Feeding and reproductive ecology of the Common Chameleon *Chamaeleo chamaeleon* (Linnaeus, 1758) and the African Chameleon *Chamaeleo africanus* Laurenti, 1768 from Greece

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INTRODUCTION

In Greece there are two chameleon species, *C. chamaeleon* and *C. africanus*. *C. chamaeleon* has the broadest distribution of all chameleon species. The distribution of this species in Greece includes the Aegean islands of Samos, Chios, and Crete. *C. africanus* in Europe is found only at a locality near Pylos, W. Peloponnese (Ondrias, 1968; Böhme *et al.,* 1998). This is the first time that information on the diet of Greek specimens of *C. chameleon* and the reproduction of both species is presented.

METHODOLOGY

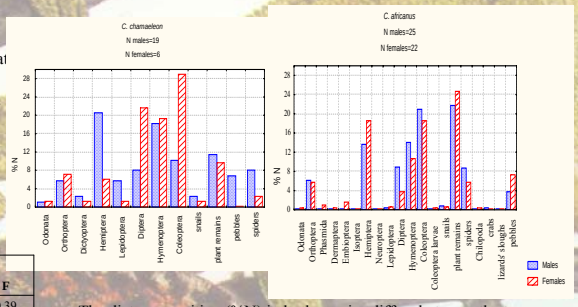
➢The stomach and faecal contents of 80 chameleon specimens were examined, coming from Samos island and Pylos respectively. For studying the reproductive ecology we examined 19 female specimens. All the specimens had been found killed by cars during the period 1996-2001 or were preserved specimens from the Museum of Natural History of Samos and the Zoological Museum of Amsterdam.

➢Diet was determined: a) as a proportion of the total number of prey items in all the stomachs and faeces examined (%N) and b) as a proportion of individuals eating a certain prey category (F). Feeding niche breadth (H') was calculated using the Shannon-Wiener index: H' = -Σpjlog pj (pj is the proportion of individuals using prey category j).

➢Sexual maturity of females was determined based on the presence of either large ovarian eggs (diameter larger than 3mm) or oviductal eggs (Castilla *et al*., 1992).

➢Egg volume (V) was estimated through the formula for the volume of a prolate ellipsoid since both chameleon species lay ellipsoid eggs. $V=4/3x\pi xa/2x(b/2)^2$ (a: length, b: width).

RESULTS



The diet composition (%N) in both species differs between the two sexes (G test, $p<0.01$). This is not the case for *C. chamaeleon* from Spain (Pleguezuelos *et al.*, 1999), or for *C. africanus* in our preliminary results (Dimaki *et al*., 2001).

➢We found significant differences in the diet between the two species (G test, $p<0.01$). However, there is no difference in the frequency of occurrence (F) between the two species (x^2, $p>0.05$).

➢The values of the niche breadth indicate that both species use a wide variety of preys ($H'_{C.chamaeleon}$= 0.945, $H'_{C.africanus}$= 0.905).

➢Plant material, specifically leaves and seeds are included in the diet of both species. Percentage of 97.66% of the plant remains found in *C. chamaeleon* were leaves and 2.34% were seeds. For *C. africanus* the respective values were 68.91% leaves and 31.09% seeds.

➢Both sexes of the examined species are euryphagous (H'_{male}= 0.977, H'_{female} =0.823 for *C. chamaeleon* and H'_{male}= 0.894, H'_{female}= 0.908 for *C. africanus*).

➢Both chameleon species reach sexual maturity at their first year. In none specimen was observed the presence of oviductal and ovarian eggs at once, this indicates that both species lay their eggs once a year (Vitt, 1982). The same stands for *C. chamaeleon* from Spain (Blázquez, *et al*., 2000, Diaz-Paniagua *et al*., 2002).

➢The clutch size (N) was estimated based on the number of oviductal eggs (Tinkle, 1967). *C. chamaeleon* lays 4-31 eggs (mean: 16) and *C. africanus* 4-43 (mean: 23.5). There is no difference in the clutch size between the two chameleon species (t-test, $p>0,05$). The results for *C. chamaeleon* from Spain is 4-40 eggs (Diaz-Paniagua *et al*., 2002) are close to ours. Blasco *et al*. (1985) records 25-30 eggs. The differences observed for a species are due to different climatic conditions and especially humidity and temperature (Mayhew, 1966a, b).

C. africanus from Pylos (photo. M. Dimaki)

The duration of incubation for the two studied species is 11-12 months. In *C. chamaeleon* from Arabian Peninsula the incubation lasts for 9.3 months (Haas, 1947), and in Morocco 8.5 months (Bons & Bons, 1960). For *C. africanus* the duration is about 6 months (Shaw, 1960). These differences are possibly due to the different climatic conditions (different conditions of incubation) of these regions, especially the different temperatures (Shaw, 1960; Bons & Bons, 1960).

C.chamaeleon from Samos (photo M. Dimaki)

Dimensions of eggs of the two chameleon species. *C. chamaeleon* lays larger eggs (length and width) than *C. africanus* (t-test, $p<0.05$). The mean length of *C. chamaeleon*'s eggs from Spain according to Blasco *et al*. (1985) is 16.03 mm and width 10.09 mm.

Species		Mean	Range	S.D.
C.chamaeleon	Length (mm)	15.32	10.70 - 19.00	2.29
N_{eggs}=102	Width (mm)	9.78	7.40 - 11.90	0.71
$N_{specimens}$=10	Volume (mm^3)	770.24	406.80 - 993.75	147.85
C.africanus	Length (mm)	12.77	4.20 - 24.40	6.05
N_{eggs}=94	Width (mm)	8.00	3.40 - 11.40	1.93
$N_{specimens}$=9	Volume (mm^3)	539.10	25.41 - 1516.68	428.93

The diet of the two chameleon species

Prey Category	C. chamaeleon (n=26)			C. africanus (n=54)		
	item number	%N	F	item number	%N	F
Odonata	2	1,14	2,27	1	0,13	0,39
Orthoptera	12	6,82	10,23	49	6,13	11,20
Phasmida	0	0,00	0,00	3	0,38	0,39
Dermaptera	0	0,00	0,00	1	0,13	0,39
Embioptera	0	0,00	0,00	5	0,63	0,39
Dictyoptera	3	1,70	3,41	0	0,00	0,00
Diplopoda	0	0,00	0,00	1	0,13	0,39
Hemiptera	24	**13,64**	13,64	130	**16,27**	15,44
Neuroptera	0	0,00	0,00	1	0,13	0,39
Lepidoptera	6	3,41	3,41	4	0,50	1,54
Diptera	25	**14,20**	11,36	48	6,01	8,88
Hymenoptera	33	**18,75**	17,05	101	**12,64**	12,74
Coleoptera	34	**19,32**	14,77	173	**21,65**	18,15
Coleoptera (larvae)	0	0,00	0,00	1	0,13	0,39
Snails	3	1,70	3,41	5	0,63	1,54
Plant remains	19	10,80	7,95	175	**21,90**	13,90
Spiders	9	5,11	6,82	56	7,01	9,27
Chilopoda	0	0,00	0,00	1	0,13	0,39
Crabs	0	0,00	0,00	2	0,25	0,77
Lizards' sloughs	0	0,00	0,00	1	0,13	0,39
Pebbles	6	3,41	5,68	41	5,13	3,09
Total	**176**	**100,0**	**100,00**	**799**	**100,00**	**100,00**

DISCUSSION

➢Differences are observed between the most frequent prey categories taken by *C. chamaeleon* from Greece (present study), Spain (Blasco *et al*., 1985; Pleguezuelos *et al*., 1999), northern Libya (Burmeister, 1989), and Malta (Luiselli & Rugiero, 1996). As in our study, differences in prey composition among different chameleon species have been reported. However, it is not certain whether these differences are due to the food preferences of the species, the composition and availability of the local prey fauna, or the season (Burrage, 1973).

➢Many plant remains were found in our specimens, which is in accordance with other chameleon species {*C. namaquensis* (Burrage, 1973), *C. pardalis* (Bourgat, 1972), *C. calyptratus, C. parsoni, C. dilepis, C. senegalensis* and *C. jacksoni* (Sullivan & Tremper 1991; Abate, 2002)}. Plant remains were found in *C. chamaeleon* (Burmeister, 1989) from northern Libya, but not from Spain (Blasco *et al*., 1985; Pleguezuelos *et al*., 1999). We presume that in Greece plant material is a regular dietary component of both *C. chamaeleon* and *C. africanus.*

➢Pebbles that were found at a considerable percentage in both the examined species seem to be common for a chameleon like *C. namaquensis* (Burrage, 1973). Johnson (1966) and Sokol (1971) suggest that deliberate lithophagy is common in lizards, because it hastens the penetration of digestive juices into the ingested insect prey and plant material, also for assisting in internal, physical degradation of food and/or parasite removal (Burrage, 1973).

➢The mean and range of the item number found was 7 (0-44) items in *C. chamaeleon* and 15 (0-50) items in *C. africanus.* These fall within the range of some chameleon species studied, like *C. chamaeleon* 16-20 items (Blasco *et al.,* 1985), or 5-74 according to Pleguezuelos *et al*. (1999). *Furcifer pardalis* eats 7-8 items (Bourgat, 1971), and *C. namaquensis* 5-15 items (Burrage, 1973).

➢Both chameleon species are sit-and-wait predators; they take active and mobile prey (Huey & Pianka, 1981). The high frequency of slow moving prey that we found indicates a strategy of actively searching for food. We agree to Belver & Avila (2002) that chameleons adapt their foraging strategy according to food availability.

➢Both studied species lay their eggs from the end of August until early November. In Spain *C. chamaeleon* lays its eggs from late September until early November (Blasco *et al*., 1985, Cuadrado & Loman, 1999, Diaz-Paniagua *et al*., 2002), and in Morocco from the first fortnight of October until early December (Bons & Bons, 1960).

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