HERPETOLOGICAL JOURNAL, Vol. pp. 474-477 (1990)

THE FOOD OF *CYRTODACTYLUS KOTSCHYI* (STEINDACHNER, 1870) (SAURIA-GEKKONIDAE) DURING THE WET SEASON IN THE MEDITERRANEAN INSULAR ECOSYSTEMS OF THE AEGEAN

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(Accepted 23.5.89)

ABSTRACT

This report gives data on the feeding ecology of *Cyrtodactylus kotschyi* (Sauria-Gekkonidae), during the wet season in the mediterranean ecosystems of the Aegean. *C. kotschyi* feeds mainly on the larvae of insects. There are no significant differences in the food of this gecko among the different populations in the Aegean ecosystems.

INTRODUCTION

Cyrtodactylus kotschyi (Steindachner, 1870) (Sauria-Gekkonidae) is the most widely spread lizard in all the ecosystems of the Aegean archipelago. In quite a large number of them, it co-dominates with lizards of the family Lacertidae, while in others, it is the unique dominant species. In the above ecosystems, *C. kotschyi* is active during the whole year, belongs to the sit-and-wait predators and feeds mainly on arthropods. It has to be reported however that most of the data about the food of *C. kotschyi* has come from specimens collected during the warm period of the year, while data from the wet period are rather limited (Valakos and Vlachopanos, 1987).

This study reports data on the food of *C. kotschyi*, collected during February 1988, from ecosystems of the island of Antikythera (S.W. Aegean), together with a comparison of the data with that already published on the wet period in an ecosystem of Naxos island (central Aegean).

The climate of the central and north Aegean islands belongs to the thermomediterranean type (hot, semi-arid). The average annual precipitation is about 400-500mm, while the mean temperature of the year is 19°C, the hotest being 25°C and the coldest 12°C. The dry season is restricted to the April-October period while the wet is from October to April. The vegetation is characterised by evergreen shrublands and phrygana.

LOCALITIES AND METHODS

The insular ecosystems of the central and south Aegean Sea, as well as the climate, belong to the Mediterranean type.

During the month of February 68 specimens were collected from the island of Antikythera, where *C. kotschyi* is the commonest among the reptile species.

The main characteristics of the area are the rocky terrain and the vegetation, which is mainly degraded maquis. The most predominant plant species are *Juniperus phoenica, Pistacia lentiscus, Thymus capitatus* and *Genista acanthoclada*.

The geckoes were collected by hand during the daily period of 9 a.m. to 4 p.m. and were put in aqueous solution of methanesulfonate (MS222) (Polymeni, 1988), in order to get them anaesthetised.

Finally, the animals were put and kept in 75 per cent alcohol with 5 per cent glycerine. Both the whole length and the body length (snout-vent) for each specimen were recorded. The same procedure was followed for the animals collected on Naxos island during November 1986 and March 1987. During the next step, the animals were examined under an ocular micrometer, fitted to a dissecting microscope, where their sex was determined and the content of the stomach was recorded.

The food items were distributed into length categories of 5mm. The volume of each food item was calculated as if it were the volume of a prolate spheroid according to the type:

$$V = \frac{4}{3}\,\pi\left(\frac{a}{2}\right)\left(\frac{b}{a}\right)^2 \quad \text{(Dunham, 1983)}$$

where: V = the volume of each food item.
a = the maximum length of the food item.
b = the maximum width.

The food niche breadth (B) was calculated according to the type:

$$B = \frac{1}{\Sigma p_i^2} \quad \text{(Simpson, 1949)}$$

where p_i = the percentage of each prey of the i^{th} category.

The food overlap between allopatric species or allopatric populations (Qkj) was calculated using Pianka's formula:

$$Qkj = \sum_{1}^{n} (p_{ik} \times p_{ij}) \Big/ \left(\sum_{1}^{n} p_{ik}^2 \times \sum_{1}^{n} p_{ij}^2\right)^{1/2}$$

where Q = overlap
p_i = the percentages of the i^{th} category of prey for the species k and j.

Food category	*n*	*%n*	*V*	*%V*	*f*
Gasteropoda	6	3.13	50.30	1.71	0.04
Araneida	19	9.90	201.00	6.83	0.20
Pseudoscorpions	9	4.69	13.80	0.47	0.10
Opiliones	3	1.70	2.00	0.07	0.04
Thysanura	24	12.50	104.50	3.54	0.27
Coleoptera	24	12.50	99.60	3.38	0.33
Embioptera	2	1.00	4.30	0.14	0.03
Heteroptera	2	1.00	48.20	1.63	0.03
Hymenoptera	1	0.50	9.15	0.31	0.01
Mantidae	1	0.50	10.90	0.37	0.01
Blattidae	1	0.50	5.50	0.19	0.01
Diptera	4	2.10	3.16	0.10	0.03
Insects larvae	72	37.60	1833.00	62.17	0.66
Neuroptera larvae	2	1.00	9.14	0.31	0.03
Isopoda	18	9.40	552.10	18.72	0.21
Diplopoda	2	1.00	0.24	0.03	0.01
Total	190		2948.00		
B	5.26		2.32		

TABLE I: Food items found in stomachs of 68 *C. kotschyi* specimens. The symbols represent: n = number of food items, %n = percentage of the number of food items, V = volume of food items in mm^3, %V = percentage of the total volume, f = number of specimens containing one food category/total number of specimens (frequency), B = niche breadth.

The niche overlap between males, females and juveniles was found using the method of Petraitis (1985), calculated with the help of computer program (Lundwing and Reynolds, 1988). The correlation between the body length of each animal and the mean length of food items was determined by means of Spearman coefficient (Zahr, 1984).

The percentage of lizards containing each prey category is mentioned as frequency (f = number) of specimens containing one food category/total number of specimens.

RESULTS

From the 68 geckoes examined, only two had empty stomachs. The categories, the number, the volume of the prey, as well as the corresponding percentages and frequency are presented in Table 1.

It is obvious that larvae were the main constituents of the prey of *C. kotschyi* followed by Coleoptera, Thysanura, spiders and Isopoda. The percentage and the frequency of the remaining groups was very low.

According to the volumes, larvae represented the highest percentage, 62.17 per cent, followed by Isopoda (18.72 per cent) and spiders (6.83 per cent).

The food niche breadth was found to be larger when it was determined as a function of the number of specimens of each group of the prey, while it was smaller when determined as a function of the volume.

According to Table 2, where the prey of males, females and juveniles is shown, larvae made the largest contribution among the different categories of food.

High overlap occurred between males and females (general overlap GO = 0.966, statistic V = 10.42 $p<0.05$), as well as between adults and juveniles (GO = 0.92, V = 32.23 $p<0.005$).

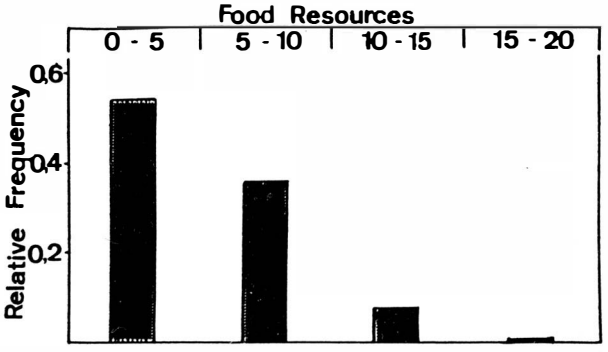

Fig. 1 Relative frequency in use of food categories (in mm) by *C. kotschyi*.

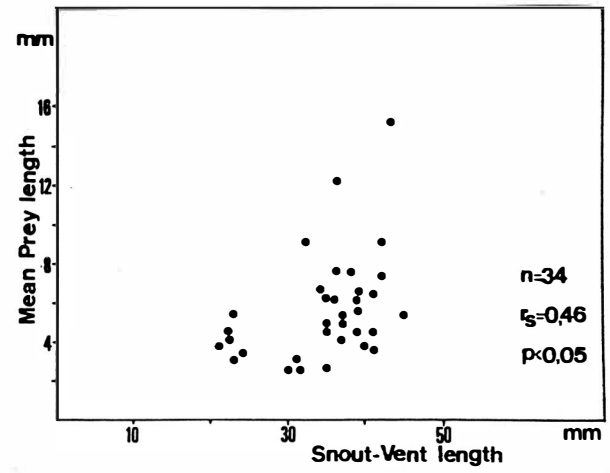

Fig. 2 The correlation between mean prey length and snout-vent length (in mm).

Food category	Males		Females		Juveniles	
	n	%*n*	*n*	%*n*	*n*	%*n*
Gasteropoda	2	2.68	4	5.26	—	—
Araneida	7	9.21	11	14.20	1	2.77
Opiliones	—	—	—	—	3	8.33
Pseudoscorpions	4	5.26	4	5.26	1	2.77
Thysanura	10	13.15	6	7.89	8	22.20
Coleoptera	12	15.78	10	13.15	2	5.26
Embioptera	1	1.31	1	1.31	—	—
Mantidae	—	—	1	1.31	—	—
Blattidae	1	1.31	—	—	—	—
Heteroptera	1	1.31	1	1.31	—	—
Hymenoptera	—	—	1	1.31	—	—
Diptera	2		2	2.68	—	—
Insects larvae	28	36.84	23	30.26	21	58.33
Neuroptera larvae	1	1.31	1	1.31	—	
Isopoda	7	9.24	9	11.34	2	5.55
Diplopoda	—	—	2	2.68	—	—
Total	76		76		38	
B	5.29		6.84		2.85	
GO			0.96		—	
					0.92	

TABLE 2: Food items found in the stomachs of 28 males, 23 females and 15 juveniles *C. kotschyi*, GO = general niche overlap. Other symbols as in Table 1.

Food category	November (10)					March (10)				
	n	%*n*	*V*	%*V*	£	*n*	%*n*	*V*	%*V*	£
Araneida	8	30.8	6.07	1.83	0.7	1	2.6	3.02	0.98	0.1
Chilopoda	1	3.8	3.88	1.19	0.1	—	—	—	—	—
Coleoptera	3	11.5	24.80	7.39	0.3	5	13.6	22.3	7.24	0.3
Ants	8	30.8	7.21	2.18	0.2	—	—	—	—	—
Hymenoptera	1	3.8	9.58	2.89	0.1	1	2.6	0.13	0.04	0.1
Diptera	2	7.7	3.65	1.10	0.1	—	—	—	—	—
Collembola	2	7.7	—	—	0.1	—	—	—	—	—
Larvae of Holometabola	1	3.8	276.1	83.42	0.1	5	13.6	143.42	46.36	0.1
Larvae of Hemiptera	—	—	—	—	—	26	68.4	140.47	45.41	0.3
Total	26		330.90			38		309.34		
B	5.88		1.42			1.49		1.19		

TABLE 3: Food items found in stomachs of *C. kotschyi* from the island of Naxos during November and March. Number in parenthesis: number of the geckoes. Other symbols as in Table 1.

Fig. 1 shows the different size groups of the prey. It was noticed that *C. kotschyi* fed mainly on prey items belonging to two big groups. One group contained food items of length less than 5mm, while the second contained food items with lengths between 5 and 10mm. The relative frequence of the other groups was low (less than 10 per cent).

A positive correlation was found between the average food length and the length of the animals themselves with full stomachs ($rs = 0.46 p < 0.05$ Fig. 2).

Table 3 shows the categories, the number and the volume of prey for the months of November and March from the ecosystem of Naxos. In November *C. kotschyi* fed mainly on spiders and ants (30.8 per cent) followed by Coleoptera (11.5 per cent), while in March it fed mostly on larvae of Hemiptera (68.4 per cent), followed by larvae of Holometabola (13.6 per cent) and Coleoptera (13.6 per cent). According to volume, insect larvae represented comparatively high percentages both in November and March 42 per cent and 92 per cent respectively. It can be gathered that there was no significant difference between geckoes' prey in the two ecosystems. Also larvae represented the biggest percentage in the volume of the prey of

C. kotschyi. In this case too, the food niche breadth was the widest when measured by the number of the specimens of each group, instead by the volume. The volumes of the prey in the two ecosystems, during the three months, were similar. (February-November Qjk = 0.85, February-March Qjk = 0.86, November-March Qjk = 1).

DISCUSSION

During summer, in the Aegean ecosystems, *C. kotschyi*, like most Gekkonidae, feeds mainly on insects. Larvae participate in the prey, with a percentage of 78 per cent and 98 per cent in volume. (Valakos and Vlachopanos, 1987). According to the results, the above findings are valid for the wet season. In Naxos ecosystems, during March, *C. kotschyi* feeds mainly on larvae) (81 per cent in taxon and 92 per cent in volume). On the contrary, during November it feeds mainly on spiders and ants. During this period the percentage of larvae in the soil fauna is low. Differences concerning the prey categories between March and November are due to the different conditions existing on the soil fauna during the two periods (Paraschi, 1988).

It is already known that most Gekkonidae are sit-and-wait predators. (Ananjeva and Tsellarius, 1986). *C. kotschyi*, in Naxos ecosystem, behaves similarly. (Valakos and Vlachopanos, 1987). The results from the Antikythera ecosystem are in agreement with the above ones. The arguments which follow, support the above conclusion:

1. The prey is composed of many kinds of mobile animals, like spiders, Thysanura, Coleoptera, Diptera (Pianka, 1981).
2. Some groups are present in the prey in particularly high percentages. (Huey and Pianka, 1981). In our case the insect larvae contributed to the prey by more than 60 per cent. Yet, similar results were reported for the summer. (Valakos and Vlachopanos, 1987).
3. For the sit-and-wait predators, there is a positive correlation between predator's body size and average prey length. (Roze, 1976). In fact, the results concerning the wet season support this point of view along with those for the summer (Valakos and Vlachopanos, 1987).

According to Fuentes (1976), similar species of lizards that live in the Mediterranean type biotopes, even when living in two different continents, use similar food resources. The food resources for allopatric Lacertidae species and subspecies in the Aegean ecosystems are very similar. (Valakos, 1987). In fact a great similarity is observed in the food of the populations of *C. kotschyi* of Antikythera and Naxos islands. On the contrary, sympatric species, *C. kotschyi* and *Podarcis erhardii* (Sauria-Lacertidae), of the island of Naxos, show a big difference between the groups of their prey. In accordance with previous works (Valakos, 1986), the degree of similarity between the two species is Qjk = 0.3.

Lizards select their prey more by size than by taxon, (Schoener, 1968). Comparing the different groups of the prey size of *C. kotschyi* on the island of Antikythera, to the prey size of *Tarentola mauritanica* (Sauria-Gekkonidae), from Mediterranean Spanish ecosystems (Mellado, *et al.*, 1975), we are led to the conclusion that there is a high degree of similarity: Qjk = 0.86. Similar is the case of sit-and-wait predators of the Mediterranean ecosystems of Chile and California (Fuentes, 1976).

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