

## Two new genera of Lacertid lizards (Reptilia: Squamata: Sauria: Lacertidae) from the Middle-east.

RAYMOND T. HOSER

488 Park Road, Park Orchards, Victoria, 3134, Australia.

Phone: +61 3 9812 3322 Fax: 9812 3355 E-mail: snakeman (at) snakeman.com.au

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### ABSTRACT

In spite of the excellent reclassification of the Lacertidae by Arnold *et al.* (2007), now widely accepted by most herpetologists, two genera as widely recognized consist of taxa sufficiently divergent to warrant being placed in their own genera.

Molecular studies indicate that the most divergent species within the genera *Phoenicolacerta* Arnold *et al.* 2007 and *Timon* Tschudi, 1836 as recognized to date, diverged from other species within their genus about 10 Million years ago.

Coupled with significant morphological differences, this makes a compelling case for the divergent taxa to be placed in new genera.

As there are no available names, the relevant taxa are herein placed within genera newly named according to the rules of the *International Code of Zoological Nomenclature* (Third edition) (Ride *et al.* 1999).

The species *Atlantolacerta andreanskyi* (Werner, 1929) is also sufficiently divergent from others within the tribe Eremiadini to warrant being placed within its own monotypic tribe, which is where Arnold *et al.* (2007) had placed the taxon. It is therefore placed in a new tribe, namely Atlantolacertiini *tribe nov.*

**Keywords:** Taxonomy; snakes; nomenclature; lizards; Lacertidae; *Atlantolacerta*; *Phoenicolacerta*; *Timon*; *andreanskyi*; genus; genera; new genera; *Duboisilacerta*; *Greerlacerta*; new tribe; Atlantolacertiini.

### INTRODUCTION

As part of an ongoing audit of the world's reptiles, including snakes and lizards, a review of the generic level placement of species within the Lacertidae as of 2015 found that the excellent reclassification of the Lacertidae by Arnold *et al.* (2007), largely resolved the issue of species assigned to wrong genera (prior to that publication).

Their paper reassigned species to various genera and when none were available, several were erected.

In spite of the excellent reclassification of the Lacertidae by Arnold *et al.* (2007), now widely accepted by most herpetologists, two genera as widely recognized, consist of taxa sufficiently divergent to warrant being placed in their own genera.

Molecular studies (e.g. Pyron *et al.* 2013, Tamar *et al.* 2015) indicated that the most divergent species within the genera *Phoenicolacerta* Arnold *et al.*, 2007 and *Timon* Tschudi, 1836 as recognized to date, diverged from other species within their genus about 10 Million years ago.

Coupled with significant morphological differences that have been known for a long time, this makes a compelling case for the divergent taxa to be placed in new genera.

As there are no available names, the relevant taxa are herein

placed within genera newly named according to the rules of the *International Code of Zoological Nomenclature* (Third edition) (Ride *et al.* 1999).

The species *Atlantolacerta andreanskyi* (Werner, 1929) is also sufficiently divergent from others within the tribe Eremiadini to warrant being placed within its own monotypic tribe, which is where Arnold *et al.* (2007) had placed the taxon. It is therefore placed in a new tribe, namely Atlantolacertiini *tribe nov.*

The relevant materials and methodology used as a basis for the taxonomic decisions herein include inspection of specimens when in Europe in 1980 as well as a review of all the relevant and available literature available to me in Australia as of mid 2015 and earlier.

Unfortunately records, including photos, notes, computers, disks and the like (all we held at the time) was seized during an illegal armed raid on 17 August 2011 and most of the material relevant to this paper was not returned to me (Court of Appeal, 2014, Magistrates Court of Victoria 2014, VCAT 2015).

I should note that the Court of Appeal, 2014 made a costs order in my favour and in contempt of the court the rogue government department officials have yet to pay me a cent in costs, damages, restitution or compensation.

Rather than delay publication indefinitely in the hope this

material is eventually returned, something that in 2015 I think is unlikely, or that I find time to go on a collecting or research trip to Europe and the currently politically unstable Middle-East or North Africa, the following descriptions are published herein to enable other zoologists to properly assign the relevant taxa and for conservation agencies to better plan management of the relevant taxa, noting the greater degree of uniqueness of the relevant species.

The literature relevant to the taxonomy of the three genera subject to taxonomic actions in this paper, namely *Phoenicolacerta* Arnold *et al.* 2007, *Timon* Tschudi, 1836 and *Atlantolacerta* Arnold *et al.* 2007 is extensive. Publications directly relevant to the taxonomic decisions herein include the following:

Al-Quran (2009), Arets (2003a, 2003b), Arnold *et al.* (2007), Bannert (1994), Bar and Haimovitch (2012), Barbour (1914), Barata *et al.* (2015), Berroneau *et al.* (2010), Bertolotto *et al.* (2004), Bird (1936), Bischoff (1982, 1985a, 1985b, 2005, 2007), Bischoff and Müller (1999), Bischoff *et al.* (1984), Blanford (1874), Boettger (1880), Bonetti (2002), Boulenger (1889, 1891, 1916), Bruekers (2010), Budak and Göcmen (1995), Busack (1987), Castroviejo and Mateo (1998), Cortés (1982), Daudin (1802), Disi *et al.* (2001), Doré *et al.* (2011), Duméril and Bibron (1839), Eiselt (1968, 1969), Engelmann (1933), Esser and Böhme (2009), Frommer (2008), Frynta (1997), Funke (1999), Galán (1931), Galán Regalado (2014), Galán Regalado and Fernandez Arias (1993), Gebhart (2013), Geniez *et al.* (2004), Ghaffari and Parsa (2007), Godinho *et al.* (2005), Gray (1838), Hahne (1994), Hahne and Fenske (1992, 1994), Hediger (1935), Hraoui-Bloquet (2002), Ilgaz and Kumluta<sup>o</sup> (2008), In den Bosch (1998, 1999, 2002), In den Bosch *et al.* (2003), Kober (2004, 2013), Kwet (2010) and Trapp (2014), Langerwerf (1981), Lantermann (2005), Lantermann and Lantermann (2013), Lataste (1880), Laurent (1935), Leviton *et al.* (1982), Malkmus (1981, 1982, 1990, 1995, 2003, 2013), Mateo and Castroviejo (1991), Mateo *et al.* (1996, 1999, 2004), Mayer and Bischoff (1996), Mediani *et al.* (2015), Meinig and Schlüpman (1987), Melani (2006), Mertens (1952), Mertens and Wermuth (1965), Michels and Bauer (2004), Modryi *et al.* (2013), Montori *et al.* (2005), Mulder (1998), Müller and Wettstein (1932, 1933), Nathan and Werner (1999), Odierna *et al.* (1990), Pfau (1988), Podnar *et al.* (2009), Pottier *et al.* (2008), Pyron *et al.* 2013, Rutschke (1989), Rykena and Bischoff (1997), Rykena *et al.* (1977), Salvador (1998), Schleich *et al.* (1996), Schlüter (2004, 2012), Schmidtler and Bischoff (1999), Seoane (1885), Sindaco and Jeremcenko (2008), Sindaco *et al.* (1995, 2004), Sprünken and Rutschke (1992), Tamar *et al.* (2015), Trapp (2006), Trold (1999), Trutnau (1975), Warnecke *et al.* (2002), Werner (1929, 1931, 1935, 1936), Wettstein (1960), Wirth (2010), Zauner (2002), Zawadzki (2000, 2013) and sources cited therein.

In terms of the descriptions that follow, the spellings of the names should not be changed unless mandatory under the relevant rules of the *International Code of Zoological Nomenclature*.

#### GENUS DUBOISLACERTA GEN. NOV.

**Type species:** *Lacerta princeps* Blanford, 1874.

Currently widely known as *Timon princeps* (Blanford, 1874).

**Diagnosis:** The genera *Duboislacerta gen. nov.* and *Timon* Tschudi, 1836 differ from all other Lacertidae by the following suite of characters: larger adult body sizes (100-210 mm or more from snout to vent); maxillary-jugal suture not stepped, medial loop of clavicle more often interrupted posteriorly, occipital scale more frequently very broad, dorsal body scales not always keeled; no narrow light stripes in dorsal pattern, often well defined blue ocelli on flanks, hemipenial microornamentation of hook-shaped spines, 32 single-armed and 2 double-armed macrochromosomes and two microchromosomes.

The genus *Duboislacerta gen. nov.* is separated from *Timon* by having long recurved spines occurring on the hemipenial lobe

flanks, a state not seen in *Timon*. In *Duboislacerta gen. nov.* the nasal process of premaxilla is slender, versus broad in the genus *Timon*.

Arnold *et al.* (2007) wrote: "*Timon* consists of two distinct units: the *Timon lepidus* group of the western Mediterranean region (*T. lepidus*, *T. pater*, *T. tangitanus*) and *T. princeps* of southwest Asia. It is this second identified group that consists *Duboislacerta gen. nov.*"

**Distribution:** Iran, Iraq, Turkey, Syria.

**Etymology:** Excluding the obvious reference in the name to the genus being within the Lacertidae, the genus is named in honour of Dr Alain Dubois, who in 2014 was working at Muséum National

d'Histoire Naturelle, Department of Systematics and Evolution, in Paris, France.

This is in recognition for his defence of the zoological code (Ride *et al.* 1999) and previous versions of the same document from taxonomic vandalism by others who set to operate outside of the code and use their own coined names in favour of properly proposed scientific names.

Dubois publicly supported the works of Wells and Wellington (1983 and 1985) in the face of unwarranted attacks from others who sought to steal the work of these authors and put their own coined names on the taxa first scientifically described by Wells and Wellington (Dubois *et al.* 1988).

More recently, he defended the code from similar actions by others and highlighted improper actions within the ICZN secretariat by people who had apparently hijacked the organisation to further their own unscientific, code violating activities (Dubois 2005).

In 2014, Dubois came out in support of myself against the reckless and unwarranted attacks by the Wüster gang, as stated via the documents Kaiser (2012a, 2012b, 2013, 2014a, 2014b) and Kaiser *et al.* (2013), (Dubois 2014).

I have no hesitation in having etymologies for species in honour of people who have made significant and lasting contributions to science and in this case the actions of Alain Dubois are clearly worthy of such recognition.

I also make no apologies for naming more than one species or genus in honour of such a person and in recognition of the work of such worthy people.

**Content:** *Duboislacerta princeps* (Blanford, 1874) (type species); *D. kurdistanica* (Suchow, 1936).

#### GENUS GREERLACERTA GEN. NOV.

**Type species:** *Lacerta kulzeri* Müller and Wettstein, 1932.

**Diagnosis:** Treated here as a monotypic genus, there are quite likely three full species within the *Greerlacerta kulzeri* complex based on the findings of Tamar *et al.* 2015.

*Greerlacerta gen. nov.* and *Phoenicolacerta* Arnold *et al.*, 2007 are separated from all other Lacertidae by the following suite of characters:

Pterygoid teeth sometimes present, sternal fontanelle occasionally weakly heart-shaped, occipital scale often broad; five upper labial scales in front of subocular, apical sections of hemipenial lobes longer than basal ones, their sulcal lips large. Other more widely distributed features include: head and body not or moderately depressed, seven to eleven premaxillary teeth in adults, usual number of presacral vertebrae 26 in males, inscriptional ribs frequently absent, tail not brightly coloured in hatchlings; hemipenial microornamentation of crownshaped tubercles.

They are small to medium-sized Lacertini up to about 90 mm from snout to vent; adult males larger than females. Head and body not or moderately depressed and head very large in some male *Phoenicolacerta laevis*.

There are seven to eleven premaxillary teeth; pterygoid teeth sometimes present; nasal process of premaxilla slender;

postfrontal and postorbital bones separate and postorbital often relatively short; maxillary-jugal suture not stepped. Supraocular osteoderms often complete in adults, occasionally fenestrated.

The post-cranial skeleton is characterised as follows: Usual number of presacral vertebrae 26 in males and 27 in females (ranges 25-26 and 26-28 respectively); usually six posterior presacral vertebrae with short ribs; medial loop of clavicle often continuous but sometimes interrupted posteriorly; lateral arms of interclavicle more or less perpendicular to sagittal axis; sternal fontanelle oval or sometimes weakly heart-shaped; inscriptional ribs frequently absent; pattern of caudal vertebrae A- or B-type.

Scaling is as follows: Rostral separated from frontonasal scale; row of supraciliary granules often complete but not always so; outer edge of parietal scale reaching lateral border of parietal table posteriorly, and sometimes also anteriorly in *Greerlacerta gen. nov.*; two postnasal scales; no contact between supranasal and anterior loreal above nostril; five upper labial scales in front of subocular; first upper temporal scale large; masseteric scale often but not always present (absent in some *Greerlacerta gen. nov.*). Dorsal body scales small but clearly keeled, especially in males. Collar more or less smooth, six or eight longitudinal rows of ventral scales; preanal scale relatively large, bordered by one semicircle of smaller subequal scales; scales under toes smooth or tubercular; whorls of scales on tail often more or less subequal.

In colour the flanks are often dark, sometimes with pale spots, and the back plain or dark-speckled with these markings sometimes confined to a broad vertebral band. Dorsal ground colour often brown. No blue ocelli in the shoulder region. Underside white, green, greenish-blue or red; throat colour sometimes differentiated; dark spotting frequent ventrally; blue spots often present on outer row of ventral scales; tail not brightly coloured in hatchlings.

Distinctive internal features are the insertion of retractor lateralis anterior muscle in front of vent lateral, away from mid-line.

Hemipenis is characterised as follows: Lobes with plicae, apical section of each longer than basal one (less so than in *Podarcis* Wagler, 1830), their sulcal lips large; no armature or folding of lobes in retracted hemipenis; microornamentation consisting of crown-shaped tubercles.

There is a diploid number (2n) of chromosomes = 38; 36 single-armed macrochromosomes and 2 microchromosomes; sex chromosomes ZW-type; nucleolar organizer in a medium-small macrochromosome (MS-type).

When mating the males have been observed to bite the flank of females during copulation; clutches consisting of about 2-6 eggs.

These lizards are often climbing on rocks, walls, and sometimes trees, including human habitation and ruins when available and including montane areas.

*Greerlacerta gen. nov.* is separated from *Phoenicolacerta* Arnold *et al.*, 2007 by the following characters: females are larger than the males (reversed in *Phoenicolacerta*; Arnold *et al.*, 2007),

The mean values of the masseteric / parietal index is small in *Greerlacerta gen. nov.* being 15-27, versus 31-40 in *Phoenicolacerta*.

Young specimens of *Greerlacerta gen. nov.* display bluish or greenish (turquoise) tails, never present in *Phoenicolacerta*.

Adult *Phoenicolacerta* always display blue points on the outer ventrals. Throat and belly are mostly blue, green, yellow or red, especially in adult males (less pronounced in females, missing in juveniles), invariably in all in that genus. However in *Greerlacerta gen. nov.* none of these colours occur at these areas.

**Distribution:** Higher regions of the Lebanon Mountains including the Antilebanon, at Mount Hermon, at Djabal Druz in Syria, and near Petra in Jordan, and areas occupied by Israel.

**Etymology:** Named in honour of Dr. Allen E. Greer in recognition of his work on Lizards from various parts of the world and also more significantly for his spirited defence of the *International Code of Zoological Nomenclature* in the 1980's when he caught the wrath of a group now known as the Wüster gang after making a submission published in the *Bulletin of Zoological Nomenclature* (Greer 1988) against the illegal attempt by Richard Shine and others to suppress the works of Wells and Wellington (1984, 1985).

The ICZN in 1991 and again in 2001, accepted the submission of Greer and others and ruled in favour of the works of Wells and Wellington (1984, 1985) in two separate judgements in order to defend the rules of zoology from unscientific attacks.

In the 30 years since 1985, most times other herpetologists have revisited the taxa classified by Wells and Wellington they have upheld the validity of the taxonomic judgements the men made at the time and the nomenclature has followed from this, with these two men properly being cited as the "name authority" for the relevant taxa.

**Content:** *Greerlacerta kulzeri* Müller and Wettstein, 1932 (treated herein as monotypic, but most likely consisting at least three full species).

#### TRIBE ATLANTOLACERTINI TRIBE NOV.

(Terminal taxon: *Lacerta andreanskyi* Werner, 1929)

**Diagnosis:** The tribe is monotypic for the genus *Atlantolacerta* Arnold *et al.* and therefore the current diagnosis for the tribe is as for the genus.

Atlantolacertini *tribe nov.* species are separated from all other Lacertinae by the following suite of characters: Lacks a derived condition of the ulnar nerve, an armature and folded lobes in the hemipenis and from all genus groups except *Omanosaura* Lutz, Bischoff and Mayer, 1986 in possessing

a clavicle loop that is sometimes interrupted behind, and A and B-type caudal vertebrae. Other features

that in combination distinguish it from other genera of tribes Eremiadini and of Lacertini (the only others in the Lacertinae) include the following: small body size, often high numbers of presacral vertebrae (26-28 in males, 29 in females), sternal fontanelle sometimes weakly heart-shaped, edge of parietal scale reaching lateral border of parietal table both posteriorly and anteriorly, one postnasal scale, supranasal scale contacting anterior loreal above nostril; narrow light supraciliary stripes often present; no blue spots on outer ventral scales; outer sulcal lips on lobes of hemipenis large.

Other more widely distributed features found in all of Atlantolacertini *tribe nov.*, Eremiadini and Lacertini include: head and body not strongly depressed and supraocular osteoderms complete in adults, seven premaxillary teeth in adults, inscriptional ribs often present, tail brightly coloured in hatchlings, hemipenial microornamentation of hookshaped spines.

Atlantolacertini *tribe nov.* are smallish lizards being up to about 55 mm from snout to vent; adult females often larger than males; head and body not strongly depressed.

The skull of Atlantolacertini *tribe nov.* is described as follows: Seven premaxillary teeth in adults; pterygoid teeth absent; nasal process of premaxilla slender; postfrontal and postorbital bones separate, subequal in length; maxillary-jugal suture not stepped. Supraocular lamellae complete in adults.

The postcranial skeleton of Atlantolacertini *tribe nov.* is described as follows: Number of presacral vertebrae 26, 27 or 28 in males and 29 in females; six or seven posterior presacral vertebrae with short ribs; medial loop of the clavicle continuous or interrupted posteriorly; lateral arms of interclavicle more or less perpendicular to the sagittal axis; sternal fontanelle oval or weakly heart-shaped; inscriptional ribs often present; pattern of tail vertebrae A- and B-type.

The scaling of Atlantolacertini *tribe nov.* is described as follows:

Rostral separated from frontonasal scale; row of supraciliary granules complete; outer edge of parietal scale reaching lateral border of parietal table both posteriorly and anteriorly. One postnasal scale; supranasal scale in contact with anterior loreal above nostril; four upper labial scales in front of subocular; first upper temporal large, masseteric scale usually well developed. Dorsal scales small and smooth, about 36 to 42 in a transverse row at mid-body. Collar fairly smooth; six longitudinal rows of ventral scales; preanal scale broad and of moderate size, bordered by a semicircle of smaller scales; scales under toes smooth or tubercular; whorls of scales on tail subequal in length.

The colouring of *Atlantolacertini* *tribe nov.* is described as follows: Often with a clear pattern of longitudinal stripes, including a dark vertebral stripe and flanks and narrow light dorsolateral stripes, although pattern may be reduced to spots in some adult males which may be faintly reticulated. Background colour brown or greyish. No blue ocelli in shoulder region. Underside whitish sometimes with a greenish tinge, the throat not differentiated, some dark spotting often present; no blue spots on outer ventral scales. Juveniles have greenish-blue tails. The distinctive internal features of *Atlantolacertini* *tribe nov.* are described as follows: Partial thoracic fascia present; insertion of retractor lateralis anterior muscle in front of vent lateral, away from mid-line.

The hemipenis of *Atlantolacertini* *tribe nov.* is described as follows: Lobes with plicae, apical section of each not longer than basal one, their sulcal lips large; no armature, or folding of lobes in retracted hemipenis; microornamentation consisting of recurved spines.

The chromosomes of *Atlantolacertini* *tribe nov.* is described as follows: Diploid number (2n) = 38; 36 single-armed macrochromosomes and 2 microchromosomes; sex chromosomes ZW-type; position of nucleolar organizer unknown.

Ecology of *Atlantolacertini* *tribe nov.* is described as follows: They are mainly ground-dwelling in a variety of mountain situations: screes and areas with boulders, meadows, among low clump-forming shrubs, and in places without plant cover; frequently found in the vicinity of small watercourses.

Arnold *et al.* (2007) stated: The relatively large and apparently disjunct range of *Atlantolacerta* with populations occurring on isolated 'mountain islands' suggests it may not be a single species. The correct spelling of the name of the one species of *Atlantolacerta* recognised to date is *andreanskyi*, as used in the type description (Werner 1929), rather than *andreanszkyi* (with a "z"). This latter spelling is closer to the real name of the Hungarian botanist, Baron Gábor Andreánzsky (1895-1967), to whom the species was dedicated, and was used subsequently by the describer (Werner 1931), but it does not have priority. Also, it is clear that *andreanskyi* is not a *lapsus calami*, as Werner uses this spelling more than once in his original paper and misspells Andreánzsky's name in a similar way.

The species *Atlantolacerta andreanskyi* (Werner, 1929), as defined by herpetologists at the present time (e.g. Arnold *et al.* 2007) in fact consists of at least six full species (Barata *et al.* 2015).

**Distribution:** Higher parts of the western and central part of the High Atlas Mountains in Morocco, Africa.

**Content:** *Atlantolacerta* Arnold *et al.*, 2007 (monotypic).

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**CONFLICT OF INTEREST**

The author has no known conflicts of interest in terms of this paper and conclusions within.

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Request PDF | Two new genera of Lacertid lizards (Reptilia: Squamata: Sauria: Lacertidae) from the Middle-east | In spite of the excellent reclassification of the Lacertidae by Arnold et al. (2007), now widely accepted by most herpetologists, two genera as (2007), now widely accepted by most herpetologists, two genera as widely recognized consist of taxa sufficiently divergent to warrant being placed in their own genera. Molecular studies indicate that the most divergent species within the genera *Phoenicolacerta* Arnold et al. Keywords: Taxonomy; snakes; nomenclature; lizards; Lacertidae; Atlantolacerta; *Phoenicolacerta*; *Timon*; *andreanskyi*; genus; genera; new genera; *Duboislacerta*; *Greerlacerta*; new tribe; Atlantolacertiini. Fu J. Phylogeny of Lacertid Lizards (Squamata: Lacertidae) and the Evolution of Unisexuality. Unpubl. PhD. diss., Univ. of Toronto. Roitberg E. S. Morphological analysis of the Caucasian rock lizards *Lacerta caucasica caucasica* and *L. c. daghestanica* from the contact zone. *Russian Journal of Herpetology*, 1994, vol. 1, no. 2, pp. 179–184. Darevsky I. S., Roitberg E. S. A new subspecies of the rock lizard *Lacerta caucasica* (Sauria, Lacertidae) from the south-east of Chechen Republic of the Caucasus. *Russian Journal of Herpetology*, 1999, vol. 6, no. 3, pp. 209–214. Two such putative transitions were reported in the lacertid lizards based on published data in *Podarcis pityusensis* and *Eremias multiocellata*. In addition, we designed new primers for one autosomal gene with an ortholog in GGAZ (*smad7*), and four candidate Z-linked genes with orthologs linked to GGA4p (*gab3*, *mbnl3*) and GGA17 (*hspa5*, *lrrc8a*). The gene *mecom* was used as a reference gene for the normalization of the qPCR values. Odierna, G., Kupriyanova, L. A., Capriglione, T. & Olmo, E. Further data on sex chromosomes of Lacertidae and a hypothesis on their evolutionary trend. *Amph.-Rept.* Rojo Or3ns, V. Cytogenetic and molecular characterization of lacertid lizard species from the Iberian Peninsula. Doctoral Thesis, Universidade da Coru±a (2015). 20. *Eremias kakari*. Masroor, Khisroon, Khan & Jablonski, 2020. DOI: 10.11646/zootaxa.4786.1.8. Facebook.com/RafaqatMasroor. Abstract. A new , morphologically distinctive lacertid lizard of the genus *Eremias* ( *Rhabderemias* ) is described from the arid mountains of northwestern Balochistan Province in Pakistan. *Eremias kakari* sp. nov. has an isolated distribution and can be easily distinguished from all other species of mainly desert subgenus *Rhabderemias* ( *E. andersoni*, *E. cholistanica*, *E. fasciata*, *E. lineolata*, *E. pleskei*, *E. scripta*, *E. vermiculata* ). The Lacertidae probably arose in the European area, with the Gallotiinae later reaching Northwest Af. Systematics of the *Mesalina guttulata* species complex (Squamata: Lacertidae) from Arabia with the description of two new species. Relationships of lacertid lizards (Reptilia: Lacertidae) estimated from mitochondrial DNA sequences and morphology. D. Harris, E. N. Arnold, R. H. Thomas. *Biology, Medicine.* A phylogeny of the European lizard genus *Algyroides* (Reptilia: Lacertidae) based on DNA sequences, with comments on the evolution of the group. D. Harris, E. N. Arnold, RICHARD H. Thomas. *Biology.*