of the nest and the Dipteran larvae was first reported in the study carried out by McGowan *et al*. (2001b) and they have been reported that transplanted nests having fewer infested eggs and this may be explained by the fact that transplanted nests tended to be located at a greater depth in the sand column when compared to natural nests. In French Guiana the mole cricket *Scapteriscus didactylus* affected on average 18% of yolked eggs in each nest (Maros *et al*., 2003). The occurrence of red imported fire ants (*Solenopsis invicta*) in green sea turtle, *Chelonia mydas*, and loggerhead sea turtle, *Caretta caretta*, nests have been documented (Wilmers *et al*., 1996;

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Moulis, 1997). Allen *et al.* (2001) conducted experiments on a fresh water turtle (*Pseudemys nelsoni*) to determine the impact of red imported fire ants infestation and found a 71% mortality rate of hatching turtles exposed to imported fire ants. According to Parris *et al.* (2002), hatching sea turtles may be at risk to red imported fire ants predation during egg incubation and especially at risk once piped from the egg, prior to hatching emergence from the nest and red imported fire ants have increasingly been observed between the years 1995-1998 in Cape San Blas, Florida. Donlan *et al.* (2004) reported the egg predation in loggerhead sea turtle nests by click beetle larvae (*Lanelater sallei*) and factors leading to the use of nest as a food source by *L. sallei* larvae were unclear in Cape Florida State Park on the southern end of Key Biscayne, Florida.

Research carried out between 1999 and 2001 nesting seasons at Fethiye beaches show that insect infestation ratio's (especially Tenebrionidae larvae) on eggs and hatchlings of loggerhead turtle was quite high level (Baran *et al*., 2001; Özdemir *et al*., 2004). The scope of our study covers invertebrates, a relatively new topic (especially to take a measurements for protecting eggs and hatchlings of loggerhead turtle against invertebrate infestation) that has been dealt with in very few studies for Turkey and the objectives include determining the impacts of these invertebrates on the *Caretta caretta* nests on Fethiye beaches as well as the relationships between the invertebrate groups and the physical factors of the nests; and suggesting recommendations that would minimize the impact of these invertebrates within the framework of conservation studies.

MATERIALS AND METHODS

Study site: The data have been collected from the *Caretta caretta* nests on the beaches along the Fethiye Coastline (between the 36°41'48-36°39'24 parallels north and the 29°02'18-29°06'36 meridian east) during the nesting season 2002 and 2003.

Fethiye beaches include three subsections as Çalış, Yanşklar and Akgöl. There is a high level of tourism and human activity on Çalış beach and its sand grain size observed thicker than other two beaches. There is a stabilized road that is quite near the beach is situated close to Çalıştepe hill. Yanıklar has fewer tourism and human activity than Çalış and Akgöl. Sand dune vegetation at Yanıklar subsection is sparser than the other two beach subsections and beach is lasted with forest (ambar forest, *Lequidambar orientalis*). Approximately 5 m of the Yanıklar subsection from the high tide line is covered with big stones and wastes of vegetation (boughs, twigs and leaves). There are small streams in different parts of Yanıklar beach and these streams constitute swamp and marshy places in the forest. Akgöl subsection has a fewer tourism activity than Çalış subsection and a large part of the beach subsection covering big stones is not suitable for nesting. There is a small lake near the main nesting zone of Akgöl subsection and sometimes flood is happened.

Data collection and statistical analysis: During nest excavations carried out on the nests following hatching (6-9 days), eggs and hatchlings destroyed by invertebrates were examined one by one, which enabled the researchers to identify the invertebrate groups and to record independent variables such as the distance of the nests to low vegetation (weeds and grassy vegetation), trees and the sea, their depths (distance from nest bottom to beach surface), diameter (mean of diameters that are measured from the bottom, mid and top of nest chamber) and the total number of eggs. Distances to the high water mark, trees, low vegetation. Nest dimensions were measured a plastic tape measure. As a dependent variable, the invertebrate animal groups (Tenebrionidae, Acarina, Diptera and Oligochaeta) found in the nests were coded as present (1) or not present (0). An examination of the holes made by Tenebrionidae larvae helped us determine the fact that it caused damage to the eggs and the hatchlings in the nests. Diptera, Acari and Oligochaeta were recorded in decaying or rotting eggs and hatchlings.

In some cases, females nested high risk area (if a nest is made near river mouths, beneath eroding sea walls, near picnic areas, near road or near a light) and these nests (six nests) were transplanted to a safer area. We used six scenarios of distance of the nests to low vegetation (1, 3, 5, 7, 9 and 11 m) for relocating nests. Eggs were transferred to a newly prepared nest with similar depths and diameters of the original nests. Other physical attributes of the relocating nests were randomly. In line with the results obtained from the analyses, precautions that need to taken while relocating the nests due to unfavourable conditions were suggested.

Data on invertebrate infestation on eggs and hatchlings obtained during 2002 and 2003 seasons were compared with results in the papers of Baran *et al.* (2001) and Özdemir *et al.* (2004) and the effects of protective measurements against invertebrate infestation were discussed. In this study, Mrymeleonidae group found only two nests was excluded while Oligochaeta group that was excluded in the paper of Baran *et al.* (2001) and Özdemir *et al.* (2004) was included. Protective measurements taken against invertebrate infestation during 2002 and 2003 nesting seasons were given as

suggestion in conclusion section. Only 2003 data was used the relation analysis and the relations were compared with results of former studies done in this area. The relationships between the invertebrates and the factors were obtained on SPSS 9.0 statistics package program using the logistic regression analysis ($p<0.05$).

RESULTS

The distribution of invertebrate animal groups in nests: At least one of the Coleopteran (Tenebrionidae, *Pimelia* sp.), Acarina (Cryptostigmata), Dipteran (Muscidae, *Musca sp.*) and Oligochaeta groups was found in 53 (66.25%) of the 80 nests in 2002 (Table 1 and Fig. 1) and 73 (76.04%) of the total of 96 nests examined on Fethiye beaches in 2003 and 50 (28.4%) of the 176 nests, however, these invertebrate groups were not infested both of the years (Table 1). Özdemir *et al.* (2004) reported that at least one of the invertebrates (Tenebrionidae, Acari, Diptera and Myrmelonidae) were not found 30 (29%) of the 104 nests for 2001 season.

An examination of the distribution of the invertebrates on Fethiye beaches, found in the nests at different combinations, revealed that 61 (88.4%) of the 69 nests on the Yanıklar beach had been infested by invertebrates, followed by Akgöl (50%, 8 of the 16 nests) and Çalış (36.36%, 4 of the 11 nests) beaches in 2003 (Fig. 1). According to a report by Baran *et al.* (2002) the corresponding figures for Yanıklar, Akgöl and Çalış were 88%, 59% and 19%, respectively for the 2002 season. Yanıklar was the worst affected beach in terms of the number of nests, fallowed by Akgöl and Çalış.

As can be understood from Table 2, 265 (56.98%) of the 465 nests contained the Tenebrionidae group accompanied by other invertebrates between the 1999 and 2003. This is followed by Diptera (38.34%, 148 of the 386 nests), Acarina (27.97%, 108 of the 386 nests), and Oligochaeta (22.15%, 39 of the 176 nests).

The impact of invertebrate groups on hatchlings and eggs: The invertebrates observed in the nests harm varying numbers of hatchlings and eggs. As can be seen

Table 1: The Ratios of infestation and predation related to causative agents in Fethiye Beaches in 2002 and 2003

	Infestation					
	No. of infested nest (%)		No. of hatchlings in infested nest (%)		No. of eggs in infested nests (%)	
Combined groups of invertebrates	2002 N = 80	2003 N = 96	2002 N = 3233	2003 N = 4532	2002 N = 4542	2003 N = 6368
T	14 (17.50)	4 (4.16)	5 (0.15)	5 (0.11)	142 (3.13)	98 (1.54)
TA	2 (2.50)	3 (3.12)			32 (0.7)	28 (0.44)
TAD	5 (6.25)	11 (11.44)			3 (0.07)	4 (0.06)
TADO	3 (3.75)	7 (7.28)				
TAO	3 (3.75)	3 (3.12)			12 (0.26)	8 (0.13)
TD	6 (7.50)	18 (18.72)		2 (0.04)	23 (0.51)	78 (1.22)
TDO	2 (2.50)	7 (7.28)				3 (0.05)
TO	5 (6.25)	3 (3.12)			5 (0.11)	17 (0.27)
A	1 (1.25)	2 (2.08)			29 (0.64)	35 (0.55)
ADO	2 (2.50)	2 (2.08)				
AO	1 (1.25)				4 (0.09)	8 (0.13)
D	8 (10.00)	11 (11.44)	21 (0.65)	30 (0.66)	34 (0.75)	68 (1.07)
O	1 (1.25)				12 (0.26)	10 (0.16)
AD		1 (1.04)			10 (0.22)	5 (0.08)
OD		1 (1.04)				1 (0.02)
Total (%)	53 (66.25)	73 (76.04)	26 (0.8)	37 (0.82)	306 (6.74)	363 (5.71)
	Other causative factors					
	No. of nests (%)		No. of dead hatchlings (%)		No. of predated eggs (%)	
Dog	1 (1.25)			2 (0.04)	10 (0.22)	
Bird			11 (0.34)	5 (0.11)		
Car			3 (0.09)			
Congestion (Blocking)*			163 (5.04)	197 (4.35)		
Sun or cold			3 (0.09)	26 (0.57)		
Total (%)	1 (1.25)		180 (5.57)	230 (5.08)	10 (0.22)	
General total (%)	54 (67.5)	73 (76.04)	206 (6.37)	267 (5.89)	316 (6.96)	363 (5.71)

Abb.: T. Tenebrionidae; A. Acarina; D. Diptera; O. Oligochaeta; N. Number

* Congestion (Blocking) : because of stones, other dead hatchlings, infested eggs, vehicles and etc

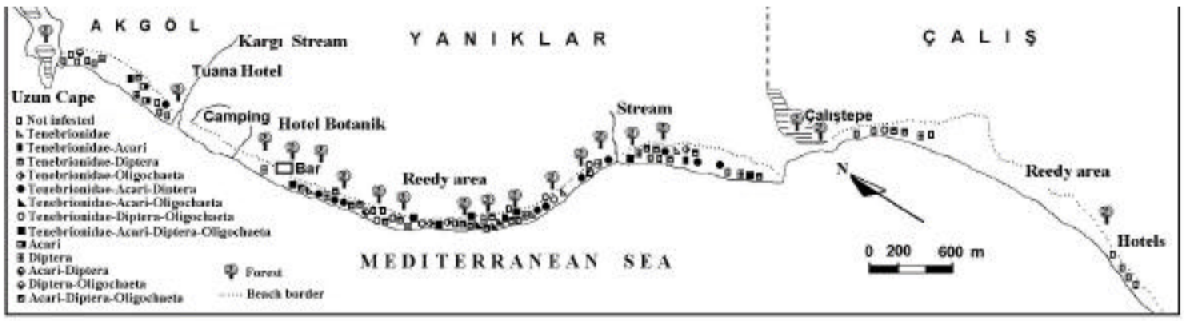

Fig. 1: Distribution of invertebrates groups in nests on Fethiye beaches in 2003

in Table 1, Dipteran, Tenebrionidae and a combination of these two groups are known to be most prevalent on the hatchlings. As for the eggs, all the groups were found at different combinations; nevertheless, it is possible to say that especially Tenebrionidae, Dipteran and both groups acting together were most destructive. These groups were followed by Acarina and Oligochaeta. Tenebrionidae larvae cause a greater damage to eggs (8.22%, 1847 of 22444 eggs in 265 infested nests) on Fethiye beaches as compared to other groups (Table 2).

It is found that hatchlings usually die at Fethiye beach because of the high pressure (congestion) into the nests. Abundance of punctured eggs on the surface of the nest may cause blocking the hatchlings from leaving the eggs and reaching the nest surface. When stones and dead hatchlings are situated on the surface of the nests, it is obvious that infested eggs make more pressure for eggs and hatchlings situated at the middle and on the bottom of the nests. So the number of hatchlings died from the high pressure is increased. In addition, different colouration was observed on eggshells and into the eggs. We think that fungus or bacteria cause these colorations. Eggshells can be thinner because of the harmful effects of these micro organisms thus Diptera, Acari and Oligochaeta groups can enter the eggs from these parts that are explored by micro organisms.

The relationship between invertebrates and some ecological factors: The analyses conducted revealed that the distance between the nests and low vegetation was significant for the Tenebrionidae larvae (β = -0.2454 R = -0.2338 Wald = 9.1280 df = 1 p = 0.0025). The distance of the nests with Tenebrionidae larvae from low vegetation ranged between 0.1 and 8.5 m (mean 2.1), while this distance was between 0.1 and 34.7 m (mean: 6.9) for the nests without Tenebrionidae. Baran *et al*. (2001) observed high level of Tenebrionidae larvae infestation on *Caretta caretta* nest with a fine sand grain size (<2 mm) nearby vegetation (approximately 1-15 m) and abundant plant remains on Fethiye beaches. Özdemir *et al*. (2004) found that the presence of Tenebrionids is negatively correlated to grain size, while positively correlated with nest diameter on *Caretta caretta* nest on Fethiye beaches for 2001 season.

Six nests that were not far away from the tide line relocated at Yanıklar subsection in order to determine infestation of Tenebrionidae larvae on eggs and hatchlings. In these nests, 12 eggs were got holed by Tenebrionidae larvae. Also Acari group was found in 5 holed eggs. As can be seen from Table 3, it is better that relocated nests are placed about 10 meters far away from low vegetation. However, more detailed studies must be possessed on sex ratio determination whether it resembles in natural and relocated nests at Fethiye beach.

It was established that the presence of Dipteran larvae had a positive relationship with the total number of eggs (β = 0.0306, R = 0.1202, Wald = 3.8636, df = 1, p = 0.0493), and a negative one with the depth of the nest (β = -17.8519, R = -0.2184, Wald = 8.1454, df = 1, p = 0.0043). According to the results of the logistic regression analysis, it can be stated that Dipteran larvae are found in nests that have greater number of eggs and that are shallower. The number of eggs in the nests without Dipteran larvae ranged between 61 and 135 (mean: 88.13), whereas the same figure was between 53 and 121 (mean: 81.78) in the nests with Dipteran larvae. There was a positive relationship between the depth and the total number of eggs (bivariate correlation = 0.46, p<0.01). McGowan *et al*. (2001a) reported that the number of infested eggs by Dipteran larvae in a nest decreases with increasing nest depth. On the other hand, Özdemir *et al*. (2004) found that Dipteran infestation was found to be negatively correlated with the depth of nests in a study that carried out during 2001 breeding season on Fethiye beaches.

Table 2: The impact of the invertebrates between the years 1999-2003 (1999 and 2000 from Baran *et al.*, 2001; 2001 from Özdemir *et al.*, 2004)

	Çalış		Yanıklar		Akgöl		Total					
Year	a	b	a	b	a	b	a	b	c	d	e	f
Tenebrionidae												
1999	NS	NS	58	47 (81.03)	21	2 (9.52)	79	49 (62.02)	4175	489 (11.71)	2964	0
2000	19	1 (5.26)	65	48 (73.5)	22	4 (18.18)	106	53 (50)	4353	354 (8.13)	2737	17 (0.62)
2001	15	3 (20)	69	57 (82.6)	20	7 (35)	104	67 (64.42)	5587	551 (9.86)	3632	14 (0.38)
2002	16	0	42	32 (76.19)	22	8 (36.36)	80	40 (50)	3510	217 (6.18)	2234	5 (0.22)
2003	11	3 (27.27)	69	50 (72.46)	16	3 (18.75)	96	56 (58.33)	4819	236 (4.89)	3357	7 (0.2)
Total	61	4 (6.55)	303	234 (77.22)	101	16 (15.84)	465	265 (56.98)	22444	1847 (8.22)	14924	43 (0.28)
Diptera												
2000	19	2 (10.52)	65	38 (58.46)	22	4 (18.18)	106	44 (41.5)	3740	98 (2.62)	2655	44 (1.65)
2001	15	2 (13.33)	69	16 (23.18)	20	2 (10)	104	20 (19.23)	1700	78 (4.58)	1088	24 (2.2)
2002	16	2 (12.5)	42	20 (47.61)	22	4 (18.18)	80	26 (32.5)	2073	70 (3.37)	1470	21 (1.42)
2003	11	4 (36.36)	69	49 (71.01)	16	5 (31.25)	96	58 (60.41)	5112	159 (3.11)	3767	32 (0.84)
Total	61	10 (16.39)	245	123 (50.2)	80	15 (18.75)	386	148 (38.34)	12625	405 (3.2)	8980	121 (1.34)
Acarina												
2000	19	1 (5.26)	65	14 (21.53)	22	3 (13.63)	106	18 (16.98)	1413	112 (7.92)	1018	0
2001	15	3 (20)	69	36 (52.17)	20	5 (25)	104	44 (42.3)	3674	383 (10.42)	2388	0
2002	16	1 (6.25)	42	12 (28.57)	22	4 (18.18)	80	17 (21.25)	1441	90 (6.24)	1026	0
2003	11	0	69	25 (36.23)	16	4 (25)	96	29 (30.2)	2602	88 (3.38)	1804	0
Total	61	5 (8.19)	245	87 (35.51)	80	16 (20)	386	108 (27.97)	9130	673 (7.37)	6236	0
Oligochaeta												
2002	16	0	42	10 (23.8)	22	6 (27.27)	80	16 (20)	1270	33 (2.59)	907	0
2003	11	1 (9.09)	69	21 (30.43)	16	1 (6.25)	96	23 (23.95)	1975	47 (2.37)	1205	0
Total	27	1 (3.7)	111	31 (27.92)	38	7 (18.42)	176	39 (22.15)	3245	80 (2.46)	2112	0

Abb.: NS. Not studied; a. No. of nests examined; b. No. of nests with invertebrates (%); c. No. of eggs in nests with invertebrates; d. No. of destroyed eggs in nests with invertebrates (%); e. No. of hatchlings in nest with invertebrates; f: No. of destroyed hatchlings in nests with invertebrates (%)

Table 3: Invertebrates and nest site factors of six relocated nests in 2002 and 2003

	Codes				Nest site factors				
Relocated Nest	T	A	D	O	DLW	DT	DHWM	ND	Noiam
1	1	1	0	0	1	4.2	25.1	67	23
2	1	0	0	0	3	3.5	24.2	59	20
3	1	1	0	0	5	19	14	68	25
4	1	0	0	0	7	3.2	24.6	52	17
5	0	0	0	0	9	10.5	12	50	20
6	0	0	0	0	11	12	18.2	55	23

Abb.: T. Tenebrionidae, A. Acari, D. Diptera, O. Oligochaeta; Codes 1: Presence 0: Not presence; DLW. Distance from low vegetation (m); DT. Distance from tree (m); DHWM. Distance from high water mark (m); ND. Nest depth (cm); NDiam. Nest diameter (cm)

The analyses revealed the presence of a statically significant positive relationship between the high water mark and Acarina ($\beta = 0.0878$, $R = 0.1484$, Wald = 4.5912, $df = 1$, $p = 0.0321$). The distance of the nests with Acarina from the sea was ranging between 9.50 and 41.60 m. (mean: 21.24), while this distance was between 7.20 and 37.30 m. (mean: 17.45) for the nests not having Acarina. Özdemir *et al.* (2004) stated that larger grain size attracted less Acarins in nests on Fethiye beaches in 2001 breeding season.

The logistic regression analysis that was carried out revealed no relationship between Oligochaeta and the factors taken as independent variables. Other factors that are not specified at this time are believed to be effective on the presence of this invertebrate group in the nests.

DISCUSSION

It was observed in this study that the invertebrates were most prevalent on the Yanıklar beach, followed by Akgöl and Çalış, in terms of nest locations. Destruction of the hatchlings was caused by Tenebrionidae and Dipteran larvae, while all invertebrate groups detected were responsible for the infestation in the eggs. Tenebrionidae larvae can be defined as a predator. Because, there are cues that have contain directly and indirectly impacts. Directly impact: It was observed that eggs situated at the surface of the nests were got punctured by Tenebrionidae larvae between 1999 and 2003 breeding seasons in general. We are the opinion that Tenebrionidae larvae does not only select eggs containing dead embryos for getting hole. If Tenebrionidae larvae selected only eggs containing dead embryos, many eggs situated at the surface of the nests would not damaged by Tenebrionidae larvae. We also think that Tenebrionidae larvae can easily find the exact place of the nest, because of the smell of spoiled eggs into the nests. Indirect impact: It is believed that fluid leaking from infested eggs can decay eggs situated in the middle and at the bottom of nests. In addition, decay, or clotting of sand and assorted egg

debris blocking turtles from leaving the eggs and reaching the beach surface. We also estimate that other invertebrate group can enter the eggs from holes caused by Tenebrionidae larvae. From all of cues mentioned above, Tenebrionidae larvae can be accepted as a predator.

According to the results obtained from logistic regression analyses, the Tenebrionidae larvae had a negative significant relationship with the distance of the nest from low vegetation. Yanıklar subsection has more intensive low vegetation than the other beach subsections so it is caused higher level of Tenebrionidae larvae infestation on eggs and hatchlings of loggerhead turtle. Human effects on vegetation is seldom at Yanıklar subsection (to plant and cut off tree, decoration etc). We are the opinion that planting a tree and covering with grass for decoration would be another reason of changeable insect infestation rates year by year at Çalış subsection. Also diversity of invertebrate group can be influenced by intensive tourism activity at this part.

Acari, a positive one with the high water mark. We are the opinion that reason of more nests with Acari at Yanıklar and Çalış subsection are that nests are situated near to water sources like lake and stream and small grain size in the nests. Also, it is believed that Acari found in nests further from the sea enters the eggs through the holes formed as a result of destruction caused by Tenebrionidae larvae or by rotting.

Dipteran, a positive relationship with the total number of eggs and a negative one with depth. Also different rate of dipteran infestation year by year possibly depends on environmental conditions. Dipteran infestation was the most effective on nest at Yanıklar subsection. The reasons this situation are water accumulation and marshy part in the forest, accumulating of vegetation wastes and stones into nests and desiccating marshy place and disinfecting the hotel's part of Çalış subsection can reduce Dipteran infestation in the nests at this part. The Oligochaeta group, on the other hand, was found to have no statistically significant relationship with any of the factors taken into consideration in this study.

In 1999, 2000 and 2001 nesting seasons, 9.87% of the total eggs (1394 of the 14115 of the eggs in infested nests by Tenebrionidae) were punctured by Tenebrionidae larvae, while 5.43% of the total eggs (453 of the 8329 of the eggs in infested nests by Tenebrionidae) were punctured by Tenebrionidae larvae in 2002 and 2003 seasons. Also other invertebrate groups' infestations were reduced (Table 2). In view of the taking precautions in 2002 and 2003, we are the opinion that as if the nests infestation does approximately same in year by year, it was seen that decreasing of destruction rates had been observing infestation of the eggs and hatchlings in 2002 and 2003 by means of before we had compared the data in 1999, 2000 and 2001 seasons.

CONCLUSIONS

According to the results of the studies conducted from 1999 to 2003 in Fethiye beaches, it would be appropriate to consider the Tenebrionidae larvae as an important predator due to the fact that this larvae causes destruction in 265 (56.98%) of the 465 nests often by puncturing the eggs on the surface of the nests. However, precautions taken during the years 2002 and 2003 have proved effective in minimizing the percentage of destroyed eggs and hatchlings by the Tenebrionidae larvae (Table 2).

The main goal of this study was the some attentions for researchers. In light of the precautions taken and the findings obtained during the 2002 and 2003 seasons, management recommendations to minimize the impact of invertebrates are presented.

- Monitoring and opening the nests at right time is extremely important on Fethiye beaches. A delay in the excavations may cause decay, or clotting of sand and assorted egg debris blocking turtles from leaving the eggs and reaching the beach surface and this condition could increase the destruction of weakened hatchlings by invertebrates.
- While relocating the nests made in stony areas near the sea and affected by passing vehicles, maps related to the harmful invertebrates of the area should be taken into consideration. Especially, in order to reduce the effect of the Tenebrionidae larvae on relocated nests, relocating the nest away from low vegetation could minimize the destruction on eggs. It must be determined a standard distance of the nests to low vegetation both in order to prevent insect infestation and not to change natural sex ration at relocated nests. At this point, firstly it must be standardized altogether effect of different conditions such as number of eggs, depth and diameter of nests, distance to sea and low vegetation, grain size and humidity on natural sex ration in the relocated nests.
- The eggs punctured by Tenebrionidae larvae on the surface of the nest make it difficult for the hatchlings to emerge from the nest at the end of the incubation period. Therefore, nests where incubation period is delayed for Fethiye beaches should be checked regularly. Thus, the hatchling mortality could be reduced.
- Dipteran larvae emerge from the nests after they reach maturity. These nests should be monitored and

partial control openings could be carried out in the nests where fly emergence is observed. Thus, blocking turtles could be prevented by clearing dead hatchlings and rotten eggs accumulating on the surface.

- While carrying out activities such as planting trees and growing green grass in the area, it should not be ignored that such activities could increase the rate of infestation caused by the invertebrates, because a significant relationship has been established between the distance from grassy vegetation and Tenebrionidae larvae.

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