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New data on the distribution and population density of the African Chameleon, *Chamaeleo africanus* and the Common Chameleon, *Chamaeleo chamaeleon* in Greece

Novi podatci o distribuciji i populacijskoj gustoći afričkog kamelenona, *Chamaeleo africanus* i običnog kameleona, *Chamaeleo chamaeleo* u Grčkoj

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Abstract

New data on the distribution and the population density of the Common Chameleon *Chamaeleo chamaeleon* (Linnaeus, 1758) and the African Chameleon *Chamaeleo africanus* Laurenti, 1768 are reported from Greece. The data for the Common Chameleon was collected from Samos Island (Aegean Sea) and for the African Chameleon from the SW Peloponnese. The period of the data collection is from 1998 till 2014. The African Chameleon is an allochthonous species for Greece and its presence in the area of Gialova Pylos is likely due to its introduction in historical times, because chameleons were often used in the past as pets by people and kings (Bodson, 1984). Some months ago a new population of the Common Chameleon was discovered in Attica. The distribution of the African Chameleon has expanded in the western Peloponnese with at least two new populations. This expansion is due to the local translocation of the species by humans. The population density of the African Chameleon ranged from 0.44 (in 2014) to 401.30 (in 1999) individuals/ha, while for the Common Chameleon ranged from 0.83 (in 2001) to 53,33 ind/ha (in 1998). The mean population density of the African Chameleon in Pylos was 9.69 ind/ha (estimated without the extreme value of 401.30), while that of the Common Chameleon in Samos was 5.26 ind/ha. No statistically significant difference was found in the sex ratio for either chameleon species. Only in the African Chameleon we did find a statistically significant difference between juvenile and adult numbers, as juveniles were more numerous (60.7% of the population).

Key words: *Chamaeleo africanus, Chamaeleo chameleon*, Greece; distribution, population density.

Sažetak

Novi podaci o rasprostranjenosti i gustoći populacije običnog kameleona *Chamaeleo chamaeleon* (Linnaeus, 1758) i afričkog kameleona *Chamaeleo africanus* Laurenti, 1768 su iznešeni. Podaci za *C. chamaeleon* su sakupljani na otoku Samos (Egejsko more), a za *C. africanus* na JZ Peloponezu. Sakupljanje podataka je trajalo od 1998. do 2014. Afrički kameleon je unešena vrsta u Grčkoj, prisutna na području Gialova Pylos i vrlo vjerojatno je unešena davno, jer su kameleoni često uzimani za ljubimce, pogotovo od monarha (Bodson, 1984). Nova vrsta običnog kameleona je otkrivena u Atici pred nekoliko mjeseci. Afrički kameleon se proširio na zapadni Peloponez, gdje tvori bar dvije nove populacije. To je vjerojatno zbog lokalne translokacije od strane ljudi. Gustoća populacije afričkog kameleona se kretala od 0,44 (2014.) do 401,30 (1999.) jedinki/ha, a za

običnog od 0,83 (2001.) do 53,33 (1998.) jed./ha. Srednja gustoća populacije u Pylosu je bila 9,69 jed./ha (procijenjeno bez ekstremne vrijednosti od 401,30 jed./ha) za afričkog, odnosno na Samosu 5,26 jed./ha za običnog kameleona. Nije pronađena statistički značajna razlika u omjeru spolova za obje vrste. Statistički značajna razlika između brojnosti juvenilnih i odraslih jedinki je uočena samo kod afričkih, s time da su juvenilne jedinke bile brojnije (60,7 % populacije).

Ključne riječi: *Chamaeleo africanus, Chamaeleo chameleon*, Grčka; distribucija, gustoča populacije

INTRODUCTION

The distribution of the Common Chameleon in Greece includes the Aegean islands of Samos, Chios and Crete (Ondrias 1968, Chondropoulos 1986, Dimaki 2008), while the African Chameleon had been observed only at Gialova near Pylos, in the southwestern Peloponnese (Böhme et al. 1998, Dimaki 2008). Both species are rare in Greece. The Common Chameleon is listed in the Annex II of the Bern convention, in the Annex IV of the EU Habitats Directive and is also protected by the Greek Law (Presidential Decree 67/1981). The Greek Red Data Book of Threatened Vertebrates refers to it as an "Endangered" taxon and to the African Chameleon as "Critically Endangered". The genus is listed in the Annex II of the CITES Convention. Basic information (such as population size and density) is especially needed for the conservation and management of these threatened species.

In this paper we report basic information about the population of both species in Greece. Information includes density of the population, and new data on the distribution of the African Chameleon. Available information for both species exists in the PhD thesis of the first author. For the Common Chameleon there is more information on the populations in southern Spain (Cuadrado & Santos 1997, Cuadrado 1998, 2001).

MATERIALS AND METHODS

Field work on the Common Chameleon took place on Samos island and on the African Chameleon in the west Peloponnese. The total area in which the chameleons were found in the Peloponnese is about 30 ha (Dimaki 2008). Twelve ha of this area consist of flooded land, meadows that have no vegetation during the summer, and roads, so the size of the suitable habitat for the African Chameleon is 18 ha (Dimaki 2008). In 2013 and 2014 we looked for African Chameleons further north of the known distribution of the species in the Peloponnese in case we could find any new population of the species.

Samos is 47700 ha, 21.4% of the island consists of pine woods, 40.5% is pastures and 3.6% is villages and roads (Dimitropoulos et al. 1998), so 65.5% of Samos is unsuitable habitat for chameleons. Only 16450 ha are optimum habitat for the Common Chameleon. After a big fire in July 2000 the optimum habitat was diminished considerably. For August 2000 and September 2001 we estimate the total habitat of the species about 12720 ha (Dimaki 2008).

The population size was estimated using the capture-marking-recapture and the line transect method (Pianka 1970). The Schnabel (Schumacher estimation) and Petersen indices were used for population estimation. The animals were marked using waterproof ink, as done by Cuadrado & Loman (1997) and Cuadrado (2001) with the Common Chameleon in Spain and by Dimaki (2008) in Greece. The animals were handled with care and no animal was hurt during the study.

Using the line transect method we recorded individuals identified in the transect, the boundaries of which are located on either side of the route that is

chosen by the researcher. The distances traveled were measured by pedometer.

Our estimation of the total population of the species was based on the methodology of Nilson et al. (1999). Data was collected from Samos in June 1998, July 1999, May, July, August-September 2000, September 2001, August 2010, and August 2014. The exact dates of sampling are given in Table 2. Data from Pylos was collected in April and May 1998, June 1999, May 2000, April 2001, June and August 2003, August-September 2011, August 2013, May and August 2014. The exact dates of sampling are given in Table 1.

Sex identification was based on the presence of the hemipenes at the base of the tail of the males. For the African Chameleons we also used the presence of spurs at the hind legs of the males.

Age identification was based on the length of the body; individuals of the African Chameleon of SVL ≥ 114 mm and of the Common Chameleon of SVL ≥ 84 mm are considered adults (Dimaki 2008).

Using Mann-Whitney U test we compared the ratio of the two sexes as well as that of adult to juveniles. Juveniles were considered African Chameleons of SVL < 114 mm and Common Chameleons of SVL < 84 mm. Newborns were excluded, we also used the measurements of each chameleon only once in case of a recapture.

RESULTS

We counted a total of 1150 African Chameleons during field work (395 males, 492 females and 263 of unknown sex). (When it was not necessary to catch the animal and it was difficult to observe the sex – such as when the animal was very high on a tree - we did not sex them).

From that total 352 were recaptures. No statistically significant difference was found in the sex ratio of the species (Mann-Whitney U test, U= 51.0 P=0.53).

Age ratio varied significantly in this species with more juveniles (immature specimens) than adults (Mann-Whitney U test, U= 17.00 P<0.05). We used data of 902 African Chameleons to check the age ratio. Of these individuals, only 164 were adults (39.3 %) (18.8%) and 738 were juveniles (60.7 %) (81.2 %) (SVL < 114 mm).

We captured a total of 125 individuals of the Common Chameleon (30 males, 31 females and 64 of unknown sex). Of these, only 17 were recaptures. Because of the small number of animals that were found on Samos at each sampling, we could not use the capture-marking-recapture method. Instead we used mainly the transect method.

Thirty-seven chameleons were adults (55.4%) and 30 juveniles (44.6%). No statistically significant difference was found in the sex ratio (Mann-Whitney U test, U= 15.00 P=0.63), nor in the age ratios of the Common Chameleon (Mann-Whitney U test, U= 15.50 P=0.68).

The population density of the African Chameleon in Pylos and of the Common Chameleon in Samos at each sampling area and period are presented in Tables 1 and 2. Our estimation of the total population of the species is presented in Table 3.

Table 1. Population density of the African Chameleon in Pylos.

Tablica 1. Gustoća populacije afričkog kameleona u Pylosu.

Date	Sampling area (ha)	Population estimation	density/ha	95% confidence limits	Method
13-15/4/1998	7	59	8.42	49.56-78.67	Petersen
14/4/1998	5.5	77	14.00		Transect
15-17/5/1998	7	94	13.37	79.87-120.90	Petersen
16/5/1998	4	24	6.00		Transect
14/5/1998	4.5	33	7.33		Transect
8-10/6/1999	7	117	16.76	100.90-140.21	Schnabel
30/6-2/7/1999	0.2	80	401.30	55.44-143.69	Schnabel
8-10/5/2000	7	79	11.31	75.79-82.80	Schnabel
7/4/2001	5.5	17	3.09		Transect
8-10/4/2001	7	160	22.83	110.64-287.72	Schnabel
5-7/6/2003	7	63	9.00	43.09-92.60	Schnabel
5-7/8/2003	7	48	6.90	32.37-73.86	Schnabel
30/8-1/9/2011	4.5	85	19	53.34-124.91	Schnabel
2-4/9/2011	7	37	5	27.14- 53.57	Schnabel
15-17/8/2013	4.5	92	20.3	64.57-133.80	Schnabel
3/5/2014	4.5	20	4.44		Transect
4/5/2014	2.7	5	1.85		Transect
12/5/2014	4.5	16	3.56		Transect
25/8/2014	0.6	13	21.67		Transect
25/8/2014	4.5	3	4.5		Transect
26/8/2014	5	14	2.8		Transect
26/8/2014	4.5	2	0.44		Transect
27/8/2014	2.7	10	3.70		Transect
27/8/2014	0.6	10	16.67		Transect
MEAN			26.01		
MEAN	without	401.3	9.69		

Table 2. Population density of the Common Chameleon in Samos (*: data from Tsapras, 2012).

Tablica 2. Gustoća populacije običnog kameleona na Samosu (*: podatci iz Tsapras, 2012).

Date	Sampling area (ha)	Population estimation	density/ha	95% confidence limits	Method
1-3/6/1998	0.075	4.0	53.33		Transect
19/7/1999	0.95	3.0	3.16		Transect
20/7/1999	1.2	3.0	2.50		Transect
21/7/1999	1.96	5.0	2.55		Transect

22/7/1999	0.95	1.0	1.05		Transect
20-22/5/00	1.2	2.0	1.67	2-2	Schnabel
22/5/2000	0.95	2.0	2.11		Transect
3/7/2000	1.96	5.0	2.55		Transect
4/7/2000	1.96	2.0	1.02		Transect
5/7/2000	1.2	1.0	0.83		Transect
6/7/2000	1.96	2.0	1.02		Transect
7/7/2000	1.2	1.0	0.83		Transect
8/7/2000	1.96	3.0	1.53		Transect
26/8/2000	1.96	4.0	2.04		Transect
26/8/2000	1.2	2.0	1.67		Transect
28/8/2000	0.95	5.0	5.26		Transect
31/8/2000	0.95	2.0	2.11		Transect
1/9/2000	0.95	6.0	6.32		Transect
2/9/2000	1.96	2.0	1.02		Transect
25/9/2001	0.95	4.0	4.21		Transect
26/9/2001	1.96	6.0	3.06		Transect
27/9/2001	1.2	1.0	0.83		Transect
13-14/8/2010	1.05	12	11.43	2.81-13.78	Schnabel
18-20/10/10*	2.4	8	3.33	0.99-9.78	Schnabel
21-23/10/10*	1.05	24	22.86	5.00-35.14	Schnabel
1/8/2014	0.48	1	2.08		Transect
2/8/2014	2.4	4	1.67		Transect
MEAN			5.26		

Table 3. Estimated total number of the African Chameleon in Pylos (30 ha) and of the Common Chameleon in Samos (47 700ha).

Tablica 3. Procjenjeni broj afričkih kameleona u Pylosu (30 ha) i običnog kameleona na Samosu (47 700ha).

Date	Total population of *Ch. africanus*	Total population of *Ch. chamaeleon*
April 1998	196	
May 1998	175	
June 1999	301	
July 1999		40000
May 2000	203	30600
July 2000		31200
August 2000		37100
April 2001	255	
September 2001		34000
June 2003	162	
August 2003	124	
August 2010		145000

October 2010		166000
August - September 2011	216	
August 2013	365	
May 2014	59	
August 2014	149	23914

During 2013 and 2014 we searched for new locations in the Peloponnese for African Chameleons. We found two new populations in the western Peloponnese (exact localities are not given due to the high incidence of illegal collection of the species in Greece). The first population is in the NATURA2000 site GR2330005 and the second in the NATURA2000 site GR2320001. The first population was monitored during 2013 and 2014. Both adults and newborns were found there. The second population was found in the summer of 2014 and we do not know the exact situation of this population because only three newborns were found there.

Also we found that the species has expanded its distribution north-west of its known distribution in Gialova. The new distribution of the species in the Pylos area is from the village of Gialova to the coastline of Romanos village.

In December 2014 a new population of the Common Chameleon was discovered, by the first author, in Attica. Because this is a new discovery we know neither the exact distribution nor the population density of this introduced population.

DISCUSSION

The area of Gialova is the only place that was known for the distribution of the African Chameleon in Greece. The distribution of the African Chameleon has expanded to the western Peloponnese with at least two new populations. This expansion is due to the introduction of the species by people who like chameleons without any permit or any other legal permission (personal communication). Also the species has expanded its distribution from the village of Gialova to the coastline of Romanos village. This happened after the introduction of individuals to Voidokilia by the same people (personal communication).

Recently a new population of the Common Chameleon was discovered in Attica. This is also an introduced population that needs to be studied.

We estimated the population density of the African Chameleon only by the 2013 known distribution of the species, without including the new regions, in order to compare the data with those since 1998. The population density of the African Chameleon was much larger than that of the Common Chameleon. A possible explanation is that habitats were very different between sites: wetlands in Pylos vs. rocky and sandy areas in Samos (Rhizos 1998). This difference could determine for instance, a) great differences in food availability between sites, b) different microhabitat conditions influencing a different soil humidity and hence, a different reproductive success (Martin 1992), and c) high differences in nesting sites.

The range of the population density of the African Chameleon was 0.44-401.30 ind. per ha. The remarkably high density recorded was in one particular area (and only one year), especially favourable for the animals. Differences like these are not unexpected and have been noted in other chameleon species (Burrage 1973). For *Chamaeleo namaquensis* the population density was 0.5-23.4 (mean 12.8), and for *Bradypodion pumilum* 8-90 ind /ha in southwest Africa (Burrage 1973).

For Common Chameleons, the range of the population density was much smaller in Samos than in Cádiz (south Spain) where the estimation was 20-25 ind/ha (with a maximum of 30 ind/ha (Cuadrado & Rodriguez 1997, Cuadrado 1998). These differences could be explained by differences in food availability, or the competition between species (Turner 1977, Avery 1980).

The total population of the African Chameleon for the period 1998-2014 ranged from 59 to 365 individuals, while the total population of the Common Chameleon in Samos for the period 1999-2014 ranged from 23914 to 166000 individuals. The prospective range in the population can be large over the total sampling period, as according to Turner (1977), lizard populations are not stable during each year, but their density changes.

In early spring a high number of the chameleons are still hibernating (personal observations), so it is possible that this is the reason that the population seems smaller in spring than in July and August. After the big fire in Samos, the population of the Common Chameleon seemed larger. This might happen because the chameleons are concentrating in optimum habitat, after the reduction of their former habitat.

August and September are favourable months for observing chameleons because they mate and thus they move a lot and do not hide themselves in dense vegetation during the night. Furthermore, in these months eggs are hatching, so generally more chameleons are observed.

No difference was found in the sex ratio of either species. This is predictable for most lizard species (Burrage 1973). However, in *Furcifer pardalis* (Bourgat 1968) and in the Common Chameleon from Spain (Blasco 1978) males were more numerous than females. These differences could be due to sampling error or a difference in behaviour between the sexes (Turner 1977)

In Gialova, juveniles were more numerous than adults, with the exception of August 1997, 1998, and 2003. In all other surveys, the juveniles ranged from 56.0% (in June 1998) to (97.8% in April 200) of the population. In Samos such a difference was not observed. This might mean that the African Chameleon had larger reproductive success.

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