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## Distribution, ecology and conservation of *Archaeolacerta bedriagae* in Sardinia (Reptilia, Lacertidae)

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### ABSTRACT

*Archaeolacerta bedriagae* is a polytypic species endemic to Corsica and Sardinia. It represents one of the most peculiar elements of the Italian herpetofauna. This species has a fragmented range in Sardinia. The aim of this paper is to summarise the knowledge on the distribution of this lizard in Sardinia, based both on literature and original records, and to define the conservation status of its populations. This research was carried out throughout the entire Sardinian territory, from June 2000 to September 2002. Most of the known sites of occurrence of *A. bedriagae* were checked, characterised from geomorphologic and florofaunistic points of view and geo-referenced. The surveys carried out explored only the potentially suitable habitats in different hours of the day. Three new localities were discovered, 10 checked sites were confirmed, 12 localities were not confirmed and 43 previously quoted sites were not explored. Two sampling sites were selected for a population study. In the latter two localities, several population parameters, such as density and sex ratio were studied. In the mountain site, a population density twenty times higher than that found at the sea level site was estimated. Only five species were found to be syntopic with *A. bedriagae*: *Podarcis tiliguerta*, *Algyroides fitzingeri*, *Tarentola mauritanica*, *Chalcides ocellatus* and *Coluber viridiflavus*. The Sardinian sub-range includes seven main areas of certain presence, but an underestimation due to their elusivity and the low density of some populations is possible. The species generally inhabits areas of scarce interest and difficult for man to reach, though at least in some localities it seems to be disturbed by an increase in tourism. Some conservation actions were proposed.

**KEY WORDS:** *Archaeolacerta bedriagae* Lacertidae - Distribution Ecology Conservation - Sardinia.

### ACKNOWLEDGEMENTS

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### INTRODUCTION

According to Arribas (1998, 1999) *Archaeolacerta* Mertens, 1921 is a polyphyletic taxon that includes several natural groups. Arribas (1999) referred *bedriagae* to the true *Archaeolacerta* genus, together with two balcanic species [*oxycephala* (Duméril & Bibron, 1839) and *mosorensis* (Kolombatovic, 1886)], while *horvathi* (Méhely, 1904) from the Eastern Alps was included in *Iberolacerta* Arribas, 1999 and not in *Archaeolacerta* as in Amori *et al.* (1993).

*Archaeolacerta bedriagae* (Camerano, 1885) (Fig. 1), a polytypic species endemic to Corsica and Sardinia, is the only representative of the genus in the Italian territory. Four subspecies were described: *A. b. bedriagae* (Camerano, 1885) from Corsica; *A. b. paessleri* (Mertens, 1927) from the Limbara Mountain (northern Sardinia); *A. b. ferrerae* (Stemmler, 1962) from Punta Falcone (northern Sardinia) [Guillame (1987, Unpublished Thesis, University Sci. Techn. Languedoc, Montpellier) considered this subspecies as a synonym of *A. b. paessleri*], and *A. b. sardoa* (Peracca, 1903) from the Gennargentu massif (central Sardinia).

*Archaeolacerta bedriagae* is a Cirno-sardo paleoendemism (Lanza, 1983) and represents one of the most original elements among Italian herpetology.

Traditionally it was considered an exclusively mountain species, but data collected in the last thirty years has led to define this species as eurizonal rupicolous. Moreover there is sufficient evidence to state that *A. bedriagae*, although preferring granitic substrate, is able to colonise every rocky habitat characterised by the presence of numerous slits.

Lanza *et al.* (1984) hypothesised that this species has an unexpected capacity of dispersion in clearly unsuit



Fig. 1 - *A. bedriagae* from Punta Balistreri (Limbara Mountain northern Sardinia) (photo P. Bombi).

able habitats for its ecological requirements and, therefore, its distribution in Sardinia (Fig. 2) could be continuous in a large part of the island, as occurs in Corse (Michelot, 1989, 1992, 1997).

The studies carried out up to now have been restricted to list the occurrence sites of *A. bedriagae* with a brief description of them. Studies regarding the biology of *A. bedriagae* in Sardinia are almost absent. Some ecological data can be retraced in more general studies on Sardinian herpetofauna, mainly on circumsardinian islands (for references see Table D).

The aim of this paper is to summarise the knowledge on the distribution of this lizard in Sardinia, based both on literature and original records, and to define the habitat preferences and conservation status of the populations. More detailed research on the ecology, dynamics and genetics of the Sardinian populations are in progress (Bombi, unpublished).

## MATERIALS AND METHODS

### Study Area

This research was carried out throughout the entire Sardinian territory (including the minor islands). The surveys aimed at carefully exploring the known sites of *A. bedriagae* and to discover new localities

All the known localities of *A. bedriagae* in Sardinia (Fig. 2) are listed in Table I.

### Field observations and data collecting methods

The current research data was collected in ten samplings elaborated monthly from June to October 2000, from April to May 2001, and in May, July and September 2002. Most of the known sites of occurrence of *A. bedriagae* were checked, with more attention paid to the localities where data regarding its presence was collected previous to 1990. In fact, in the last ten years tourism, especially in coastal areas, has increased greatly.

Each site was surveyed a minimum of one to a maximum of four times, in different seasons, and was characterised from geomorphologic and floro-faunistic points of view, with a detailed analysis regarding the description of the herpetological community. Geographical co-ordinates were registered via GPS.

The surveys carried out explored only the potentially suitable habitats in different moments of the day, from dawn to dusk with a preference for the late morning and late afternoon.

Specimens were located on sight or using a binocular to monitor inaccessible rocky areas, and were sometimes caught using a noose, rather than by hands. All the captured lizards were released a few minutes after being captured and usually photographed. The specimens were not marked using the "toe clipping" method because the effects of this technique on this rupicolous lizard are unknown.

Two sampling sites were selected for a population study, one representative of the Mediterranean mountain habitat (Punta Balistreri, on the Limbara massif, 1359 m a.s.l., northern Sardinia), the second one in the Mediterranean coastal rocky habitats (Punta

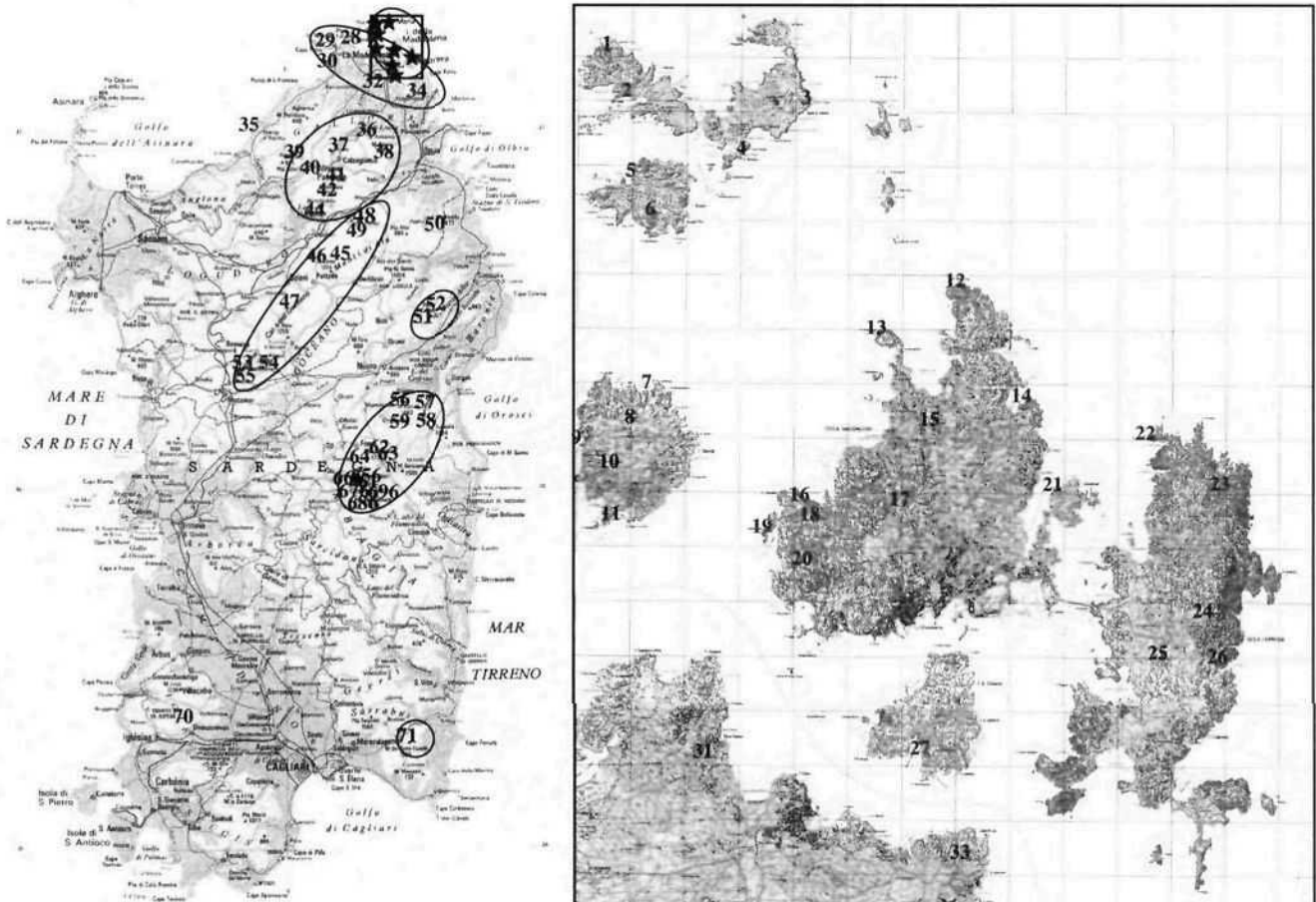


Fig. 2 - Sites of occurrence and main areas of presence of *A. bedriagae* in Sardinia and on La Maddalena Archipelago. See Table I for details.

TABLE I - Sites of occurrence of *A. bedriagae* in Sardinia (the acronyms SS, NU, OR and CA indicate respectively the Sardinian provinces of Sassari, Nuoro, Oristano and Cagliari).

	Locality	Habitat	First record	References	Current research
1	Lighthouse, Razzoli Island (SS) (41°18'27"N 9°20'22"E)	Granitic cliffs with scattered vegetation	Cesaraccio (V.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
2	Cala Lunga, Razzoli Island (SS) (41°17'58"N 9°20'37"E)	Granitic cliffs with scattered vegetation	Cesaraccio (V.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
3	Punta Filetto, S. Maria Island (SS) (41°17'58"N 9°22'58"E)	Schistose rocks with scattered vegetation	Cesaraccio (1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
4	Cala Fosso, S. Maria Island (SS) (41°17'24"N 9°22'07"E)	Granitic cliffs with scattered vegetation	Cesaraccio (1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
5	Cala di Trana, Budelli Island (SS) (41°17'02"N 9°20'51"E)	Granitic cliffs with scattered vegetation	Cesaraccio (V.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
6	Monte Budello, Budelli Island (SS) (41°16'50"N 9°20'50"E)	Granitic cliffs surrounded by vegetation	Cesaraccio (VIII.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
7	Cala Pietranera, Spargi Island (SS) (41°14'58"N 9°20'56"E)	Granitic cliffs crossed by basic rock veins	Cesaraccio (VIII.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
8	Punta dei Banditi, Spargi Island (SS) (41°14'42"N 9°20'43"E)	Granitic cliffs without vegetation		Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
9	Cala Pisciole, Spargi Island (SS) (41°14'32"N 9°20'08"E)	Granitic cliffs near a water source	Cesaraccio (IV.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
10	Casa Natale, Spargi Island (SS) (41°14'18"N 9°20'30"E)	Granitic masses	Cesaraccio (IV.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
11	Cala Corsara, Spargi Island (SS) (41°13'48"N 9°20'27"E)	Granitic cliffs	Cesaraccio (VI.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Confirmed VIII.2000 L. Vignoli

Continued.

TABLE I - *Continued.*

	Locality	Habitat	First record	References	Current research
12	Punta Marginetto, La Maddalena Island (SS) (41°16'02"N 9°25'07"E)	Granitic cliffs	Cesaraccio (VII.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed IV.2001 P. Bombi
13	Punta Abbatoggia, La Maddalena Island (SS) (41°15'35"N 9°24'06"E)	Basic rock vein	Cesaraccio (1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VII.2000 L. Vignoli
14	Punta Spalmatore, La Maddalena Island (SS) (41°14'52"N 9°25'58"E)	Granitic cliffs with scattered vegetation	Cesaraccio (IV.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VII.2000, V.2002 L. Vignoli, P. Bombi
15	Punta Boccalta, La Maddalena Island (SS) (41°14'30"N 9°24'35"E)	Granitic cliffs	Cesaraccio (VI.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
16	Cala Inferno, La Maddalena Island (SS) (41°13'53"N 9°23'05"E)	Granitic cliffs	Cesaraccio (VIII.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VII.2000 L. Vignoli
17	Punta S. Trinità, La Maddalena Island (SS) (41°14'06"N 9°24'28"E)	Granitic cliffs with scattered vegetation	Cesaraccio (VII.1983) (uncertain observation)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
18	Punta dei Colmi, La Maddalena Island (SS) (41°13'41"N 9°23'29"E)	Granitic cliffs	Cesaraccio (IV.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Confirmed IV.2001-V.2002 P. Bombi
19	Madonna del pescatore, La Maddalena Island (SS) (41°13'38"N 9°22'29"E)	Granitic cliffs with scattered vegetation	Cesaraccio (IV.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VII.2000, IX.2000, IV.2001, V.2002 L. Vignoli, P. Bombi
20	Monte Puntiglione, La Maddalena Island (SS) (41°13'09"N 9°23'10"E)	Disused granitic quarry	Cesaraccio (V.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
21	NW coast of Giardinelli Island (SS) (41°14'03"N 9°26'29"E)	Low coast with scarce vegetation	Cesaraccio (1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VII.2000, IX.2000, IV.2001, V.2002 L. Vignoli, P. Bombi
22	Punta Galera, Caprera Island (SS) (41°14'39"N 9°27'44"E)	Granitic cliffs with scattered vegetation	Cesaraccio (V.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VIII.2000 L. Vignoli

*Continued.*

TABLE I - *Continued.*

	Locality	Habitat	First record	References	Current research
23	Messa del Cervo, Caprera Island (SS) (41°13'56"N 9°28'51"E)	Granitic cliffs with scattered vegetation	Cesaraccio (VI.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed VIII.2000, IV 2001 L. Vignoli, P. Bombi
24	Monte Teialone, Caprera Island (SS) (41°12'49"N 9°28'26"E)	Granitic cliffs with scattered vegetation	Cesaraccio (V.1982)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Confirmed IV.2001, V.2002 P. Bombi
25	Petraiaccio, Caprera Island (SS) (41°12'25"N 9°27'47"E)	Granitic cliffs emerging from the pinewood	Cesaraccio (VII.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Confirmed VIII.2000, IX.2000, V.2002 L. Vignoli, P. Bombi
26	Cala Brigantino, Caprera Island (SS) (41°12'22"N 9°28'38"E)	Granitic cliffs with scattered vegetation	Cesaraccio (VI.1983)	Cesaraccio & Lanza (1984); Lanza <i>et al.</i> (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	
27	Cala di Vela Marina, S. Stefano Island (SS) (41°11'32"N 9°24'34"E)	Granitic cliffs with scattered vegetation	Cesaraccio (VIII.1983) (1984); Lanza <i>et al.</i>	Cesaraccio & Lanza VIII.2000 (1984); Borri <i>et al.</i> (1988); Poggesi <i>et al.</i> (1996)	Not confirmed  L. Vignoli
28	Punta Falcone (SS) (41°15'06"N 9°13'26"E)	Granitic cliffs with scattered vegetation	Stemmler (1962)	Stemmler (1962); Lanza <i>et al.</i> (1984)	Confirmed VI.2000 L. Vignoli
29	Punta Contessa (SS)	Granitic cliffs with scattered vegetation	In den Bosch (VI.1989)	In den Bosch (1992)	Confirmed VI.2000 L. Vignoli
30	Ciuchesu			Bruno (1986); Puddu <i>et al.</i> (1988)	
31	Monte Altura			Bruno (1986); Puddu <i>et al.</i> (1988)	
32	Punta Martino			Bruno (1986); Puddu <i>et al.</i> (1988)	
33	Capo d'Orso (SS) (41°10'22"N 9°24'52"E)	Granitic cliffs with scattered vegetation	This paper		New locality V.2002 P. Bombi
34	Monte Moro (SS) (41°06'30"N 9°30'58"E)	Granitic cliffs with scattered vegetation	This paper	Bruno (1986)	Confirmed IX.2002 P. Bombi
35	Isola Rossa di Trinità d'Agultu (SS) (41°00'57"N 8°52'31"E)		Sanna (III.1990)	Poggesi <i>et al.</i> (1996)	
36	S. Antonio di Calangianus (SS)		Sochurek (1951)	Lanza <i>et al.</i> (1984)	
37	S. Leonardo (SS)	Rocky brook	Sochurek (1951)	Lanza <i>et al.</i> (1984)	

*Continued.*

TABLE I - *Continued.*

	Locality	Habitat	First record	References	Current research
38	Monte Pinu (SS) (40°56'45"N 9°19'35"E)	Granitic cliffs with scattered vegetation	Malenotti & Falchi (VIII.1982); Malenotti (VIII.1983)	Lanza <i>et al.</i> (1984)	Confirmed VII.2000, IX.2000, VII.2002 L. Vignoli, P. Bombi
39	Monte della Croce, Aggius (SS) (40°56'04"N 9°03'42"E)	Granitic cliffs with scattered vegetation	This paper		New locality VII.2002 P. Bombi
40	Along the railroad near Tempio Pausania (SS)		Sochurek (1951)	Lanza <i>et al.</i> (1984)	
41	Monte Lu Sciocou, Limbara Mt (SS) (40°51'31"N 9°10'01"E)	Granitic cliffs with scattered vegetation	This paper		Confirmed VII.2002 P. Bombi
42	Punta Balistreri, Limbara Mt (SS) (40°51'04"N 9°10'26"E)	Granitic cliffs with scattered vegetation	This paper		Confirmed VI/VII. 2000, IV.2001, VII 2002 L. Vignoli, P. Bombi
43	Limbara Mt (SS)	Granitic cliffs with scattered vegetation	Mertens (1927)	Mertens (1932); Lanza <i>et al.</i> (1984)	Confirmed V.2000, VII.2002 L. Vignoli, P. Bombi
44	Monte Acuto			Bruno (1986); Puddu <i>et al.</i> (1988)	
45	Monte sas Broccas (SS) (40°42'20"N 9°12'38"E)	Granitic rocks surrounded by low maquis	Malenotti & Falchi (V.1983)	Lanza <i>et al.</i> (1984)	
46	Monte Lerno			Bruno (1986); Puddu <i>et al.</i> (1988)	
47	Between Cantoniera di Mandria Olostriu and Monte Paidorzu, Goceano Mts (SS) (40°30'55"N 9°05'00"E)	Granitic cliffs in pasture grassland	Malenotti & Falchi (VII.1982); Malenotti & Falchi (V.1983)	Lanza <i>et al.</i> (1984)	Not confirmed VII.2000 L. Vignoli, P. Bombi
48	Monte Olia			Bruno (1986); Puddu <i>et al.</i> (1988)	
49	Senalonga			Bruno (1986); Puddu <i>et al.</i> (1988)	
50	Monte Nieddu			Bruno (1986); Puddu <i>et al.</i> (1988)	
51	Monte Turuddò			Bruno (1986) Puddu <i>et al.</i> (1988)	
52	Monte Albo (near Janna 'e Nurai) (NU) (40°29'19"N 9°32'28"E)	Calcareous rocks	Camarda (?)	Lanza <i>et al.</i> (1984); Poggesi <i>et al.</i> (1996); Michelot (1997)	Not confirmed VII.2000 L. Vignoli, P. Bombi
53	Nuraghe Ortachis, Marghine Mts (NU) (40°20'55"N 8°54'28"E)	Rocks in pasture area or o ilex wood	Corrias (1981); Malenotti & Malenotti (1983)	Lanza <i>et al.</i> (1984)	Confirmed VII.2000, IX.2002 M. Bologna, P. Bombi
54	Rio Biralotta			Bruno (1986) Puddu <i>et al.</i> (1988)	
55	Punta Palai, Marghine Mts (NU) (40°20'40"N 8°55'08"E)		This paper		New locality IX.2002 P. Bombi

*Continued.*



TABLE I - *Continued.*

Locality	Habitat	First record	References	Current research
56 Punta Corراس, Supramonte di Oliena (northern slopes) (NU) (40°15'00"N 9°25'40"E)	Calcareous rocks in pasture area	Corrias (1980); Lanza & Malenotti (1983)	Lanza <i>et al.</i> (1984); Poggesi <i>et al.</i> (1996)	Confirmed IX.2000, IX.2002 L. Vignoli, P. Bombi
57 Monte Tiscali			Bruno (1986); Puddu <i>et al.</i> (1988)	
58 Monte Oddeu			Bruno (1986); Puddu <i>et al.</i> (1988)	
59 Punta Salita			Bruno (1986); Puddu <i>et al.</i> (1988)	
60 Lanaitto valley			Bruno (1986); Puddu <i>et al.</i> (1988)	
61 Punta Paulino, Gennargentu Mts (NU)		Meloni (1900)	Peracca (1905); Bruno (1982); Lanza <i>et al.</i> (1984)	
62 Passo Caravai			Bruno (1986); Puddu <i>et al.</i> (1988)	
63 Arcu Correboi			Bruno (1986); Puddu <i>et al.</i> (1988)	
64 Monte Spada			Bruno (1986); Puddu <i>et al.</i> (1988)	
65 Bruncu Spina			Bruno (1986); Puddu <i>et al.</i> (1988)	
66 Monte d'Iscudu			Bruno (1986); Puddu <i>et al.</i> (1988)	
67 Arcu Guddetorgiu			Bruno (1986); Puddu <i>et al.</i> (1988)	
68 Bruncu Furu			Bruno (1986); Puddu <i>et al.</i> (1988)	
69 Punta La Marmora			Bruno (1986); Puddu <i>et al.</i> (1988)	
70 S. Giovanni cave, near Domusnovas (CA)	Calcareous rocks		Lanza <i>et al.</i> (1984)	Not confirmed V.2000 L. Vignoli
71 Monte dei Sette Fratelli (CA)	Granitic rocks		Poggesi <i>et al.</i> (1996)	See Addendum

Falcone, sea level, northern Sardinia). In these two localities, some population parameters (density and sex ratio) were studied. All the specimens were caught, sexed and released.

To determine the population size at Punta Balistreri, the removal sampling method (April 2001) and the mark-recapture technique (July 2002) were used (specimens were marked with a colour spot on their back) (see, e.g., Heyer *et al.*, 1993; Capula *et al.*, 2002). At Punta Falcone, only the removal sampling method was used (June 2000).

## RESULTS

### *Distribution*

The field research on this species presented several difficulties due to its elusive habits, to the low population density, and the inaccessibility of some suitable habitats.

Currently 71 sites of occurrence of *A. bedriagae* are known in literature (Table I; Fig. 2). Three new localities

of presence were discovered: 1) Capo d'Orso near Palau (SS), just in front of Caprera Island; 2) Monte della Croce, near Aggius (SS); 3) Punta Palai on the Marghine mountains (NU) (See "Addendum"). Several of these sites are geographically very close, as is the case of the 27 sites on the eight islands of La Maddalena Archipelago.

During the present research, 10 sites were confirmed; 12 checked localities were not confirmed, although eight of them are close to other confirmed sites. The remaining 43 sites were not explored, but several of them are close to other confirmed localities.

#### Population estimate

At the Limbara massif, *A. bedriagae* is distributed more or less continuously from 1200 m a.s.l. to the top (1359 m a.s.l.). Near the summit, the vegetation is scattered and large rocky nude areas are present. The absence of recorded presence below 1200 m a.s.l. could be related to the different habitat, which is characterised by the presence of vegetation that reduces the emerging rocks surface.

The population density was estimated considering a homogenous area of a granite group of masses: within an area of about 50–60 m<sup>2</sup>, the presence of 7–10 specimens of *A. bedriagae* (approximately 0.2 specimens/m<sup>2</sup>) with a sex ratio of 1.5 males/females was evaluated by removal sampling. In the same area, the presence of 19.67 specimens (0.33 specimens/m<sup>2</sup>) with a sex ratio of 1.1 males/females was estimated by mark-recapture.

According to our observations, males are very sedentary and territorial, and tenaciously defend an area variable in dimensions in relation to the morphology of the inhabited granite masses, from other co-specific males. A dispute, often rather violent, begins only when another male enters the field of vision of the first, and generally ends with the invading male escaping.

The Punta Falcone site, situated at sea level, is characterised by low maquis up to approximately 30 meters from the sea where it is replaced by some granite surface plateaux, separated by a system of deep fissures, constituting the elective habitat for *A. bedriagae*. In June, a density of 0.01 specimens/m<sup>2</sup> with a 2.5 males/females ratio was registered. It is possible that this density, twenty times lower than on Limbara massif, is related to the habitat characteristics or to the relationships with potential competitors, such as *Podarcis tiliguerta*. In fact, the substrate morphology of this locality is very different from that of the Limbara massif: the flat surface of the masses allow each male to control a larger territory. Moreover, *P. tiliguerta* here occurs on rocky masses more frequently than at the Limbara massif, where it is widely distributed only in areas covered by vegetation.

The daily activity period of individuals at Punta Falcone is slightly longer compared to that observed at the mountain site; some specimens were observed basking or exploring the territory from 8.30 a.m. to 7.30 p.m. at sea level and from 8.15 a.m. to 6.20 p.m. at 1300 m a.s.l.

On the basis of our field research, the herpetological community found in the rocky habitat inhabited by this species is generally constituted by a few number of species. Only five species were found syntopically with *A. bedriagae*, i.e. *Podarcis tiliguerta*, *Algyroides fitzingeri*, *Tarentola mauritanica*, *Chalcides ocellatus* and *Coluber viridiflavus*. *Coluber viridiflavus* could be a potential predator of the Bedriaga lizard. On the other hand, *T. mauritanica* and *P. tiliguerta* may be regarded as possible competitors of *A. bedriagae*: the first species occurs in the same habitat as *A. bedriagae*, while the second one is an euriecan species which occurs in several types of habitats. *A. fitzingeri* and *C. ocellatus* are not rupicolous species and occur occasionally in the studied areas.

#### DISCUSSION

The Sardinian distribution of *A. bedriagae* still remains questionable and needs further studies. The Sardinian subrange includes 7 main areas of presence: 1) La Maddalena Archipelago; 2) the Gallura coast (northern Sardinia); 3) the area delimited by Aggius, S. Antonio di Calangianus, Monte Pinu and Monte Limbara (northern Sardinia); 4) the mountain complex made up by Marghine Mountains, Goceano Mountains and Alà Mountains; 5) Monte Albo (eastern Sardinia); 6) Supramonte di Oliena and Gennargentu massif (central Sardinia); 7) Monte Settefratelli (southern Sardinia). An eighth area (near Domusnovas) is very doubtful and needs confirmation.

In several northern Sardinian sites, apparently suitable for this species, *A. bedriagae* was not found: for example, the numerous localities along the Costa Paradiso between Monte Tinnari and Serra Tamburu, where Bruno (1986) and Puddu *et al.* (1988) generically cited the occurrence of the species. The absence of recovery is possibly due to the elusivity and low density of some populations of this species. In other localities, where the same method of sampling was adopted, *A. bedriagae* was found only occasionally during the surveys.

Even though Bruno (1982, 1986) and Puddu *et al.* (1988) indicated that the Bedriaga lizard found shelter on a large area of the Gennargentu massif, the species seems to be confined only to a high valley near Punta Paolinu, which represents the first Sardinian record (Peracca, 1905). Bruno (1982, 1986) and Puddu *et al.* (1988) cited several localities on Supramonte di Oliena, but *A. bedriagae* was observed only in a little valley near the top (Punta Corraisi). This population is characterised by the darkest coloration of the species, having a tawny blackish back with green spots. Repeated surveys on Monte Paidorzu and on Giardinelli Island (both cited by Lanza *et al.*, 1984) gave negative results. In the first locality, the meteorological conditions negatively influenced the researches, while the negative sampling on Giardinelli Island was probably due to increased tourism. The site near S. Giovanni Cave (Domusnovas, Cagliari), considered uncertain by Lanza *et al.* (1984), ap-

pears unsuitable for the species. Finally the locality cited by In den Bosch (1992), and not precisely localised by the author, probably corresponds to Punta Contessa, where the species was confirmed during the present research.

Concerning the ecological features of this Tyrrhenian endemism, according to Bruno (1986) it seems that at sea level the *Bedriaga* lizard aestives; however, this ecological feature was not confirmed by our research. In fact, the species was observed throughout the summer months, also during the hottest hours of the day in several localities.

Our observations indicate that the *Bedriaga* lizard's activity begins with the first rays of the sun and finishes before sunset, and it seems that it is more intense during the antemeridian hours, as already indicated by Müller (1904). Although Sochurek (*in*: Schneider, 1984) noted that the species is active also during rainy days, we never registered activities with cloudy sky or rain, in agreement with Bauwens *et al.* (1990).

#### *Conservation status and managing proposals*

*Archaeolacerta bedriagae* is included in Annex II (closely protected fauna) of the Bern Convention, aimed at conserving European wild fauna and natural habitats, listed in the Annex D of D.P.R. no. 357 of September 8, 1997 (Italian Amphibians and Reptiles of Community interest that demands strict protection), and also included in the Red Data Book of the Italian Vertebrates (Bulgarini *et al.*, 1998). In spite of this, the greater part of known populations do not occur in protected areas. The Supramonte-Gennargentu complex is only formally a National Park, while La Maddalena Archipelago is a recently instituted National Park.

At present it is difficult to carry out a reliable estimation of the consistency of the Sardinian populations of *A. bedriagae*. However, this research clarifies that the species is still present in many of the known sites, even if some populations appear to be geographically very isolated.

The present research shows that the species inhabits areas of scarce interest and difficult for humans to reach. It is disturbed by human activities, at least in some localities, such as along the coast, where human presence has increased enormously because of tourism. Another threat is represented by the collection of specimens by hobbyists who keep them in captivity. This species, in fact, generates interest among collectionists because of its easy maintenance in terrarium and endemic status.

The following protection and conservation actions are proposed:

- Limitation of tourism in known sites of presence, at least in the reproductive period (spring and early summer).
- Increase of ties to the infrastructures construction in proximity of areas sheltering the species or potentially suitable to maintain a genic flow between the populations.

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ADDENDUM: When this paper was in press, the presence of *A. bedriagae* in three localities of Monte Sette Fratelli was confirmed, and a new site on Monte Genis (Cagliari province) was discovered.