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OBSERVATIONS ON THE NATURAL HISTORY AND MORPHOMETRICS OF THE MONTPELLIER SNAKE, *MALPOLON MONSPESSULANUS*, ON LAMPEDUSA ISLAND (MEDITERRANEAN SEA)

CLAUDIA CORTI[1], LUCA LUISELLI[2] AND MARCO A. L. ZUFFI[3]

[1]*Dipartimento di Biologia Animale e Genetica, Università degli Studi di Firenze, via Romana 17, I-50125 Florence, Italy*

[2]*Istituto di Studi Ambientali "Demetra" (E.N.I. S.p.A.), via dei Cochi 48/B, I-00133 Roma, Italia; and F.I.Z.V., via Cleonia 30, I-00152 Rome, Italy; and Department of Biological Sciences, Rivers State University of Science and Technology, P.M.B. 5080, Port Harcourt (Rivers State), Nigeria*

[3]*Museo di Storia Naturale e del Territorio (sez. Zoologia e Anatomia Comparata), Università di Pisa, via Roma 79, I-56011 Calci (Pisa), Italy*

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Lampedusa is an offshore island of Sicily, approximately 20.2 km² in surface area (Fig. 1). From a geological point of view it is part of the African platform. Once covered by Mediterranean woodlands, the whole surface of this island is now entirely deforested, and characterized by stony and rocky formations (either man-made or natural) on grasslands, and uncultivated land (mainly degraded Mediterranean maquis). This small island is very important in ecological terms because of its rare and diverse wildlife (Meschini & Frugis, 1993), including several endemics (Massa, 1995 and literature cited therein). With regard to herpetofauna, Lampedusa is noteworthy because of some important peculiarities, including the fact that it is (1) an important reproduction site for marine chelonians (Bruno, 1986; Jesu, 1995); (2) one of the few Mediterranean islands without any representative of the family Lacertidae (Corti, Lo Cascio, Vanni, Turrisi & Vaccaro, 1997); and (3) is inhabited by only two species of snakes, i.e. the colubrids *Macroprotodon cucullatus* and *Malpolon monspessulanus* (Bruno & Maugeri, 1990; Corti *et al.*, 1997).

Natural history information on Lampedusa snake populations is very limited (Bruno & Maugeri, 1990). The presence of one species with a lizard-based diet, i.e. *Macroprotodon cucullatus* (e.g. see Bruno & Maugeri, 1990), and one with an ontogenetic shift from a lizard-based diet to a bird and mammal-based diet, i.e. *Malpolon monspessulanus* (Pleguezuelos, 1997), on an island without lacertids and with introduced rat populations, may be of interest. It provides an excellent opportunity to test for the ecological adaptations of colubrids to Mediterranean environments characterized by a relatively small surface area and limited food resources. Therefore, we decided to start an ecological project on the snakes of Lampedusa, also in consideration of the fact that this island is currently under heavy pressure from tourism for the whole of the summer season, and its snake populations may likely be exposed to serious conservation threats (Corti & Luiselli, 2001).

In this report we offer (1) a preliminary morphometric analysis of Lampedusa specimens of the Montpellier snake (*Malpolon monspessulanus*) with comparisons with museum vouchers from other geographic regions; and (2) some notes on this species' natural history.

Detailed morphometric data on *M. monspessulanus* specimens from Lampedusa are not available in the literature, given also the extreme rarity of such specimens in museum collections (but see Lanza & Bruzzone, 1960). Consequently we measured all the specimens stored in the collections of the Zoological Museum "La Specola", Florence (MZUF), which is likely to store the highest number of Lampedusa specimens available in the world's public collections. In addition, we examined specimens in the collections of MSNG (Museo Civico Storia Naturale, Genoa) and of ZFMK (Zoologisches Forschungstinstitut und Museum A. Koenig Bonn). The specimens examined were labelled as follows: MZUF 585, 11352, 11353, 32640, 35108, 36591, 38063, 38066, 38067 (all from Lampedusa); MZUF 128, 7935, ZFMK 48836, 48839, 48840 (all from Cyprus); MZUF 1328, 1330, 6983, 6984, 10563, MSNG 48613 (all from France or north-western Italy); MZUF 9054, 23876, 33026, 36577, 38068 (all from the Iberian peninsula); MZUF 1249, 1250, 11337, 11338, 31677, 31678, 38064 (all from Croatia and north-eastern Italy); MZUF 1254, 2614, 12483, 19935, 29754; MSNG 30619, 30620, 31582, 36538, 37852, ZFMK 23042, 23044, 23047 (all from Tunisia, Egypt, and Israel).

Every museum specimen was measured (to ± 0.1 cm) for snout-vent-length (SVL), tail length (TL), head length (HL), head width (HW), interorbital length (INT-ORB), and number of ventrals.

Field research was conducted throughout several short-term survey periods by Massimo Capula, Giovanni Di Claudio, Lorenzo Rugiero (who kindly provided us with their unpublished observations) and Luca Luiselli between spring 1984 and autumn 1989; and by Claudia Corti and Stefano Vanni during spring 1991. These periods ranged from three to seven days each, from March to October, and involved searching for snakes along randomly selected paths.

Free-living specimens were individually marked by scale-clipping, measured for SVL (to ± 0.5 cm) and processed to determine their diet. The snakes were pal-

Correspondence: C. Corti, Dipartimento di Biologia Animale e Genetica, Università degli Studi di Firenze, via Romana 17, I-50125 Florence, Italy. *E-mail*: claudia.corti@unifi.it

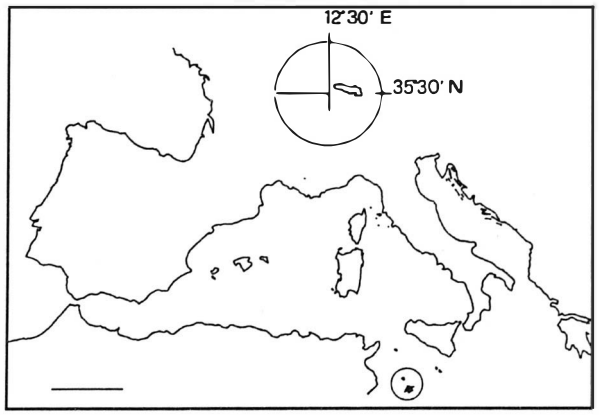

FIG. 1. Position of Lampedusa island in the western Mediterranean area. The line represents 500 km; the enlarged circle represents geographic co-ordinates of the studied island, from the small circle.

pated in the abdomen until regurgitation of the ingested food or defecation occurred. The prey items were identified to the lowest taxon possible. The snakes were then forced to reingest the disgorged prey. However, vouchers of some of the disgorged prey items are deposited in the herpetological collections of M. Capula and L. Rugiero (both collections in Rome).

Dorsal coloration of Lampedusa specimens >1000 mm SVL was normally uniform green or grey-green, whereas smaller specimens had many dark spots on a grey-greenish background. Moreover, females tended to be more spotted than males. These colour patterns were consistent in both the living (n=17) and preserved (n=9) specimens examined by us.

For morphometric analyses, museum voucher specimens were grouped into six geographical groups: (1) Lampedusa, (2) Cyprus, (3) France + NW Italy, (4) Iberian peninsula, (5) Croatia + NE Italy, (6) north Africa. SVL's of museum vouchers were not significantly different between sexes (Kruskal-Wallis ANOVA: F=0.30, df=1,45, P=0.586) or among geographical groups (Kruskal-Wallis ANOVA: F =1.61, df=1,41, P=0.177). Since SVL was significantly correlated with TL, HL, HW, and INT-ORB (in all cases at least Spearman's r> 0.6, P<0.0001), residual scores from the general regressions of these parameters to SVL were used to test for size-corrected intergroup differences.

TABLE 1. Mean number of ventral scales of museum vouchers of *Malpolon monspessulanus* in relation to geographic area. Standard Deviations and sample sizes are also indicated. For statistical details, see text.

Locality	Mean± SD	Sample Size
Croatia + NE Italy	161.6±5.29	n=7
Cyprus	162.6±1.95	n=5
North Africa	168.5±2.74	n=14
Lampedusa	172.5±4.82	n=9
France + NW Italy	174.0±1.67	n=6
Iberian Peninsula	175.5±2.43	n=6

General MANOVA models indicated no effects on the regression of TL against SVL (independent variable) of both sex and locality (sex: F=3.97, df=3,31, P=0.140; locality: F=3.19, df=3,31, P=0.185). This means that males and females do not differ in terms of body proportions (i.e. tail length relative to body length), contrary to most snake species studied to date (e.g. cf. Shine, 1994). Neither is there any specific geographic variation in this general pattern. In this respect, our results fully agree with literature data (e.g. see Pleguezuelos, 1997, and literature cited therein).

However, there were important geographical variations in other morphometric and meristic traits. For instance, both sex and locality had significant effects on the regression of HL against SVL (general MANOVA - sex: F=8.37, df=3,40, P=0.050; locality: F=36.66, df=3,40, P=0.0062), and Tukey honestly significant *post-hoc* test (Sokal and Rohlf, 1981) indicated that (1) males had larger heads than females for the same body length, and (2) there were differences between areas in relative head size. Nevertheless, Lampedusa specimens were not distinctive (relatively to the average of the whole sample examined) in terms of head size patterns.

With regard to the number of ventral scales, there was no significant correlation between SVL and number of ventrals (Spearman's r=0.226, ANOVA: F=2.42, df=1,45, P=0.126). The mean number of ventrals in relation to geographic area is presented in Table 1. There was a very strong effect of locality on the numbers of ventrals (ANOVA: F=17.84, df=5, 41, P<0.0001), and general MANOVA models indicated that both locality and sex (as the covariates) significantly affected the regression of numbers of ventrals against SVL (locality: F=48.53, df=3,42, P=0.0040; sex: F=113.36, df=3,42, P=0.0011), with the interaction effect between sex and locality being also statistically significant (F=77.58, df=2,42, P=0.012). A Tukey honestly significant *post-hoc* test indicated that specimens from Spain, France and Lampedusa had significantly higher ventral counts for the same body length than specimens from North Africa, Cyprus and Croatia. The number of ventral scales is generally assumed to be an indirect way of counting vertebrae number, in both viperid (Saint Girons, 1978; Luiselli & Zuffi, 2001; Zuffi unpubl.), and colubrid species (Corti, Zuffi & Luiselli, 2000; Zuffi, 2000; Zuffi *et al.*, unpubl.). Significant differences may well lead to the critical re-evaluation of the taxonomic position of the involved taxon (Zuffi & Bonnet, 1999; Luiselli & Zuffi, 2001; Zuffi *et al.*, unpubl.). According to some authorities, *M. monspessulanus* should be divided into three subspecies (e.g. Bruno, 1986), or according to other authorities, into two subspecies (e.g. Pleguezuelos, 1997), but in both cases the Lampedusa population should be assigned to the same subspecies as the populations from North Africa, Sinai, and Palestine (ssp. *insignitus* Geoffroy Saint-Hilaire, 1827; Lanza & Bruzzone, 1960). Our data, even if preliminary, offer a quite heterogeneous, but furthermore

stimulating scenario throughout the whole species distribution range, and suggest that additional morphometrics and genetic research is needed before accepting the current taxonomic views on *M. monspessulanus*.

It is possible that natural colonization of wild *M. monspessulanus* on Lampedusa occurred well after the separation of the island from the African coastline, even though the open question remains about the migration route that *M. monspessulanus* could have followed. Alternatively, the Lampedusa population is the result of introduction(s) by man. Available data on non-flying terrestrial vertebrates, from which the zoogeography of the circum-Sicilian islands have been reconstructed, indicate a gradual orientation of corological categories in a north-west to south direction. The presence of southern European species decreases along this gradient, while western Mediterranean species increase in the same direction (Corti *et al.*, 1997). This set of results makes the presence of south-western species, such as *M. monspessulanus*, compatible with the faunistic composition of Lampedusa and the circum-Sicilian islands. On the other hand, even if compatible with the Lampedusa fauna, introduction by man can not be excluded for *M. monspessulanus*, as recently demonstrated for some other amphibian and reptilian taxa of this area (Böhme & Corti, 1993; Corti *et al.*, 1997).

Concerning Lampedusa specimens, faeces with identifiable prey items were removed from six specimens (five males and one female), and stomach contents from three additional males and three additional females. No identifiable food item was detected from juveniles. Faeces contained identifiable remains of rats (five specimens, one female and four males) and of an undetermined lizard (probably a *Chalcides ocellatus*). Stomach contents were all rats (five adults in five specimens, three females and two males; and newborns in another male snake). Although based on a small sample size, it is clear that Lampedusa *Malpolon* tend to prey almost exclusively upon small mammals, which represent an abundant resource in the environment (Corti *et al.*, unpublished observations). A rodent-based diet for *M. monspessulanus* is not surprising, as it is known in mainland regions. However, this species also consumes lizards, snakes, birds and mammals (e.g. see Naulleau, 1984; Pleguezuelos, 1997, and literature cited therein), which tends to confirm its status as an opportunistic species (Pleguezuelos, 1997).

In terms of conservation, our preliminary data suggest that *M. monspessulanus* is less uncommon in Lampedusa than *Macroprotodon cucullatus* (Corti & Luiselli, 2001). However, an immediate monitoring project by the pertinent authorities is required to census the total population size on this Mediterranean island. We suggest that this project should work through some major research phases as already presented for Sardinian *Coluber hippocrepis* (Corti *et al.*, 2000). According to our own unpublished qualitative data, traffic over busy roads, especially during the summer months, could affect the survival of large adult specimens. We believe that this could be the main threat to the populations of *Malpolon monspessulanus* on Lampedusa, as we have found some specimens squashed along the roads. Fortunately, this snake seems adaptable to altered habitats in Lampedusa, possibly as a result of its adaptation to a rat-based diet. Indeed, in Lampedusa rats are extremely abundant and are present virtually everywhere.

Given the small size of Lampedusa and its easily accessible environments, it is likely that it will be possible to obtain a good estimate of the whole population size of *M. monspessulanus* once this island is thoroughly surveyed.

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