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THE BRITISH HERPETOLOGICAL SOCIETY

BULLETIN

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BRITISH HERPETOLOGICAL SOCIETY

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Correspondence, membership applications, subscription renewals and purchase orders for the British Journal of Herpetology should be sent to the above address.

The British Herpetological Society was founded in 1947 with the broad aim of catering for all aspects of interest in reptiles and amphibians. Initiated by a small number of enthusiastic and well-known naturalists, including the first President and author of the standard textbook on British herpetofauna Dr. Malcolm Smith, the Society expanded rapidly and today enjoys national status with many international connections.

Activities of members range over a number of interrelated fields. In many cases the prime interest is in maintaining, breeding and observing various species in captivity and the Society acts as a forum for the interchange of experiences in this area. Others are concerned with the observation of animals in the wild state. There are active sub-committees which help to cater for these various tastes, notably the Captive Breeding Committee and the Conservation Committee. The former encourages the development of effective breeding techniques for captive specimens, thus providing animals for observation and study in vivaria, and for conservation purposes, while simultaneously reducing the need to take fresh stock from wild and possibly declining populations. The Conservation Committee is actively engaged in field study, conservation management and political lobbying with a view to improving the status and future prospects for our native British species. It is the accepted authority on reptile and amphibian conservation in the U.K. and has an advisory role to the Nature Conservancy Council (the statutory Government body). There are also professional scientists within the ranks of the Society engaged in increasing our understanding of all aspects of reptile and amphibian biology.

Meetings

About ten meetings covering a broad sphere of interests are held each year.

Subscriptions

Ordinary Members £15. Junior Members £5. (Junior Members do not receive the British Journal of Herpetology). Institution rates £25 (U.S. $40).
All subscriptions become due on the first day of January each year.

The Bulletin is edited and produced by
John Pickett and Simon Townson

Contributions and correspondence arising from the Bulletin should be sent to:
John Pickett, 84 Pyrles Lane, Loughton, Essex IG10 2NW

FRONT COVER
Male juvenile Rhinoceros Viper, *Bitis nasicornis* showing body markings. Note undeveloped nasal horns.
See *Captive Breeding of the Rhinoceros-Horned Viper*, Bitis nasicornis, by John Akester, p.31.

REMAINING LONDON MEETINGS

IMPORTANT NOTICE: CHANGES IN MEETING VENUES

The meetings of August 30th and September 2nd will be held in the Lecture Theatre of the Zoo Studies Centre, Zoological Society of London, Prince Albert Road (opposite Ormonde Terrace), London, N.W.1.

The August 30th meeting will be from 7.00 – 9.00 pm. The September 2nd meeting is a special Saturday afternoon meeting from 2.00 – 5.30 pm.

The meetings of October 10th and November 29th will be held at the old venue, The Lecture Theatre of the Linnean Society of London, Burlington House, Piccadilly, London W.1., at 7.00 pm.

30 AUGUST	Dr. William Branch (Port Elizabeth Museum, South Africa): *Herpetofauna of Southern Africa.* Venue: Zoo Study Centre (see above).
2 SEPTEMBER	*Care and Breeding of amphibians and reptiles: an open meeting.* Contributions from members – live animals and photographic display. There will be facilities for the sale and exchange of members' private home-bred stock. A special Saturday afternoon meeting from 2.00 – 5.30 pm. Venue: Zoo Study Centre (see above).
10 OCTOBER	Dr. David Corke (Department of Biology and Biochemistry, North East London Polytechnic): *Lizards in paradise – Conservation on St. Lucia (Windward I., Lesser Antilles), West Indies.* Venue: Linnean Society (see above).
29 NOVEMBER	Dr. Clive Cummins (Monks Wood Experimental Station, Abbots Ripton): *Effects of acid rain on amphibians.* Venue: Linnean Society (see above).

JOURNAL EDITOR'S REPORT, 1988

GENERAL MATTERS

Publication ran smoothly enough during 1988, with the usual two editions appearing on time. Book reviews reappeared as promised. Altogether 18 full papers, 7 short notes and 1 mini-review were published in numbers 6 and 7, compared with 14 full papers, 3 short notes and 1 mini-review (+ 2 Forum articles) in 1987; a moderate expansion has thus occurred, with a view to reducing the waiting time for authors between acceptance and publication.

COSTS

Increased publication costs in 1988 reflected the increase in Journal size; the total bill for both editions was £4,200. Happily, Institutional membership rose again to about 150, contributing some £3,400, and reprints + advertising (included in the above expenditure) yielded a further £430 (approx.) Net cost to the Society (excluding postage) was therefore about £370.

PAPERS SUBMITTED

31 papers were submitted to the Journal during 1988, of which 21 (68%) were eventually accepted. It was notable that UK submissions rose to 14 (compared with 10 in 1987, and an average of just under 10 since 1985).

Once again it is a pleasure to thank those who were kind enough to referee papers during the year; these were:

Dr R. Avery, Mr B. Banks, Dr D. Broadley, Prof. J. Cloudsley-Thompson, Dr R. Griffiths, Dr A. Hailey, Prof. G. Haslewood, Dr M. Lambert, Dr C. McCarthy, Dr I. Spellerberg, Dr H. Strijbosch, Dr I. Swingland, Dr P. Verrell and Prof. Y. Werner.

Trevor Beebee, April 1989

DGHT 25th ANNUAL MEETING, 27 SEPTEMBER TO 1 OCTOBER 1989, FRANKFURT

The German herpetological society – DGHT (Deutsche Gesellschaft für Herpetologie und Terrarienkunde) is holding its 25th Annual Meeting at the Senckenberg Museum, Senckenberganlage 25, D-6 Frankfurt/Main, F.R. of Germany, from 27th September to 1st October 1989. The Congress Language is German. Paper and poster titles should be sent by 31st May to Herr. Ingo Pauler, Im Sandgarten 4, D-6706 Wachenheim, F.R. of Germany.

An invitation is extended to members of the British Herpetological Society and other herpetologists in the UK who would be very welcome.

4th (SPANISH) NATIONAL CONGRESS OF HERPETOLOGY, 6th TO 8th DECEMBER 1989, MADRID

The Spanish herpetological society – AHE (Asociacion Herpetologica Espanola) is holding its 4th meeting at the Consejo Superior de Investigaciones Cientificas (Serrano, 117), Madrid, Spain, from 6th to 8th December 1989. Titles and abstracts of communications should be sent by 31st July 1989 to Luis GARCIA HIDALGO (oral papers) and Pilar HERRERO SOLANS (posters) IV Congreso, Asociacion Herpetologica Espanola, Museo Nacional de Ciencias Naturales, Jose Gutierrez Abascal 2, 28006 Madrid, Spain. Abstract forms and accommodation details are available from AHE (address above), together with registration forms which should be completed and returned.

An invitation is extended to members of the British Herpetological Society and other herpetologists in the UK who would be welcome.

4th EUROPEAN CHELONIAN SYMPOSIUM

After the 1st at Nancy, France (1980), the 2nd at Oxford, England (1981) and the 3rd at Marseille, France (1988), the 4th European Symposium on Chelonians is to be organised by RANA International and will be held at Grosseto, Italy, from 4th to 8th July 1990. For further details please contact Mr. Donato Ballasina, Centro Tartarughe Carapax, C.P. 34, I-58024 Massa Marittima (Grosseto), Italy; tel. (566) 91.54.53.

THE EDWARD ELKAN REFERENCE COLLECTION OF LOWER VERTEBRATE PATHOLOGY

Dr. Edward Elkan, who was recognised internationally for his work on the pathology and diseases of reptiles and amphibians, died in July 1983, at the age of 88.

Following Dr. Elkan's death a Memorial Fund was established in order to perpetuate his name and work and to preserve and maintain his unique collection of pathological specimens and other material. The latter is housed at the Royal College of Surgeons of England, London and is available for study by herpetologists, pathologists and research workers. Enquiries (preferably) in writing should be addressed to J.E. Cooper FRCVS at the address below.

The first "Edward Elkan Memorial Lecture" was given at the International Colloquium on the Pathology of Reptiles and Amphibians held in Nottingham (England) in 1984. A second lecture is planned for 1989.

Contributions to the Fund continue to be welcomed. Cheques should be made payable to "The Edward Elkan Memorial Fund" and forwarded to the address below.

J.E. Cooper, Royal College of Surgeons of England, 35-43 Lincoln's Inn Fields, London WC2A 3PN.

February 1987

THE SECOND EDWARD ELKAN MEMORIAL LECTURE

The Second Edward Elkan Memorial Lecture will beheld at the University of Kent at Canterbury, England, on the evening of Thursday 14th September, 1989. The speaker will be Dr. F.L. Frye, M.S., D.V.M., from Davis, California, USA. Dr. Frye is a veterinary clinician and pathologist, author of numerous books and scientific papers and leading authority on the diseases of reptiles, amphibians and other exotic species.

This lecture is the second of a series marking the life and work of Dr. Edward Elkan, the internationally renowned herpetologist, who died in 1983.

All interested persons are welcome to attend. Further details will be circulated in due course.

The lecture is being arranged to coincide with the First World Congress of Herpetology being held at the University of Kent from 11th-19th September. Information about the Congress may be obtained from the Secretariat, Ecology Research Group, Rutherford College, University of Kent, Canterbury, Kent CR2 7NY, United Kingdom.

J.E. Cooper

News item sent by the British Consul General, Shanghai, China

CHINA'S FIRST SNAKE MUSEUM TO OPEN IN AUGUST

Dalian, May 8 1989 (Xinhau) – China is establishing its first snake museum in Lushun, Liaoning province, just as swarms of snakes are slithering out of hibernation in this "snake year" in the Chinese lunar claendar.

The 1,400-square-metre museum will open in August and will feature mainly Pallas Pit Vipers from Snake Island, 25 nautical miles south of the east Liaoning peninsula.

Li Jianli, deputy head of the museum, said the number of snakes on the island was once estimated at between 50,000 and 100,000. Investigations of recent years, however, showed that there are now about 13,000, a density rarely seen in the world.

He said the snakes are multiplying by 7% a year. The island, and Mount Laotie, on the east Liaoning peninsula, have recently been declared a nature-protection zone and special measures have been taken to protect the snakes there.

Experts are still divided on the origin of the snakes on snake island. They cannot yet say why Pallas Pit Vipers do not propagate on two islands nearby that have similar geographic characteristics.

Thanks to Snake Island, Lushun city has become a base for a snake research institute, a snake zoo and a snake pharmaceutical factory, as well as a specialized hospital.

Research has shown that the ovo-viviparous snakes – that is, snakes that produce eggs that are hatched within the body of the parent – have a low reproduction rate. They have only one litter every two or three years, and only three to five snakes of a litter survive. They have a life-span of about 10 years.

MONITOR LIZARDS

DANIEL BENNETT

18 Sheffield Road, Glossop, Derbyshire SK13 8QU

Abstract of a talk given to the BHS on April 25th 1989 entitled "Goannas, monitors and other varanid lizards of the world"

The monitors are a family of carnivorous lizards that inhabit a very wide range of habitats in Africa, Asia and Australasia. Although they are all basically similar in appearance, having powerful limbs and tail and a forked tongue, they vary in specialisation (particularly of the tail and teeth), behaviour, habitat, and most noticeably, in size; the smallest species barely exceed 8 inches (20 cm), whilst the largest grows to over 15 feet (4.5 m).

The earliest monitors known from fossils were found in what is now Wyoming in North America.

Belonging to the genus *Paleosaniwa*, these lizards grew to 8 or 9 feet long (2.4 - 2.7m) and lived more than 65 million years ago. 15 million years later another genus had developed *(Saniwa)*, and spread into the southern U.S.A. and northern Europe (France and Belgium). At this point the american monitors seem to have died out, whilst the European species flourished and became more widespread; by 15 million years ago they lived in southern Europe (Spain and Portugal) and as far east as Khazakstan in the U.S.S.R. The last evidence of European monitors dates from only 5 million years ago, about the same time as the first *Varanus* monitor appeared, in India. The monitors did not reach Australia until 2 million years ago, where they flourished because of the absence of large mammalian competitors. The early Australian monitors included the largest lizard that ever lived *Megalania prisca*, from Queensland, New South Wales and South Australia. This giant monitor reached a total length of 23 feet (7m) and a weight of over 1320 lbs (600 kg). Today, all the genera mentioned above have died out, with one exception: *Varanus*. Three species are found in Africa (only one African fossil monitor has been found which is, as yet, unidentified): *V. exanthematicus*, which is known in two very different forms: *V.e. exanthematicus* from the west of the continent, and *V.e. albigularis/microstictus* from the south, which grow to twice the size of the nominate race, and are easily identified by the banded tail. The largest African monitor is *V. niloticus*, which is found in watery habitats throughout the continent, except for the far north. Early in the 20th century, specimens in excess of 8 feet were known, but now even those of 6 feet (1.9m) are said to be rare.

The other African monitor, *V. griseus*, is restricted to desert areas of the north, but its range extends over desert habitats across Asia, as far east as India, and as far north as the Caspian and Aral Seas in the U.S.S.R. Depending on their location they grow from 2.5 - 4 feet (0.7-1.2m) long.

The Asian species include the Roughnecked Monitor *V. rudicollis*, a shy tree dwelling species, from Thailand, Burma and Malaysia; the Water Monitor *V. salvator* (commonly imported for the pet trade despite its adult length of between 8 and 9 feet (2.4-2.7m); the rare Yellow Monitor *V. flavescens* and *V. dumerilli*, an arboreal species found near water in Thailand, Borneo, Sumatra and Malaya. This monitor is often confused with *V. rudicollis* although they do not appear very similar at all. The Bengal Monitor *V. bengalensis* is found from Iran through Pakistan and India into Malaysia. Two subspecies are recognised; *V.b. bengalensis* from the north and *V.b. nebulosus* from the south. This species is both an expert climber and burrower. Despite their large size (over 4 feet or 1.2m) most of their food consists of small invertebrates such as scorpions and beetles. The famous Komodo Dragon, *V. komodoensis*, is restricted to just 700 square miles (1813 m^2) on the islands of Flores, Pintjar, Padar and Komodo, and is by far the largest of the living monitors, reaching over 9 feet (2.7m) in length, with a weight of as much as 550 lbs (250 kg). This monitor is quite capable of overpowering, dismembering and eating an adult human, although such cases are rare, and long term captives sometimes become extremely tame. In 1981 it was estimated that there were less than 8000 of these magnificent animals left alive. Despite extensive efforts, only one zoo has succeeded in getting them to breed in captivity (the Surabaya Zoo, Indonesia).

The longest monitor in the world is *V. salvadorii*, a very poorly known species from New Guinea. Although lengths of up to 15 feet 7 inches (14.75m) have been recorded, this seems to be an arboreal species which lacks the bulk of *V. komodoensis*. Other monitors from New Guinea include *V. indicus*, a beautifully marked aquatic species, the closely related *V. karleschmidti* and the tree monitor *V. prasinus*, which has a prehensile tail that can be used as a fifth limb. On the mainland *V. prasinus* is a brilliant green colour, but on islands to the southeast and southwest they are black.

Australia houses the largest number of monitor species: they range from the 8 feet (2.4m) long *V. giganteus* to the tiny *V. brevicauda* that reaches a mere 8 inches (20 cm). This species, along with some other dwarf monitors, has a spiny tail, which is used to seal the entrance of burrows, or wedge the lizards into narrow rock crevices, making them very difficult for a predator to dislodge. Other Australian species include the Sand Monitor *V. gouldii*, its close relations *V. panoptes* and *V. rosenbergi*, the Lace Monitor *V. varius*, *V. mertensi* a highly specialised aquatic monitor with an extremely compressed tail and nostrils situated on the top of the snout, and the Rock Monitors *V. glauerti*, *V. glebopalms* and *V. pilbarensis*, which have very long delicate tails, usually over twice the length of the head and body.

In view of the variety of the monitor lizards, and the great size attained by many species, it is surprising that very few have been studied in any depth. Several members of the genus are considered to be in danger of extinction, and some of the Asian and African species are in great demand for their skins, which find a large market in Japan, Europe and America. In comparison with the skin trade, the trade in live monitors is tiny. For example, in 1984, 21,792 *V. salvator* skins and 26,908 "products" (handbags, shoes, wallets et) were imported into West Germany, while only 174 live specimens were imported at the same time. Inevitably collection on such a vast scale, together with other detrimental factors such as habitat destruction, will have a disastrous effect on monitor populations.

Monitors do not do well in captivity. Four species have been legally imported into the U.K. since 1981; *V. exanthematicus, V. dumerilli, V. niloticus* and *V. salvator.* As far as I know no monitor has ever reproduced successfully here. *V. niloticus* has never been bred anywhere, *V. dumerilli* was bred for the first time last year at the Buffalo Zoo, New York. *V. exanthematicus* and *V. salvator* have reproduced several times in Europe and the U.S.A., but these are generally "one-offs" and are rarely repeated. The major problem associated with keeping monitors in captivity is their size. Of the four species listed above, two *(v. salvator* and *V. niloticus)* grow to well over 6 feet (1.8m) long, *V. exanthematicus* to 3 or 6 feet (0.9 or 1.8m) long depending on subspecies, and *V. dumerilli* to over 4 feet (1.2m). Keeping lizards of this size in humane conditions is out of the reach of all but the most dedicated or wealthiest herpetologists. Monitors are tough animals, and will withstand the most cramped and unsuitable conditions, often for many years, before succumbing. They will never reproduce if not cared for properly, and tend to become obese and lethargic even after short periods in poor conditions. If properly maintained however, monitor lizards are very rewarding animals, but their size, strength and the lack of information that is generally available relating to their husbandry makes the task a difficult one, and sadly, one that is rarely accomplished.

I would like to express my appreciation for being given the opportunity to talk to the BHS and my thanks to everyone for listening, and for your hospitality afterwards. This note, and my talk would have been impossible without the help of many people too numerous to list, but special thanks must go to John Hackworth of Tyne and Wear for his help with translation, and patience.

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HERPETOFAUNA OF THE COMMONWEALTH OF DOMINICA (WINDWARD I., LESSER ANTILLES), WEST INDIES

PETER EVANS

Department of Zoology, University of Oxford

Abstract of a talk given to the BHS on February 28th 1989

Not to be confused with the Dominican Republic, which shares Hispaniola with Haiti, the Commonwealth of Dominica (or just Dominica) is one of the eastern Caribbean Windward Islands (Lesser Antilles) situated between the French overseas departments of Guadeloupe and Martinique. Like many others in the area, the island was discovered by Christopher Columbus in 1493, on a Sunday (= dominica). Administration of the island passed back and forth between the British and the French from 1759 until 1805. Thenceforth a British possession, Dominica became an independent member of the Commonwealth in 1978. The island is 47 km long (north-south) and 22 km wide (land area: 785 km^2), and is very mountainous (Morne Diablotin, 1447 m) and volcanic (the Boiling Lake is a geyser). The rainfall, ranging from 1778 mm

annually on the coast to 6350 mm (range 4000-10,000 mm) in the mountains, supports luxuriant tropical vegetation. Remarkably, between 60 and 75% of the island is still covered by forest, much on steep slopes and rising to nearly 1422 m, although logging has increased over the last 10-15 years (Evans, 1986). Hurricane David in 1979 caused considerable damage, particularly in the southern third of the island.

Most of the 80,000 inhabitants are concentrated along the coast, and particularly in a few small towns (notably the capital Roseau). The cost of road construction and the rugged terrain has limited most agriculture to the coastal regions leaving the forests of the mountainous interior intact. In relation to the conservation of this important resource, while encouraging the development of the country's economy, an assessment of the impact of different forms of land use on the fauna and flora was carried out. At the same time, a study was carried out on how best to improve the economy by developing particular forms of agriculture, forestry, industry and tourism without conflicting with conservation interests in line with the concept of "sustainable development".

Twenty species and subspecies of reptiles have been recorded on Dominica. The drier coastal regions are by far the most important for reptiles, although some species (e.g. *Anolis oculatus)* occur at moderate densities in elfin woodland and montane rain forest, and one snake, *Liophis j. juliae,* is commonest in areas with rain forest. Two amphibian species have been recorded on the island, a small tree frog, *Eleutherodactylus martinicensis,* and the much larger so called "mountain chicken" (also a frog), *Leptodactylus fallax,* sometimes also known as "crapaud". The former is concentrated in areas of higher rainfall, particularly rain forest, whereas the latter occurs mainly at lower altitudes in drier regions, particularly dry woodland. Mountain chickens are hunted extensively for food; they taste rather like chicken, hence their name. In its natural range, the species appears now to be confined to Dominica and Monserrat after some combination of over-harvesting, mongoose predation and habitat modification has within historic times eliminated it on neighbouring Guadeloupe, St. Kitts and St. Lucia. The large iguana, *Iguana delicatissima,* occurs in very small numbers along the leeward Caribbean coast, where it is also hunted for food. It is probable that the lizards, *Anolis o. oculatus, Ameiva fuscata* and *Mabuya m. mabouya* play an important role in nutrient cycling within the leaf litter of coastal xeric vegetation (dry scrub and littoral woodland) since decomposition otherwise would be relatively slow. Combined densities reach about 1,700 individuals per hectare, amounting to a total biomass of 21 kg per hectare. Modification of these habitats is most likely to affect the latter two species since their distribution is concentrated there, although certain tree crops (e.g. coconuts) may also afford suitable conditions for all three lizards, and are important habitats for the Boa Constritor, *Boa constrictor nebulosa.*

A list of the amphibians and reptiles known to occur on Dominica (after Bullock and Evans, in press; Schwartz and Henderson, 1985), with an indication of their range (* – introduced), follows:-

AMPHIBIA

F. Leptodactylidae

1.	*Eleutherodactylus martinicensis*	Lesser Antilles
2.	*Leptodactylus fallax*	Lesser Antilles

REPTILIA

F. Testudinidae

3.	*Geochelone carbonaria*	South America; some Antillean islands

F. Gekkonidae

4.	*Hemidactylus mabouia**	Africa; South America; Antilles
5.	*Sphaerodactylus fantasticus fuga**	Dominica
6.	*S. microlepis**	
7.	*S. vincenti monilifer*	Dominica
8.	*Thecadactylus rapicauda*	South & Central America; Antilles

F. Iguanidae

9.	*Anolis oculatus oculatus*	Dominica
10.	*A. o. cabritensis*	Dominica
11.	*A. o. montanus*	Dominica

12.	*A. o. winstoni*	Dominica
13.	*Iguana delicatissima*	Lesser Antilles
F. Teiidae		
14.	*Ameiva fuscata*	Dominica
15.	*Gymnophthalmus pleci*	Lesser Antilles
F. Scincidae		
16.	*Mabuya mabouya mabouya*	Lesser Antilles
F. Typhlopidae		
17.	*Tyhlops dominicana*	Dominica
F. Boidae		
18.	*Boa constrictor nebulosa*	Dominica
F. Colubridae		
19.	*Alsophis antillensis sibonius*	Dominica
20.	*Clelia clelia clelia*	Dominica, St. Lucia, Central & South America
21	*Liophis juliae juliae*	Dominica

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MEMBERS' ADVERTISEMENTS

The attention of members is drawn to the various Acts of Parliament and EEC regulations governing the import, possession and sale of reptiles and amphibians. Advertisements are acepted on the understanding that animals are legally obtained and offered for sale.

* **Information exchange wanted.** I am a breeder of Boids *(Chondropython viridis, Sanzinia madagascariensis)* in West Germany, and would like to correspond with breeders with similar interests in England. Erwin Alter, Weiterndorf 72, D-8807 Heilsbronn, West Germany. Tel. 0049-9872-2172

* **Information request:** 1. Has any varanid (monitor lizard) been bred in the UK? 2. Is there anyone who can and would be willing to translate Thai into English? Please reply to Daniel Bennett, 118 Sheffield Road, Glossop, Derbyshire SK13 8QU. Tel. (04574) 61069.

* **Wanted:** male *Corallus enydris* for breeding, and 4 pairs of *Naja pallida* for studying, in exchange for a furnished little house in Pisa for your holiday time. Ugo Saluzzi, via U. Viale No. 2, 56100 Pisa, Italy. Tel. 050 46336.

* **Wanted:** pair of Green Toads *(Bufo virids)* or toadlets, spawn. Will buy or exchange for Alpine Newts *(Triturus alpestris).* R. Nutt, 6 Bembridge Drive, Kingsthorpe, Northampton NN2 6LZ.

* **Wanted.** Female Bearded Dragon *(Amphibolurus nullarbor).* Will buy or exchange for male. Graham Ainge. (0202) 721790

A CHECK LIST OF THE HERPETOFAUNA OF THE ARGO-SARONIC GULF DISTRICT, GREECE

RICHARD CLARK

Haugnesveien 6, 8480 Andenes, Norway

ABSTRACT

This survey of the herpetofauna of the Argo-Saronic Gulf is largely based on the author's extensive experience with the region and on data assembled by him since 1962. This is further supplemented by the work of other researchers. In order to gain a broad perspective consideration is given to the contiguous mainland defined as The Inner Argolid. Some extension outside this zone has been allowed in a few instances. Under the species account island localities are fully listed and presented in a Table of Taxa. Both island and mainland locations can be found on the accompanying maps. Some considerable irregularity occurs in distribution patterns amongst the islands and there is an implication that the smaller islands of restricted area and biotope act as natural reserves to some species that otherwise are subjected to competition on larger islands. Here can be named *Algyroides moreoticus, Podarcis peloponnesiaca thais* and *Coluber gemonensis.* Access to many of the small islands was only possible by using one's own transport or by enlisting local aid. Since some of the most interesting finds were made on such islands it follows how rash it is to base one's knowledge of the herpetofauna of an island complex only on islands that are readily accessible. Collections made by the author are deposited in the Senckenberg Museum, Frankfurt-am-Main with a smaller number accessioned at the California Academy of Sciences, San Francisco.

INTRODUCTION

Between 1962 and 1971 I was largely resident in Greece engaged in herpetological research. During this time I used the island of Spetsai as a base. Reports on the reptile life of this region have already been made (Clark 1967 and 1970). The area is also referred to in various other publications dealing with the herpetofauna of Greece (Clark 1963, 1969 and 1972). With some further observations made more recently and the results of earlier visits to the other islands in the region, mostly small and uninhabited, remaining unpublished it seems appropriate to attempt a fuller and more thorough survey and to bring as much information as possible under one publication. Other herpetologists have contributed some useful records but it is evident that this part of Greece has been rather neglected. In checking through the literature there are to be found very few specific references to the Argo-Saronic islands themselves. The most recent work of any relevance is Bringsøe (1985): 'A check list of Peloponnesian amphibians and reptiles'. This report gives some information and is useful in contributing to our knowledge of the fauna of Salamis.

No check list of the Argo-Saronic Gulf can be considered complete without discussion of the related mainland region. In many respects this proved to be the most difficult part of the task not least in deciding the area. After careful deliberation I have set a boundary that encloses the Inner Argolid south of the route from Argos and Nafplion through to Nea Epidavros. Because of the undesirability of being too rigid I have allowed some extension north to take in species recorded from Mycenae up to Korinthos and eastwards to Elefsis and in a limited number of cases I refer to places still further outside the defined area but only when this seems to be pertinent. In the text I have referred to the principle mainland region as "the Inner Argolid". More difficult still was to decide which of the Peloponnesian species should be included in cases where there are no island records. In the end I resolved to include in the Species Account *all* species which have firm locality records from the Inner Argolid so as to make the survey as full as possible. Species totally excluded are those which have not been positively recorded from the Inner Argolid even though it is not impossible, in some instances, that these might subsequently be found. These are the following: *Salamandra salamandra, Rana graeca, Triturus alpestris, Pordarcis muralis albanica* and *Podarcis taurica*

ionica. In the latter case I have some reservations since it is on record from Mycenae and Tiryns (Boulenger 1920). Bringsøe (1985) gives no localities from the Inner Argolid. The reader should bear in mind that the main thrust of this report is the islands. If I have inadvertently through an over-sight excluded mainland locality records I would be grateful for any information that is relevant.

In the bibliography I have assembled a reference list that sets out to be as useful as possible. I have omitted from the main bibliography papers not available to me although these are quoted in the text. These papers are included in Bringsøe's 1985 work and in citing the authors vicariously I have taken care to do so only in instances where Bringsøe gives precise information as to species and finding places. To avoid ambiguity these publications are listed separately.

The islands of the Argo-Saronic consist of the main islands of Salamis, Aegina, Poros, Hydra and Spetsai, all of which are inhabited and readily accessible from Piraeus by steamer and hydrofoil, and a considerable number of smaller islands and islets, some little more than above water rocks, most of which are uninhabited and which can only be reached by recruiting local aid. Geographically we can divide these island complexes into several groups:

1. Salamis with a few attendant islets and including Prasonisi.

2. The Aegina archipelago consisting of Aegina itself, the satellite island of Angistri and Moni both of which are well wooded, and a number of small islets such as Lagouses, Diaporia and Ipsili. Except for Aegina itself very little is known of the reptile fauna of this group. Apart from Angistri with two villages all the other islands are uninhabited.

3. Poros, which in reality consists of two islands separated by a narrow isthmus with a causeway. Poros town and the port, only about 300 metres from the Peloponnese mainland, is built on the smaller island which is crowned with a rocky and steep-to pinnacle. The main island is thickly wooded and hilly with small cultivated areas.

4. The Hydra archipelago comprised of Hydra, the large and uninhabited island of Dhokos close to the mainland port of Ermioni and several lesser islands: Stavronissos, Trikkeri, Petassi, Alexandros, Ventza, Karteli and several tiny islets.

5. The Spetsai group consisting of Spetsai, Spetsopoula which is well-wooded and privately owned, the low-lying islet of Agios Ioannis and the steep-to and rocky islet of Petrokaravo.

6. The coastal islands of the Argolid Peninsula running from the Gulf of Nafplion to Portoheli: Tolon (or Romvi)), Plateia and Psili. These are uninhabited.

7. The isolated and uninhabited island of Agios Georgios which lies midway between the easternmost point of Hydra and Cape Sounion. This island is more Cycladean in aspect being largely barren, treeless and waterless. Its fauna relates to that of Attica.

In the main island identification should present no problems. In some cases the smaller islands do not feature on standard maps or if they do are not always named. I am therefore grateful to Achilles Dimitropoulos of the Goulandris Museum, Kifissia Greece for helping to locate these. The island of Psili in the Gulf of Argolis is sometimes named as Ipsili. There is another island also called Ipsili in the Saronic Gulf near to Aegina. To avoid confusion I have retained the name of Psili for the Argolid Gulf island since this is the one more generally used.

At the time of completing this report the island of Angistri remained uninvestigated. I had the chance to visit Angistri in January 1989 and although little was found due to the season a few observations were made. These are included in a brief appendix.

SPECIES ACCOUNT

SALAMANDRIDAE

Triturus vulgaris graecus (Wolterstorff 1905)

The recent discovery of eggs assumed to belong to this species at a locality 8km. north of Didyma is interesting (Bringøe 1985 quoting Adema & In den Bosch 1980). If we allow this record as valid this newt might well be present in other parts of the Argolid. Its presence on the islands remains very doubtful.

RANIDAE

Rana ridibunda ridibunda Pallas 1771

This frog is widely distributed on the mainland in all suitable habitats. On the islands known from Poros (Clark 1967). It is difficult to be certain as to its presence or absence on the larger islands. This frog is very opportunistic and can survive in open rain water cisterns and wells. It is definitely absent on Spetsai where these conditions are not provided. There is only one permanently damp locality on Spetsai, a spring at Zougeria. I never found frogs there and the seasonal streams that offer spawning facilities to *Bufo viridis* are too temporary to support the aquatic life style of *R. ridibunda.*

BUFONIDAE

Bufo bufo (Linnaeus 1758)

Although this amphibian is considered to be widespread on the mainland I can find no records from the Argolid. Since it is a solitary animal and rather difficult to find it can reasonably safely be predicted to occur there. I can express no opinion on its possible existence on the islands. Mertens & Wermuth (1960), Ondrias (1968) and Malakou, Ravasini & Tsunis (1986) include Greek Common Toads under the subspecies *spinosus* Daudin 1803. Bringsøe (1985) considers the nominate form to be valid.

Bufo viridis viridis Laurenti 1768

Widespread on the mainland. On the islands known from Salamis (Daan 1967) and Spetsai (Clark 1967). To these I can now add Poros from observations of Green Toads in October 1979 made by a colleague. These were found after dark following rain. In all probability present at least on Aegina, Hydra, Dhokos and Spetsopoula since it is a very tenacious species; see Bringsøe (1985) regarding the survival of this toad in the dry conditions prevailing in the Mani. An account of its breeding activity on Spetsai has been presented elsewhere (Clark 1967).

HYLIDAE

Hyla arborea ssp. (Linnaeus 1758)

Not recorded from the islands. On the mainland known from Didyma and I have found it near Adami in streams in the springtime (Clark unpublished).

EMYDIDAE

Emys orbicularis Linnaeus 1758

I have excluded this pond tortoise from my Table of Taxa since there are no records from the immediate area. It is known from Myli (Bringsøe 1985 quoting Skovgaards field notes) and Nemea (Ewald 1980).

Mauremys caspica rivulata (Valenciennes 1833)

There are no island records and the absence of suitable biotopes makes its presence unlikely. On the mainland known from Didyma (In den Bosch & Musters 1981) to which I can add Drepanon from observations made in September 1986 where I found this animal living in a stream by the road.

TESTUDINIDAE

Testudo graeca ibera Pallas 1814

Only recorded from Salamis (Clark 1970, Bringsøe 1985). On the mainland reported from Palea Epidavros (Zimmermann 1982). On the other islands where tortoises occur this species is replaced by *T. marginata.* Earlier identification of this species on Poros and Spetsai (Clark 1963, 1967) proved to be in error (Clark 1970).

Testudo marginata Schoepff 1792

Broadly distributed and on record from Spetsai, Poros, Psili and Tolon (Clark 1967, 1970, 1972) as well as Dhokos and Spetsopoula (Clark unpublished). Bringsøe (1985) further records it from Salamis which means that the Marginated Tortoise and the above species are found on this island. Maybe the Salamis populations need to be re-examined to determine whether in fact both species occur here. So far unknown from Aegina and Hydra. It is particularly common on both Poros and Spetsai in the spring and autumn. On the mainland records exist from the Elefsis and Corinth areas and Didyma (Bringsøe 1985, In den Bosch & Musters 1981). In late August 1986 I found *T. marginata* in the region of Agios Andrea south of

Astros. In recent years the range of this tortoise in Greece has been much extended (Lambourdis & Kattoulas 1982 and Reynolds 1984).

GEKKONIDAE

Tenuidactylus kotschyi (Steindachner 1870) (= *Cyrtodactylus kotschyi* Underwood 1954).
The present generic designation was made in 1984 by Scherbak and Golubev. Subspeciation is very complex. Naked-fingered geckos from Hydra and Salamis were originally classified under *saronicus* Werner 1937. Recently Beutler & Gruber (1977) give *saronicus* as inhabiting the Cyclades, the Saronic Islands, Ikaria and Antikythira with the form *bibroni* on the Peloponnese. Since the Saronic Islands have no affinities with the Cylcades it seems hard to accept this arrangement. *T. kotschyi* is known from Salamis, Aegina, Poros, Hydra and Spetsai from a variety of sources as well as Psili and Ag. Georgios (Clark 1972). To these we can add the following: Spetsopoula, Trikkeri, Alexandros, Ventza, Karteli, Petrokaravo and Agios Ioannis. On the small islets it was very abundant and on a number the only reptile species (Clark unpublished). On Ag. Ioannis it was sympatric with *Ablepharus kitaibelli.* Its ability to exist on many of the small and inhospitable islands of the Cyclades is well known (Wettstein 1953, Gruber & Fuchs 1977). Evidently there is a similar tenacity factor in the Argo-Saronic. On the mainland widespread and firm records exist for Palea Epidavros, Didyma, Argos and Corinth.

Hemidactylus turcicus turcicus (Linnæus 1758)
In contrast to the above species this gecko is exclusively nocturnal. It can be found by day in hiding by turning rocks and piles of debris. Known positively only from Salamis, Aegina and Spetsai but is certainly more widespread than this. I have no mainland localities but can confidently include it amongst the fauna of the Argolid.

ANGUIDAE

Ophisaurus apodus thracius Obst 1978
Unknown from the islands. On the mainland recorded from Epidavros (Obst 1978), Acro-Corinth (Bringsøe 1985), Nea Kios (Buttle 1987). Ewald (1980) mentions her two sitings from Nemea. Clearly rare in the Argolid and in my years of collecting I never found any specimens here. The single example referred to by Obst would appear to be the only one known from this region.

LACERTIDAE

Algyroides moreoticus Bibron & Bory 1833
On the eastern side of the Peloponnese the only island location known to contain populations of this lizard is Psili (Clark 1972). This is in marked contrast to the successful way this species has established itself on the Ionian islands of Kephallinia, Zakynthos and Ithaca. In the Argolid itself known from Nafplion through to Adami (Clark & Clark 1970) and Didyma (In den Bosch & Musters 1981). Doubtless more generously distributed but difficult to locate due to its reticent nature, small size and drab colouring.

Lacerta graeca Bedriaga 1881
Supposedly endemic to the Peloponnese but there one must exercise some caution since the range of this lizard and the fact that it is now known from both montane and littoral localities has been much enlarged. The only mainland locality in the Argolid available to me is Didyma. Just outside the village are two large craters allegedly the result of meteorite impact. One of these, which is set into the hillside, was found to contain a small colony of this lizard during visits there in the 1960s (Clark unpublished). A return visit in August 1986 was not successful in determining whether this population was still extant. I also searched the other crater which is deeper and offers more shade and vegetative cover. The result was also negative. There is another record 8km north of Didyma which Bringsøe thinks is dubious (Adema & In den Bosch, 1980, In den Bosch & Musters 1981). I would rate this as a possible valid siting. Although not known from the islands it is by no means improbable that *L. graeca* may subsequently be found on one or more of the islands in the Gulf of Argolis, bearing in mind the successful penetration of *A. moreoticus* and *Podarcis peloponnesiaca* into Psili.

Lacerta trilineata trilineata Bedriaga 1881
The Green Lizard is the most abundant and widespread lacertid in the area. Previously recorded finds include Salamis, Aegina, Poros, Hydra, and Spetsai as well as Psili and Plateia (Clark

1972). I also found it on Dhokos and Spetsopoula and even more interestingly on the small and isolated island of Stavronissos which lies some eight kilometres off the south coast of Hydra (Clark unpublished). It was not seen on Tolon. Extremely common on the mainland. *L. trilineata* is tolerant of a wide range of habitat which includes woodland, where it occurs both on the margins and amongst denser tree cover, open fields, stone walls, embankments, rough scrub and stream margins. Island populations seem to reach a smaller maximum size than those on the mainland (Clark 1967) whereas those from Stavronissos were much darker green in ground colour than those found elsewhere.

Podarcis erhardii livadiaca (Werner 1902)
I have already reported on this lizard from Hydra following several visits to this island in the 1960s (Clark 1967, 1970). It also occurs on Ag. Georgios (Clark 1972) and on Petassi (Clark unpublished). Bringsøe (1985) mentions it as occurring on Prassonisi in the Gulf of Salamis. I cannot locate this island on any map and I have excluded it from my Table of Taxa. Although common on Ag. Georgios it is infrequent on Hydra and Petassi. Bearing in mind the sporadic nature of these finding places it is by no means impossible that careful searching would reveal further populations that have until now have been missed. On the mainland it is known from the area of Corinth. Dimitropoulos (1986) mentions a decline in the Attica region as did Werner in the Peloponnese some 50 years ago. Whether or not populations exist in the Inner Argolid is open to speculation.

Podarcis peloponnesiaca thais Buchholz 1960
In 1972 I reported on the discovery of this supposedly endemic Peloponnesian species on the island of Psili. Bringsøe (1985 and 1988) still considers this to be the only extra-limital population. From the Peloponnese area under consideration I have records from Brountzeika as well as Galatas (Clark unpublished). The latter find was made in April 1978. Evidently widely but sparsely distributed throughout the Argolid and certainly not as common here as in other parts of its range. This can be seen on the map in Bringsøe's 1988 paper. Localities for the Argolid are: Didyma, Palea Epidavros, Tiryns and a site 25km south of Corinth. I can further add Mycenae from personal experience. I have commented elsewhere (Clark 1970) on Daan's siting of this species on Salamis as being in error (Daan 1967). I still adhere to this view. Three subspecies are currently recognised (Buchholz 1960). *P. peloponnesiaca thais* is the form found in the Argolid.

SCINCIDAE
Ablepharus kitaibelli kitaibelli Bibron & Bory 1833
Widely and abundantly distributed throughout the area. On record from Salamis, Aegina, Poros, Hydra and Spetsai. Also Psili (Clark 1972) as well as Spetsopoula and Ag. Ioannis (Clark unpublished). Can with certainty be reckoned to occur on Dhokos, Tolon and Plateia. Bringsøe (1985) says it is ubiquitous in most habitats. This is indeed so but there is a preference for plant and 'soft' vegetative cover, grassy banks and dampish places. It is especially common on Spetsai in the spring and autumn in such biotopes and this has been my experience on the Cyclades and mainland too.

Chalcides ocellatus ocellatus (Forskål 1775)
The Eyed Skink has recently been recorded from Salamis for the first time (Bringsøe 1985). Otherwise known from Aegina, Poros and Hydra (Clark 1967, 1970). Bringsøe's inclusion of this skink in the herpetofauna of Spetsai is in error (Bringsøe pers. comm.). Also known from an island between Aegina and Angistri (Bringsøe 1985, no source reference) but it is unclear exactly which island this is. On the islands it is not common and sitings made by me were few and far between. We could anticipate this skink on Dhokos and maybe Ag. Georgios since records exist from Kea and Makronisos. On the mainland it is known from Corinth (Lindfors 1976). A hitherto unpublished observation by me gives the only record so far from the Inner Argolid, namely Galatas. Two examples were found here in April 1978 amongst the rocks in a drying river bed. In Attica the Eyed Skink is quite common and is even found within Athens itself (Dimitropoulos 1986).

Ophiomorus punctatissimus (Bibron & Bory 1833)
To date unknown from any of the islands. The nearest recorded findings are from Acro-Corinth and Argos (Werner 1930, Anderson & Leviton 1966, Clark & Clark 1970, Bringsøe

1985). All specimens collected by me were found under rocks or stones either in generally rough terrain or in more open ground with isolated boulders. Certainly more common than the few isolated finding places imply. Since this reptile is known to inhabit the island of Kythira we must allow the possibility that it will subsequently be found on some of the Argo-Saronic islands given dedicated attention to its habits and biotope.

TYPHLOPIDAE

Typhlops vermicularis Merrem 1820

The only island locality is Salamis (Werner 1937). This record was overlooked by me in my 1970 report. On the mainland known from Acro-Corinth and Epidavros. (Clark 1969, Bringsøe 1985). Recently reported from Vivari (Buttle 1988). As with the aforementioned species its further and more widespread discovery is quite possible.

BOIDAE

Eryx jaculus jaculus (Oliver 1801)

As with *T. vermicularis* very few records exist. The only positive island locality is Spetsai from two specimens (Clark 1967 and Dimitropoulos personal communication). The latter instance refers to an example found under a rock by a visitor to Spetsai in the summer of 1988. In the Argolid but sparsely recorded from Nafplion and Kosta (Clark 1967) and Epidavros (Werner 1937). Some misunderstandings exist on the habits of this snake. Although largely nocturnal it can be found by day in the cooler seasons as I observed on Amorgos in April 1967 when a specimen was found in a field late in the afternoon with the sun low but still well above the horizon.

COLUBRIDAE

Coluber caspius Gmelin 1789

There are but two records for the whole area, a sighting on Spetsai dating from June 1962 (Clark 1967) and one from Aegina made in April of the same year by Roland Skovgaard. This adult snake is deposited in the Zoological Museum, University of Copenhagen (Bringsøe 1985). Steward (1971) includes the whole of the Peloponnese within the range of *C. caspius* whereas Arnold & Burton (1978) do not. To the best of my knowledge there are no records from the Peloponnese at all. The nearest other finding places are Euboia and the northern and western Cyclades. It is hard to account for the presence of this snake on Aegina and Spetsai except as a relic due to range contraction. Since no more specimens have been seen or taken in the last quarter of a century we can only surmise that *C. caspius* must be very rare indeed.

Coluber gemonensis (Laurenti 1768)

This species has one of the most erratic and unpredictable patterns of distribution of any species found in the area. Over some of the Peloponnese it is abundant in others rare and its distribution can best be described as sporadic. I found it plentiful in the Mani at Pyrgos Dirou south of Areopolis in March (unpublished record) and Bringsøe (1985) lists it mainly from the south: Monemvasia, Mistras, Kalamata and the Mani. Apart from one specimen taken at Mycenae (Clark 1969) I found no other examples in the Argolid. Competition with the Montpellier Snake could well be a factor determining the distribution of *C. gemonensis.* Both species are active and diurnal but the larger size of *Malpolon monspessulanus* together with its aggressiveness and omnivorous diet could well be an obstacle to sympatry. The situation on the islands is intriguing since *C. gemonensis* occurs in large numbers on some and is totally absent on others nearby. So far as is known it exists on Aegina (Wettstein 1953), Psili and Tolon (Clark 1972) and also Stavronissos, Dhokos and Trikkeri (Clark unpublished). At least on the five latter named islands it was found to be very common. Bowles (1988) noted a similar extreme abundance of *Coluber viridiflavus* on the Maltese offshore island of Gozo. *C. gemonensis* is sympatric with *C. najadum dahlii* on Tolon and with *M. monspessulanus* on Psili. It is apparently absent on Salamis, Poros, Hydra and Spetsai all of which have a richer snake fauna. Since this species is known from Gyaros in the Cyclades *(C. gemonensis gyarosensis* Mertens) it is possible that it might also occur in Ag. Georgios. No evidence was however found.

Coluber najadum dahlii Schinz 1833

Dahl's Whip Snake has been recorded from Salamis, Aegina, Poros, Spetsai and Tolon (Clark

1967, 1970, 1972). As yet unknown from Hydra and Dhokos which could be potential finding places. On Spetsai it is the most abundant snake and is also common on the other islands. From the mainland on record from Kranidi, Epidavros and Nafplion (Clark 1969), Acro-Corinth (Bringsøe 1985) and Vivari (Buttle 1988). Clearly widely distributed throughout the Argolid region.

Elaphe quatuorlineata quatuorlineata Lacépède 1789
The only island record is Spetsai (Clark 1967, 1969, 1970 and Bringsøe 1985). Although not actually recorded on Spetsopoula it was reliably described to me by employees working on the Niarchos estate. Poros is another possible location since I found it at Galatas (Clark unpublished). This observation was made in April 1978. Mainland sitings are scarce and date mainly from the 1930s and 1940s. Werner (1937) mentions Epidavros. During the 1960s I travelled extensively in the Argolid and never came across living specimens, road casualties or cast skins. Bringsøe's comment on the frequency of this snake on Spetsai needs clarification. I would reckon it to be rather infrequent. Over a period of several years I took only five specimens and would not rate this snake as being especially common.

Elaphe situla (Linnæus 1758)
On the islands this species is known from Salamis, Poros and Aegina (Dimitropoulos 1986) and Spetsai (Clark 1967, 1970). The Dimitropolous records are useful since they extend the range of this species in the Argo-Saronic to include all the main islands except Hydra. Although he gives no source for these finds he has personally assured me that they are *bona fide* and reliable. On Spetsai over a period of time I collected two adults and six juveniles. Next to *Coluber najadum dahlii* the Leopard Snake must be rated as the most common snake. Although it can be found in open countryside it often enters houses and outbuildings. All of my Spetsai examples were taken in or around dwellings and in gardens. On the mainland I have personal records from Ermioni, Adami and Argos. The striped morph does not seem to occur in the area. This is in contrast to the position in the eastern Aægean region where striped examples predominate.

Malpolon monspessulanus insignitus (Geoffroy 1827)
On the mainland the most commonly encountered snake and road casualties are frequent in the spring and early summer. On the islands rather erratic in its distribution. I have records from Salamis, Poros and Hydra (Clark 1967, 1970). On these islands *C. gemonensis* does not occur. It is sympatric with *C. gemonensis* only on Psili (Clark 1972). Neither species occurs on Spetsai and the Montpellier Snake to date has not been taken from Aegina. All of my examples from Salamis, Hydra and Psili were well under one metre in total length. The single specimen from Poros measured 1235mm in total with approximately one third of the tail missing (Clark 1967, 1970). This is in contrast to examples found on the mainland which were consistently large and up to 1500mm. Whether this demonstrates that the Montpellier Snake on these islands exists in a dwarf form is far from proven but it deserves further consideration.

Natrix natrix persa (Pallas 1814)
Natrix tessellata tessellata (Laurenti 1768)
These two species can be considered together. There are no records of natracine snakes on any of the islands. The adaptive powers of the former species to dry environments on the Cyclades is well known. Kratzer (1974) is particularly informative. There is no evidence that this propensity is paralleled in the Argo-Saronic. However see Bringsøe (1985) concerning the life style of *Natrix natrix* in the Peloponnese itself. Although there are several places in Argolid peninsula which could support the demands of this snake I have only found it at Galatas in the streams flowing down from the mountains. It seems less probable that *N. tessellata* occurs in the Argolid and certainly not on the islands.

Telescopus fallax fallax (Fleischmann 1831)
This snake is broadly distributed on the mainland but I can find no records from the Argolid itself. On the islands known only with any certainty from Spetsai (Clark 1970). This dead example was brought to me by a student at the Anargyrious and Korgialenos College who said he had found the snake locally.

VIPERIDAE

Vipera ammodytes meridionalis (Boulenger 1903)

It seems strange that there are no reports of this viper from the Argo-Saronic islands. Certainly there is no logical zoo-geographical reason for its apparent absence since it is common in Attica and the Peloponnese. Having said this it would appear to be less frequent in the Argolid than in other regions and I have personal records of only four specimens: one from Didyma and three from near Nafplion (Clark 1969). More recently Buttle (1988) found it at Vivari. The islands of Hydra and Dhokos would appear possible finding places and there are sizeable areas on Aegina which look promising. More careful study is needed.

DISCUSSION

ZOOGEOGRAPHY

It is convenient to think of the Argo-saronic islands as a zoogeographical unit. Although from a macroscopic viewpoint this is broadly true the situation is not quite as straightforward as this. The mainland takes in both sides of the Corinth Isthmus and there are some species that would neither be anticipated on Salamis nor the adjacent mainland. These are *P. peloponnesiaca*, *A. moreoticus* and *L. graeca*. The islands of Aegina and Angistri form a natural extension of the Peloponnese through the Methana Peninsula while Salamis can be seen to form a detachment from Gerania and Attica in the region of Elefsis. It is improbable that there was faunal interchange between Aegina and Salamis. The presence of *T. graeca ibera* on Salamis but not on any of the other islands would seem to validate this notion. The island of Ag. Georgios forms an extension of the Attica peninsula and the occurrence there of *P. erhardii livadiaca* suggests it reached Hydra and Petassi via Ag. Georgios and then through to the Peloponnese. The population dilution already mentioned implies a range contraction along this southern arc. Likewise on the northern flank a similar contraction back from the Peloponnese via Prasonisi to northern Attica. So far this lizard has not been found on Salamis itself but the possibility that it exists deserves investigation. There is no connection between the Argo-Saronic islands and the Cyclades. The nearest Cycladean island is Velopoula which can be seen clearly from Spetsai given good visibility. The presence here of *Podarcis milensis* subsp. (Clark 1972) relates Velopoula to the Milos archipelago. There are certain species which inhabit the Argo-Saronic which are typical denizens of coastal islands and the mainland but which do not occur off the continental shelf and are hence absent from the Cyclades. These are *C. najadum dahlii* and *M. monspessulanus insignitus*. *C. ocellatus* also comes into this category but manages to have reached Makronissos and Kea. Although Kea is normally thought of as a member of the Cyclades it is more clearly allied to Attica. This is further proven by the presence of the nominate form of *E. quatuorlineata*. The Four-Lined Snake inhabiting the Cyclades belongs to the distinct form *E. quatuorlineata muenteri* = *praematura* (Clark 1971). Recent attempts to assign the Cycladean race to the nominate form (Gruber 1978) are unacceptable. The fauna of Kea and its southerly neighbour Kythnos is quite distinct.

SPECIES DISTRIBUTION AND EVALUATION

Distribution in the area is summarised in the Table of Taxa, in which three symbols are used:
+ = definite record. ? = no available record but indicates a high level of probability.
- = no available record and almost certainly absent. Some caution and judgement are needed here.

Regarding Spetsai I think it safe to assume that the herpetofauna is completely known. After such a long period of residence there I doubt if any further species will be added. The other main islands of Salamis, Aegina, Poros and Hydra can be considered to be fairly well documented though there still remain some uncertainties. From the Table one gains the impression that the mainland is much richer in species than the islands. On closer inspection one finds that the shortfall of total number of species on the islands set against the total for the area adds up to only 8 taxa or 9 if we permit the near certainty of 29 for the mainland. In addition there is one species that is not found on the mainland, namely *C. caspius*. This can be summarised thus:

A	B	C	D	E
26(29)	21	1(3)	8(9)	29(30)

A = Mainland B = Islands C = Only islands D = Only mainland E = Total area

Amongst the islands themselves we notice an uneven dispersion within the main group of Salamis, Aegina, Poros, Hydra and Spetsai. Both Salamis and Spetsai have the highest totals with 12 recorded species. At the same time Salamis has four species not found on Spetsai: *T. graeca ibera, C. ocellatus* (also on Poros and Hydra), *T. vermicularis, M. monspessulanus* (also on Poros, Hydra and Psili). Spetsai likewise has four species not recorded on Salamis: *E. jaculus, C. caspius* (also Aegina), *E. quatuorlineata, T. fallax.* Amongst the other islands various species are found which do not occur, so far as is known, on either Salamis or Spetsai: *R. ridibunda* (Poros), *A. moreoticus* and *P. peloponnesiaca* (Psili), *P. erhardii* (Prasonnisi, Hydra, Petassi, Ag. Georgios), *C. gemonensis* (Aegina, Stavronissos, Dhokos, Trikkeri, Psili, Tolon).

There are several ways to account for these vagaries:

1. the normal random "chance" element whereby in an island's formative process a certain species happens to be in the right place at the right time. One can find just as irregular instances of distribution on the mainland itself.

2. the selecting out process in which some species are successful in maintaining themselves and others less so even though biotopes may be favourable and food supplies adequate.

3. the further process of elimination of the less aggressively assertive species by those that are more opportunistic.

4. inadequate habitat provision for some species that have special requirements and/or preferences. This is especially valid in the case of amphibians, pond tortoises and natracine snakes. The latter two groups are not represented at all and amphibians have a poor representation in the Argo-Saronic.

5. an island's size which in the case of small islands and islets limits the number and type of species that can be supported and heightens the competitive element. It is very difficult to give a ruling on this.

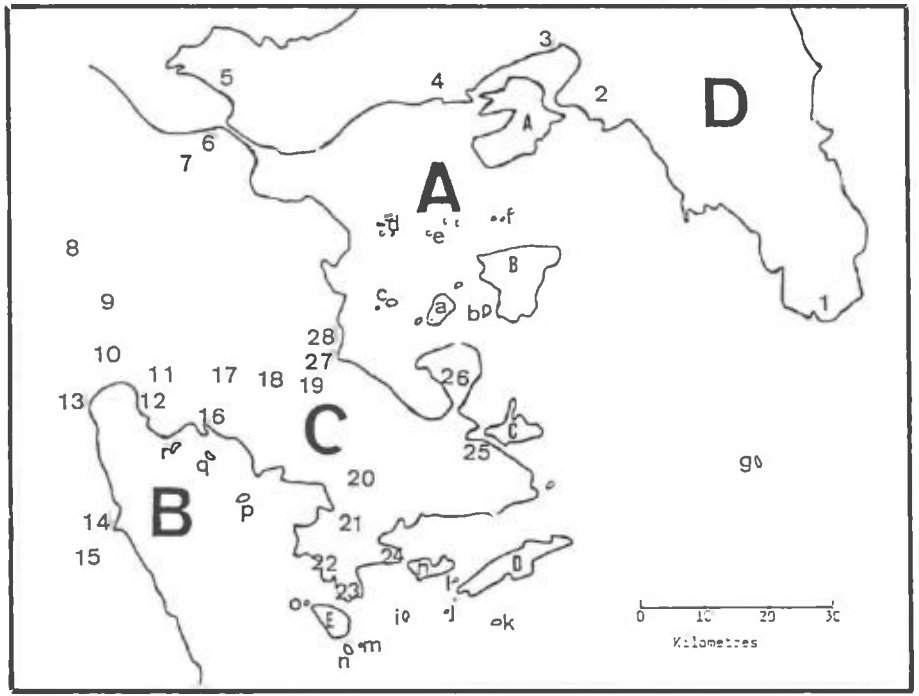
6. more empirical reasons such as inconclusive and inadequate observations. It is clear that a visit of only a day or two is less likely to give positive results than a stay of several weeks. We also have to take into account the time of year. In the spring months intensive searching over a short period will probably give a fairly complete picture of the commoner and more obvious species. The period I spent on Psili, incidentally a very small island (see point 5), in early May was limited to an afternoon and the following morning, having camped overnight. The number of species found was eight which is nearly as many as are known from Aegina, a much larger island which has been visited on many occasions by herpetologists.

It is worth pointing out that the somewhat erratic distribution pattern is more extreme than is found in the Cyclades where with clear cut definition between the different groups of islands the position is much more predictable. If we ignore the Milos group and Siphnos the main differences are no viperids or Four-Lined Snakes on Kythnos and Seriphos, no whip snakes on the central group of Naxos, Paros and Ios and more precise oddities such as no wall lizards on Paros and an endemic species, *Elaphe rechingeri,* on Amorgos. Even if the smaller satellite islands are considered the principle differences are a reduced number of species (see point 5) not anomalies. The offshore islands of the eastern Aegean are likewise more regular, the main feature being the sporadic occurrence of wall lizards represented by *L. danfordi* and *L. oertzeni* and the now-and-then occurrence of *Chamæleo chamæleon.* Without losing sight of the broad perspective it is clear that the Argo-Saronic area is one of high interest to the herpetologist and one that would repay even more detailed work.

ENVIRONMENTAL CONCERNS

What effect the growth of the tourist industry in Greece over the last 15 years or so has had on reptile life is hard to estimate. On Spetsai, to take one example, there has been marked habitat destruction in the area of the Old Harbour on the lighthouse peninsula. In the 1960s this was a natural wilderness of scrub, stone walls and a few derelict buildings. Today it is a congestion of villas. This used to be a good finding place for *L. trilineata, T. kotschyi, H. turcicus* and *C. najadum dahlii.* Salamis has also seen a lot of land taken over for building

MAP OF ARGO-SARONIC GULF



A Saronic Gulf, **B** Gulf of Argolis, **C** Inner Argolid, **D** Attica

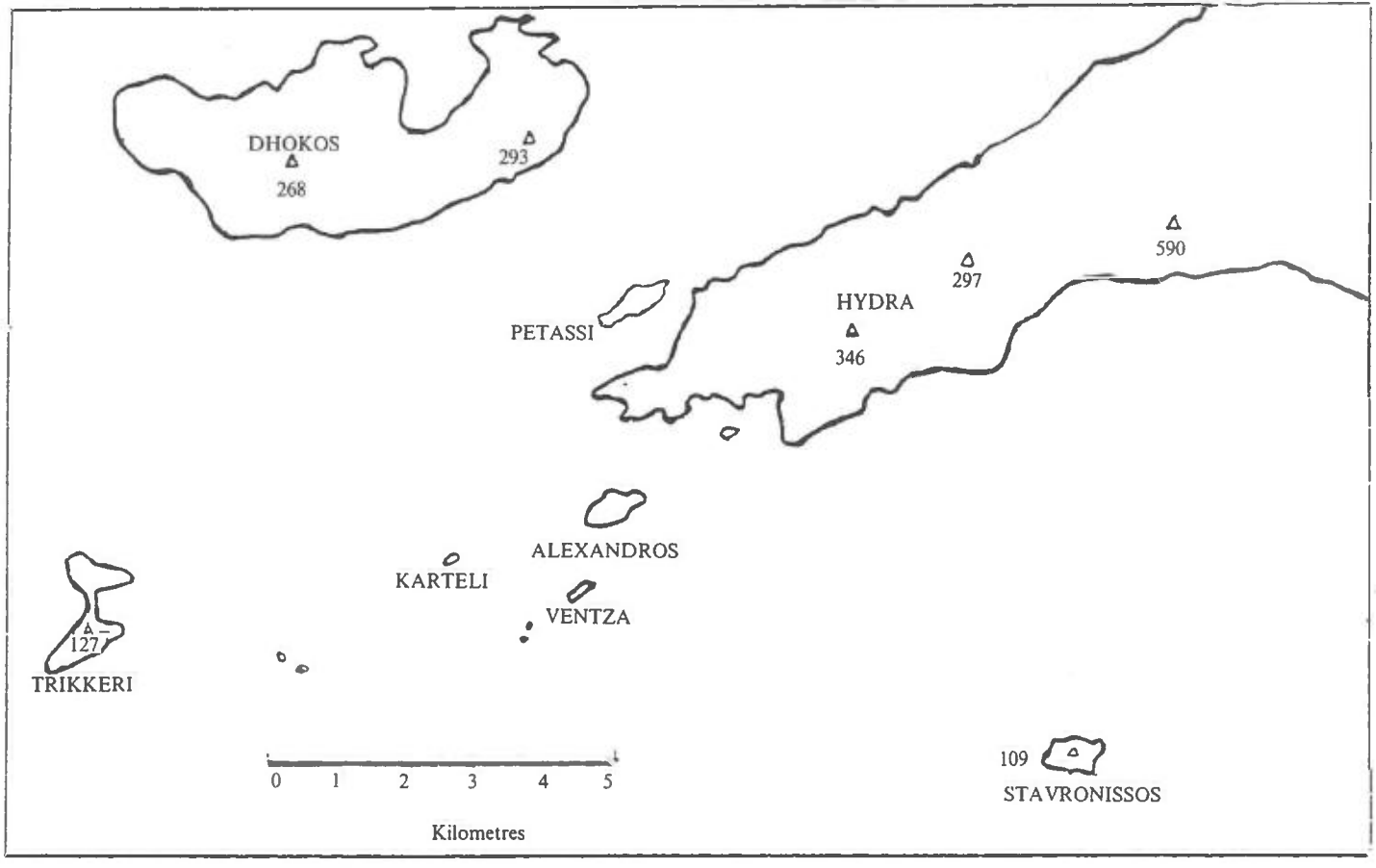
KEY TO LOCALITIES – MAINLAND

1 Cape Sounion, 2 Athens, 3 Elefsis, 4 Megara, 5 Loutraki, 6 Corinth, 7 Acro-Corinth, 8 Nemea, 9 Mycenae, 10 Argos, 11 Tiryns, 12 Nafplion, 13 Myli, 14 Astros, 15 Ag. Andrea, 16 Drepanon & Vivari, 17 Brountzeïka, 18 Ligourion, 19 Adami and Epidavros Theatre, 20 Didyma, 21 Kranidi, 22 Portoheli, 23 Kosta, 24 Ermioni, 25 Galatas, 26 Methana, 27 Palea Epidavros, 28 Nea Epidavros

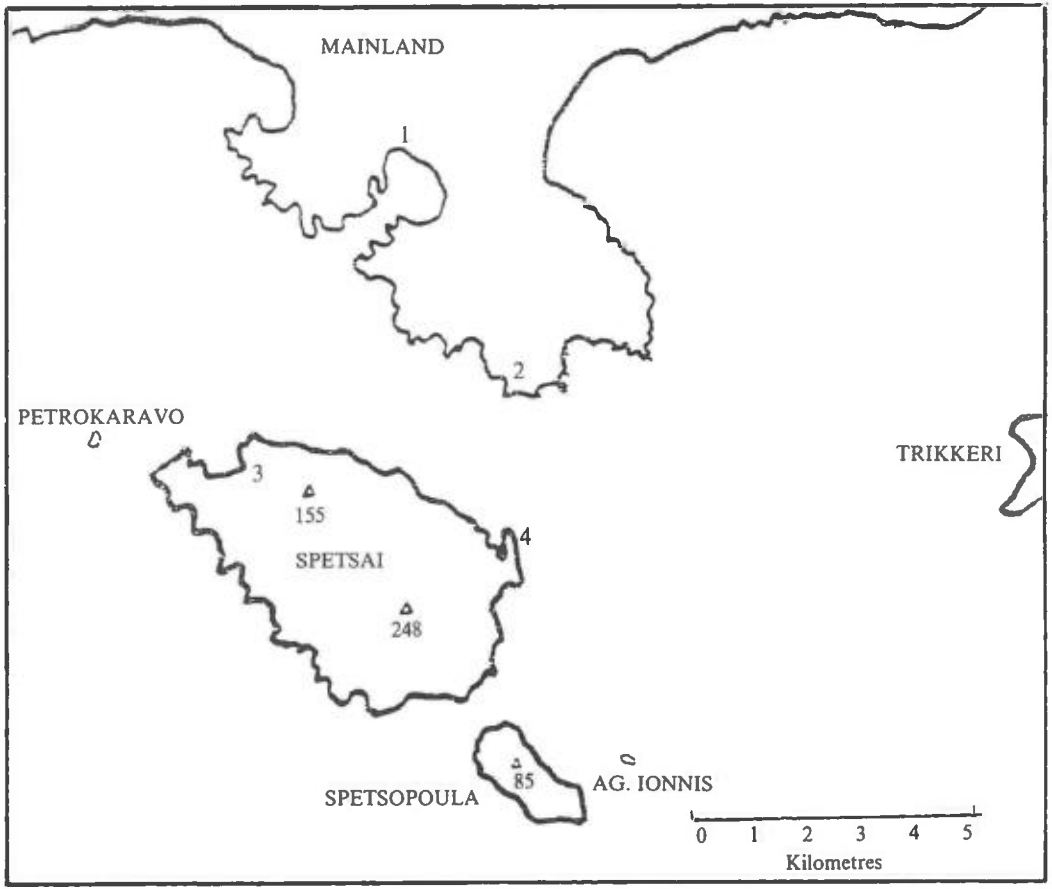
KEY TO LOCALITIES – ISLANDS

A Salamis, B Aegina, C Poros, D Hydra, E Spetsai, a Angistri, b Moni, c Kira, d Diaporia, e Ipsili, f Laousses, g Ag. Georgios, h Dhokos, i Trikkeri, j Alexandros, k Stavronissos, l Petassi, m Ag. Ioannis, n Spetsopoula, o Petrokaravo, p Psili, q Plateia, r Tolon (Romvi)

MAP OF HYDRA ARCHIPELAGO – ALTITUDES IN METRES



MAP OF SPETSAI AND ATTENDANT ISLANDS



KEY

1 Portocheli

2 Kosta

3 Zougeria

4 Lighthouse peninsula

△ Altitude in metres

TABLE OF TAXA (1)

	Salamis	Aegina	Poros	Hydra	Spetsai	MAINLAND	Ag. Georgios	Stavronissos	Dhokos	Trikkeri	Spetsopoula	Psili	Plateia	Tolon (Romvi)	Petassi	Alexandros	Ventza	Karteli	Petrokaravo	Ag. Ioannis
AMPHIBIA																				
Triturus vulgaris	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rana ridibunda	-	-	-	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hyla arborea	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bufo viridis	+	?	+	?	+	+	-	-	?	-	-	-	-	-	-	-	-	-	-	-
Bufo bufo	-	-	-	-	-	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TESTUDINES																				
Mauremys caspica	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Testudo graeca	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Testudo marginata	+	-	+	-	+	+	-	-	+	-	+	+	-	+	-	-	-	-	-	-

TABLE OF TAXA (2)

	Salamis	Aegina	Poros	Hydra	Spetsai	MAINLAND	Ag. Georgios	Stavronissos	Dhokos	Trikkeri	Spetsopoula	Psili	Plateia	Tolon (Romvi)	Petassi	Alexandros	Ventza	Karteli	Petrokaravo	Ag. Ioannis
SAURIA																				
Tenuidactylus kotschyi	+	+	+	+	+	+	+	?	?	+	+	+	?	+	+	+	+	+	+	+
Hemidactylus turcicus	+	+	?	?	+	?	?	?	?	-	?	?	?	?	-	-	-	-	-	-
Ophisaurus apodus	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Algyroides moreoticus	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Lacerta graeca	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lacerta trilineata	+	+	+	+	+	+	-	+	+	-	+	+	+	?	-	-	-	-	-	-
Podarcis erhardii	-	-	-	+	-	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-
Podarcis peloponnesiaca	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Ablepharus kitaibelli	+	+	+	+	+	+	-	-	?	-	+	+	?	?	-	-	-	-	-	+
Chalcides ocellatus	+	+	+	+	-	+	?	-	-	-	-	-	-	-	-	-	-	-	-	-
Ophiomorus punctatissimus	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE OF TAXA (3)

	Salamis	Aegina	Poros	Hydra	Spetsai	MAINLAND	Ag. Georgios	Stavronissos	Dhokos	Trikkeri	Spetsopoula	Psili	Platcia	Tolon (Romvi)	Petassi	Alexandros	Ventza	Karteli	Petrokaravo	Ag. Ioannis
SERPENTES																				
Typhlops vermicularis	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eryx jaculus	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coluber caspius	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Coluber gemonensis	-	+	-	-	-	+	-	+	+	+	-	+	-	+	-	-	-	-	-	-
Coluber najadum	+	+	+	-	+	+	-	-	?	-	?	?	?	+	-	-	-	-	-	-
Elaphe quatuorlineata	-	-	-	-	+	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Elaphe situla	+	+	+	?	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Malpolon monspessulanus	+	-	+	+	-	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Natrix natrix	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Telescopus fallax	-	-	-	-	+	?	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vipera ammodytes	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Number of taxa +	12	9	10	6	12	26	2	2	3	2	5	8	1	4	2	1	1	1	1	2
Number of taxa ?	1	1	2	3	-	3	2	2	5	-	3	2	4	3	-	-	-	-	-	-

and development but in the main there seems to have been relatively little effect on the fauna and such as there has is limited to certain coastal sites. The main body of Hydra, for example, does not lend itself to development because of its rugged and wild nature which does not attract land exploiters. On the mainland the problem is more acute. From Tolon along the coast and round to Ermioni, hotels, tourist villages and complexes have claimed large tracts of countryside. Away from the coast land has been bought up and fenced off and it is only a question of time before this too becomes built over. Probably a more serious problem is the reclaiming of land for agricultural purposes such as the planting of citrus orchards, vineyards and olives under EEC incentives and the inevitable consequence of the use of sprays and pesticides which destroy food chains, notably insect life. Birds too are very vulnerable to toxic sprays. Increased human activity increases the fire hazard in the prevailing tinder dry summer conditions. One can also point to the habitat destruction along the coast from Athens through Elefsis to Megara. This is particularly severe since almost the entire stretch is now given over to heavy industries such as factories, oil refineries and cement works. It is important to point out that at the present time these ravages are of relatively small extent compared with the area as a whole. However at a local level they are certainly significant and cause for genuine anxiety and concern.

APPENDIX

In January 1989 I visited Greece and made some observations on reptile activity at this season. On January 21st I made a day trip to the island of Angistri which is accessible from the port of Aegina. Two species were found: *Ablepharus k. kitaibelli* (two examples) and *Lacerta t. trilineata* (three juveniles). No adults or subadults were observed despite a considerable amount of stone and rock turning. Amongst a pile of rocks a cast colubrid slough was found but it was not possible to ascertain to what species this belonged since it was in very poor condition. More detailed work is needed to establish the herpetofaunal content of this island which so far seems to have escaped the attention of herpetologists. A report on the results of this winter excursion has been compiled and will appear in one of the 1989 issues of "The Herptile".

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NOTES ON SHOVEL-NOSED SNAKES AND SAND SNAKES, *CHIONACTIS* AND *CHILOMENISCUS*

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INTRODUCTION

The purpose of this note is to generate interest in the three or four species of small, desert-dwelling snakes at present placed in the genera *Chionactis* and *Chilomeniscus.*

All these animals occur in the south-western corner of North America, where they inhabit arid sandy or stony desert habitats. Their adaptations to a subterranean life-style inlcude smooth shiny scales and a flattened head. All are small, typically less than 30cm in total length, and all feed on invertebrates such as scorpions, spiders, orthopterans and the larvae of beetles etc. Because they are similar in habits, and superficially resemble one another, members of both the genera are dealt with together.

1. *CHIONACTIS,* SHOVEL-NOSED SNAKES

The genus *Chionactis* consists of two currently recognised species, *C. occipitalis* and *C. palarostris,* with four and two subspecies respectively. *Chionactis occipitalis* is the Western Shovel-Nosed Snake:

C. o. annulata, Colorado Desert Shovel-Nosed Snake (plate 1)
C. o. klauberi, Tucson Shovel-Nosed Snake
C. o. occipitalis, Mojave Shovel-Nosed Snake (plate 2), and
C. o. talpina, Nevada Shovel-Nosed Snake

Descriptions of these subspecies can be found in field guides such as that of Stebbins (1985) but briefly, *annulata* is creamy yellow with dark brown bands, *klauberi* is cream with small 'secondary' dark bands between the main ones, *occipitalis* is cream with red secondary bands, and *talpina* is cream with occasional, small dark secondary bands. *Klauberi* and *talpina* are further separated by a higher ventral scale count in the latter (more than 152 in males, more than 160 in females). Snakes from two discrete populations, the Anza-Borrego Desert in California and San Felipe in Baja California, though nominally *annulata,* show great variation in the amount of secondary banding, ranging from individuals with full bright red saddles, through others with traces of faint pink or orange to some (about 10%) with no secondary bands at all. Cross (1970) proposes a sequence of colonisation of the San Felipe region which may account for this, and the same argument probably also applies to the Anza-Borrego population.

The habitat of this species includes pockets of sand as are found in dry river washes, although, since most specimens are found on roads during the night it is often difficult to ascertain their exact micro-habitat.

Chionactis palarostris, the Sonoran Shovel-Nosed Snake, is similar to the above species but invariably has broad bright red secondary bands. *C. p. organica* is found in extreme south-western Arizona, mostly within the Organ Pipe Cactus National Monument, and in adjacent parts of Sonora, Mexico. *C. p. palarostris* is restricted to Mexico. The habitat of this species consists mainly of gravelly and rocky desert – typical 'cactus country', although again, the precise nature of its immediate habitat is often difficult to assess at the time of collection.

A third species, *Chionactis saxatilis,* from the Gila Mountains of southwestern Arizona, was described by Funk (1967), although I have been unable to find further reference to it, possibly because it has been suppressed.

2. *CHILOMENISCUS,* SAND SNAKES

Superficially, the Sand Snakes resemble Shovel-Nosed Snakes very closely. They are separated taxonomically by having 13 rather than 15 scale rows at mid-body and an inset lower jaw.

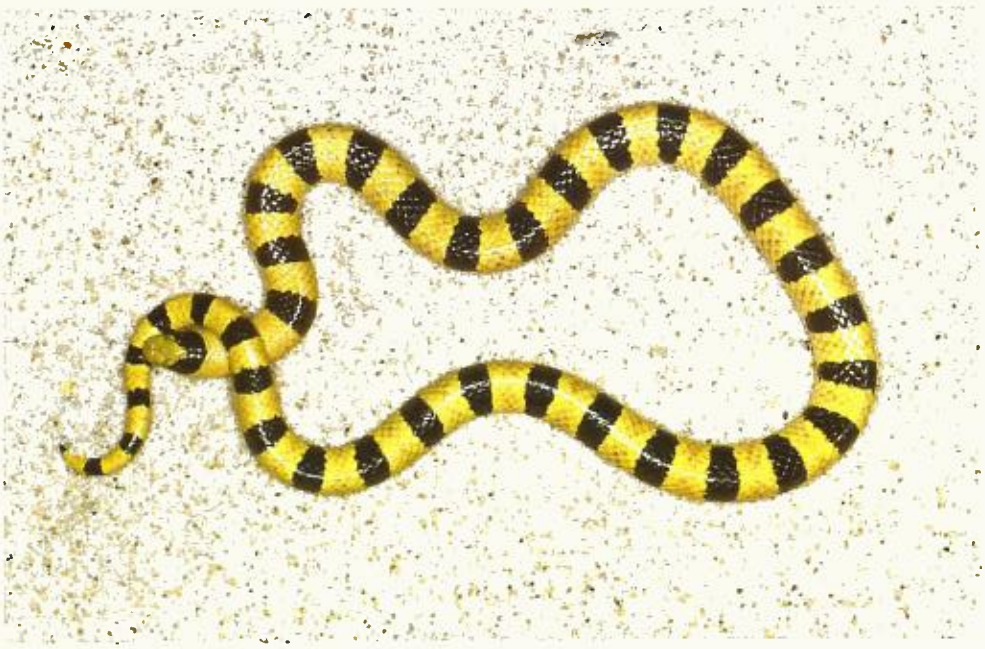

Plate 1. *Chionactis o. occipitalis* from the Coachella Valley, Mojave desert. All specimens from this area are fairly consistent in their markings and colouration.

Plate 2. *Chionactis o. annulata* from Borrego Springs, Colorado Desert. The individual illustrated is one of the more vividly marked from this population.

Plate 3. *Chionactis p. palarostris* from Sonoita, Mexico.

Plate 4. *Chilomeniscus cinctus* from near San Ignacio, Baja California del Sur, Mexico.

Plate 5. Habitat of *Chionactis occipitalis* near Borrego Springs.

Plate 6. Habitat of *Chilomeniscus cinctus* near Guerrero Negro, Baja California.

They are even more highly adapted to 'sand-swimming'. Two species are currenly recognised, but the taxonomy of this group is rather chaotic.

Chilomeniscus cinctus, the Banded Sand Snake, is cream in colour with a series of black or dark brown cross-bars, some of which may encircle the body, or be restricted to the dorsal surface. Animals from some localities have red pigment between the body bands, restricted to the upper dorsum (plate 4). Its range is disjunct, and includes much of Baja California part of southern Arizona, and adjacent parts of Sonora including a substantial stretch of the coastal region of that state.

Chilomeniscus stramineus, the Bandless Sand Snake, is restricted to the Cape Region of Baja California del Sur, and to parts of the Mexican mainland opposite this area, i.e. Sinaloa. In this species, the colour is a uniform brown, yellow or cinnamon, with a single, small black dot on each scale.

Both Sand Snakes live in fine, wind-blown sand, occasionally moving across the surface at night. Again, almost every specimen collected is found on the surface of desert roads at night.

Banta and Leviton (1963) reviewed the taxonomy of *Chilomeniscus* and recognised two further species, *C. punctatissimus,* from Isla Espiritu Santo, Gulf of California and *C. savagei,* from Isla Cerralvo, Gulf of California. They also recognised an additional subspecies of *C. stramineus, C. s. esterensis,* from Estero Salinas, in the Pacific coastal region of Baja California del Sur. The validity of some or all of these forms is dubious.

CARE IN CAPTIVITY

Members of both genera *(C. stramineus* has not been available) are a pleasure to keep in captivity. They require an inch or two of sand in which to live and a diet of crickets, waxworm larvae, etc. (A small proportion seem reluctant to eat crickets and soon become thin – in this case, alternative food should be provided until an acceptable diet is established). Despite their desert origins, they require drinking water at all times, otherwise they will soon dehydrate, and some individuals seem to prefer to drink from the side of the vivarium, etc., after it has been sprayed (especially noticeable in specimens of *Chilomeniscus cinctus*). A temperature of around 80°F appears to suit them, although a gradient, as provided by a heat tape or heat pad, is recommended.

They are relatively easily sexed by probing, and breeding should be possible (there are unconfirmed reports of regular captive breeding in a German collection). The only foreseeable problem would be the provision of a damp substrate in which the eggs could be laid: two clutches, of two eggs each, were found dried up in a cage where several recently collected *Chionactis occipitalis* were housed.

All of these snakes lend themselves to a naturalistic set-up in which rocks, cactus skeletons and living succulent plants can add to the aesthetic appeal. In addition, they may be kept (with caution) with other desert reptiles, such as the geckos, *Coleonyx,* since they appear to show no tendency to eat vertebrate prey. Owing to their fossorial habits, they are not always visible, although their period of activity usually begins in the evening regardless of whether the vivarium is lit or not.

C. palarostris is undoubtedly the most attractive species, but also the most difficult to obtain – it is protected throughout its range by virtue of the fact that this falls mostly within Mexico, or in the Organ Pipe Cactus National Monument. However, all species are attractive and interesting, and the fact that their natural history, especially with respect to breeding, is little known, should add to their appeal.

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CAPTIVE BREEDING OF THE RHINOCEROS-HORNED VIPER, *BITIS NASICORNIS*

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INTRODUCTION

Bitis nasicornis (Shaw), the Rhinoceros-horned Viper, Nose-horned Viper or River Jack, is one of the less well documented members of the African genus *Bitis* and Pitman's comprehensive description of the species is possibly one of the most informative (Pitman, 1974).

Bitis nasicornis inhabits the rain forest areas of tropical West Africa and is found as far east as W. Kenya and N.E. Tanzania. It is a large, stout snake – being one of the 'Big Three' African vipers *Bitis gabonica gabonica, Bitis arietans* and *Bitis nasicornis),* reaching an average length of just over one metre. It is just not possible to describe the beautiful markings and colouration of a newly sloughed individual with its complicated geometric pattern in olive, crimson, blue, yellow and rich brown, with a black javelin-shaped marking on the head. However, very soon after sloughing these rich colours start to fade rapidly and within a few weeks the snake has taken on quite a drab look when compared with its former gaudy appearance. It is interesting to note that the Gaboon viper, *B.g. gabonica,* although not being quite as colourful when freshly sloughed, keeps its colouration far longer than *B. nasicornis.* Its most striking characteristics are the cluster of three pairs of horns on the nose which give the snake its popular names, and the very strongly keeled dorsal scales which resemble miniature shark's fins.

Because of the lack of information about this species it was felt that a study should be made of its natural history and, in particular, its breeding habits – closely following the techniques used by us to study its congener, *B.g. gabonica* (Akester, 1979, 1984).

In May 1985 a pair of *B. nasicornis* was received in Harare, Zimbabwe from Ghana, having been in captivity there since September 1984. They were both sub-adults from the Mpraeso district of Ghana (06° 35'N 00° 44W). The immediate problem, once our customary quarantine period had elapsed, was to decide on how to acclimatise them to the conditions in Zimbabwe which are very different from those which they would experience in Ghana. May to September is the dry winter season in Zimbabwe with night temperatures falling to below freezing on occasion with very little moisture in the air at all, as opposed to Ghana where they would seldom experience temperatures below 15°C coupled with a very high humidity. They were therefore housed in heated, glass cages which had a thermostatically controlled minimum temperature of 16°C – the humidity being kept at a high level by daily spraying the cages with water.

While they were housed in the glass cages they were fed on mice and small rats and steps were taken to eradicate the high helminth infestation which faecal analysis had indicated that they both had when received. In October 1985 they were transferred to small, outdoor enclosures and remained there until the end of April 1986 when they were returned to the heated, glass cages for the winter. In August 1986 they were again transferred – this time permanently, to a large, outdoor enclosure some 14m^2 in area planted with thick vegetation and provided with a large pool of water. This enclosure is protected by a security fence which is covered by clear plastic sheeting in the colder months (May to September). At the time of transfer the minimum night temperature in the enclosure was +9°C, but, on clear nights during mid-winter, the temperature can drop to as low as +2°C. The enclosure has a built-in sprinkler system which is operated regularly in the dry season, and as and when required during dry periods in the summer months.

When gravid the female closely followed the behaviour patterns observed in gravid *Bitis g. gabonica* females (Akester, 1984) and, as the estimated time of parturition approached, the

pool was drained and the vegetation thinned out to avoid the neonates drowning in the pool and making it easier to locate them in the enclosure.

Once a parturition had taken place the neonates were removed from the enclosure as soon as possible and transferred to glass cages similar to the ones used to house the adults and, as they started to feel well and had sloughed for the second time, were transferred again – this time to a small, outdoor enclosure.

OBSERVATIONS

Upon receipt the snakes were weighed and measured – this being repeated at irregular intervals – as and when the opportunity arose as shown in Table 1.

TABLE 1. Mean mass and length of adult *B. nasicornis*

Date	Male		Female	
	Mass (g)	Length (mm)	Mass (g)	Length (mm)
May 1985	658	800	622	750
October 1985	1042	925	1017	850
November 1986	2050	1000	2450	1000
August 1987	2200	1100	3150	1120
April 1988	2500	1170	–*	1130

* The female was not weighed just prior to parturition to avoid the possibility of stressing her.

B. nasicornis are placid in temperament but can be aggressive when aroused. *B.g. gabonica* are also very placid but when really angered hiss loudly and draw back into a striking coil giving ample warning of their displeasure. However, *B. nasicornis* will strike without any warning whatever and sometimes even without a great deal of provocation. It should be noted that it is not safe to hold them by the tail as it appears to be slightly prehensile and they can, and do, throw themselves upwards and backwards to strike at the hand holding them – this is something that an adult *B.g. gabonica* is not able to accomplish. Possibly because of their partially prehensile tails *B. nasicornis* are able to climb quite well and it is not unusual for us to find the male some distance above the ground in the vegetation. Their affinity to water has often been stressed (Pitman, 1974. Stucki-Stirn, 1979. Ditmars, 1931) hence the name 'River Jack', but we have not found them to be any more fond of water than *B. gabonica*. The enclosure contains a very large pool of water but they are seldom found near to it, laying in it or even drinking from it. They do, however, become very active during rainfall or when the sprinkers are turned on – usually taking the opportunity to drink from rocks, vegetation and from off their own bodies. They are, however, powerful swimmers if it becomes necessary for them to take to the water.

The pair tended to keep apart, staying in one place for long periods. However, at 16h00 on 21st March 1987 the pair were observed copulating with the male being dragged through the vegetation by the female. The pair broke apart at 17h15.

22nd March: The sprinklers were turned on at 12h00 and 12h15 the male was observed to be moving up over the female with rapid tongue flicking and head jerking. The female at first moved away from the male but he persisted and at 13h10 they were again coupled, with the male being dragged across the enclosure. They remained coupled until 16h00.

28th March: Mating behaviour at 10h30 and the pair were coupled at 11h30 – separating at 13h30.

11th April: The sprinklers were turned on at 10h30 and at 11h15 the male was observed to have chased the female to the top of the bunker and, as the female moved off, the male actually fell off in his haste to catch her. At 11h30 the pair were coupled – separating at 14h30.

No more activity was observed until 1st June when at 17h15 the couple were again in a mating situation with the male being dragged. No more mating activity was noted after this date.

The female continued to feed well until December when she refused food from time to time. She commenced to shuttle between patches of sunlight and shade and in the late afternoons would coil up tightly – remaining like this until the following morning when the sun was again on the enclosure. About this time she began to get very aggressive and continually 'warned-off' with head flashing and hissing.

In late March she began to show signs of sloughing and on 18th April she sloughed very badly – the skin coming away in small pieces. This fragmentation of the skin also takes place in gravid *B. gabonica* females and is one of the indications that parturition is imminent.

At 17h00 on 6th May 1988 it was obvious that she had given birth during the day but all that was immediately visible were four stillborn young, three infertile eggs and one very small, live but unsloughed baby. A thorough search was made but, owing to the dense vegetation, only two other neonates were discovered before it began to get too dark to look further.

7th May: As no more neonates were visible, the adults were removed from the enclosure and the sprinklers turned on. Almost immediately numerous babies were observed to be moving around and during the course of the day thirty-seven were collected. During the following day two more were found – making a total of forty-two live young. In both colouration and markings the babies were exact replicas in miniature of the adults – but, of course, as with *B.g. gabonica* no two were exactly alike. The adults were returned to the enclosure and the neonates were sexed, weighed and measured (Table 2).

TABLE 2

Mean mass and length of 42 neonate *B. nasicornis* born 6th May 1988. 27 males and 15 females.

	Mean Mass (g)	Mean Length (mm)
Males	19.81	243.96
Females	20.00	241.94
Total	19.89	243.09

CARE OF THE YOUNG

With the exception of the small, unsloughed male all the young were perfect specimens and all had sloughed prior to collection from the enclosure. The unsloughed male was assisted by soaking in warm water with manual removal of the skin, but it never really thrived and eventually died about two weeks later.

The babies were offered new-born mice within a few days of birth and, although a few individuals took them readily, it became apparent that getting the majority to feed was indeed going to be a very difficult task. Over the next few weeks more were induced to eat by putting food in their mouths, but this left a small number which would not take food even if were placed in their mouths, and so it eventually became necessary to force feed them. It is interesting to note that the females fed more readily than the males and all of the ones which eventually had to be force fed were males. At the time of writing (December 1988) most of the young are still having to be hand fed. A number of the young were passed over to the Bulawayo Natural History Museum and I have been informed that a number of reluctant feeders have readily taken small toads (D:G. Broadley, pers. comm.). At this time of the year in Harare small toads are not yet available so we have not had the opportunity to try this for ourselves. In any case, we would like to persevere with the feeding of mice as this will make feeding easier in the future by eliminating the need to wean them back to rodents. It is interesting to note that baby *B. arietans* readily take small toads but change over to rodents as they mature.

Although the individual babies have received approximately the same amount of food, it has become apparent that those which voluntarily took food are doing better and growing faster than those which were induced to feed by putting food in their mouths and these, in turn, are doing better than those which had to be force fed. The former are now, on average, over twice the size of the latter (Table 3).

TABLE 3.
Mean Mass and Length of 24 baby *B. nasicornis* as at 5th November 1988.

Group 1. Voluntary feeders
Group 2. Hand fed
Group 3. Force fed

Group	Mean mass (g)	Mean length (mm)	No. males	No. females
Group 1	69.94	340.60	3	5
Group 2	42.79	305.41	6	6
Group 3	33.23	296.25	4	–

We have found that some baby *B.g. gabonica* also give problems with feeding but in the one hundred and fifty or so which we have bred over the past few years, we have never yet had a litter which was as difficult as this litter of *B. nasicornis* is proving to be.

All the babies sloughed immediately after birth and some started to slough for the second time at about three months. This depended on how well they were doing, and some are now undergoing their third slough at seven months, while two are still only just starting their second.

The litter has now been split into five as a precaution against accident or disease, with one batch going to the Bulawayo Natural History Museum, and another batch to another herpetologist. The remaining ones are split into good, medium and poor feeders – the good feeders are now in an outside enclosure while the others are still in indoor cages.

DISCUSSION

When the breeding of *B. nasicornis* was first considered it became obvious that, to be reasonably sure of success, the snakes should be given as much space as possible in conditions which were as natural as possible. Space was no problem nor was the provision of thick vegetation, a bunker to hide in and a sprinkler system to provide for watering. However, all this entailed the use of an outdoor enclosure in a climate very different from that which would be experienced by the snakes in Ghana and initially we were very worried by this aspect. However, we need not have concerned ourselves as they acclimatised extremely well to the extent that both the male and the gravid female were left in the enclosure to over-winter, where the minimum night temperatures dropped to as little as +2°C on some occasions. During the day the gravid female basking in the sun could experience temperatures in excess of 30°C. This did not seem to have an adverse effect on her except for perhaps the rather long 'gestation' period of eleven to fourteen months (the first confirmed mating took place on 21st March 1987 and the last on 1st June – the births taking place on 6th May 1988). Although a very close watch was kept after 1st June no further matings were observed and, from the positions of the male and female in the enclosure, no contact took place between them thereafter. Again we are faced with the possibility of sperm retention, delayed fertilisation or delayed development of the embryos as with *B.g. gabonica* (Akester, 1979).

B.g. gabonica has a well defined mating and breeding season in Zimbabwe lasting from late March until early June and coinciding with the onset of the colder months and the end of the rainy season (Akester, 1979, 1984). However, in the absence of relevant data it was assumed that the mating season would, in the case of *B. nasicornis*, not be so well defined and it came as a surprise that it coincided exactly with that of our indigenous *B.g. gabonica*. Whether the natural breeding and mating season just happens to fall at the same time as that of *B.g. gabonica* in Zimbabwe, or whether the captive *B. nasicornis* have adapted and adjusted to the conditions in Zimbabwe is a difficult question to answer.

Plate 1. Adult *Bitis nasicornis* showing cluster of three pairs of horns and very strongly keeled dorsal scales which resemble a miniature shark's fin.

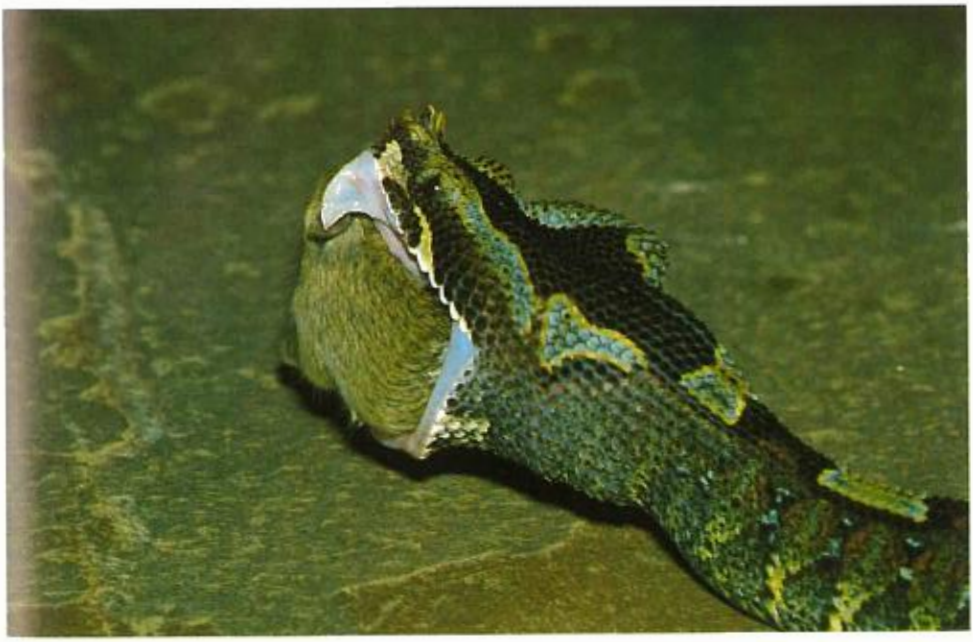

Plate 2. Head of feeding juvenile *Bitis nasicornis* showing prey being pulled into mouth with fangs.

The pre-natal behaviour of *B. nasicornis* shows an interesting parallel with that of *B.g. gabonica*. Both species become very aggressive in the latter stages of pregnancy with head flashing and minatory hissing but usually without actual strikes being made. The final slough before parturition is always fragmentary with the skin breaking up into small pieces leaving bits sticking to the body for several days. Although gravid *B.g. gabonica* females usually take no food at all during the whole period of pregnancy, the *B. nasicornis* female fed well at the beginning and only in the later stages stopped feeding altogether. Gravid females of both species bask in the sunlight but towards evening coil up tightly in places where the heat is retained – for example, among the rocks and on the cement surrounded of the drain in the enclosure.

Although it is not possible to draw accurate conclusions based on the evidence of a single litter of *B. nasicornis*, it would appear that it is more difficult to induce neonate *B. nasicornis* to commence feeding on rodents than it is to start feeding baby *B.g. gabonica* on them.

It is intended that this study will continue to record the growth rate and behaviour patterns of the young *B. nasicornis* and ultimately, when they are mature, extend to the examination of the possibility of male combat occuring in this species.

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A COLLECTION OF REPTILES FROM THE KALAKAD WILDLIFE SANCTUARY, TAMIL NADU, INDIA

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SUMMARY

A collection of reptiles from the Kalakad Wildlife Sanctuary located in Tamil Nadu, India is reported. The collections were made during 1984 and 1987 and they include two species of tortoises, 12 lizards and 12 snakes.

INTRODUCTION

Comprehensive faunistic studies of geographically limited and protected areas such as sanctuaries and biospheres are scarce in India. However, fishes, birds and mammals have been dealt with while the reptiles, despite the fact that they constitute a major component of the biota in any area, are ignored. The only available general works of reference on this group are those of Malcolm Smith's (1931, 1935, 1943) celebrated volumes in the Fauna of British India series and Murthy's (1981-1985) papers. In the circumstances the recent faunistic studies conducted by the Southern Regional Station of the Zoological Survey of India (ZSI), Madras in the heart of the Kalakad Wildlife Santuary (KWLS), Tamil Nadu, India is a good beginning. This paper reports on the collections which are the best samples of the unique reptile fauna of the evergreen forests of Kalakad, uncontaminated by man and others.

A definitive herpetology of the santuary should, however, await further exploration. It is felt, therefore, that the present paper, which records the great majority of reptiles inhabiting the KWLS, will stimulate further herpetological investigations in the area.

PHYSIOGRAPHY OF THE KALAKAD SANCTUARY

The Kalakad Wildlife Sanctuary is located in Nanguneri Taluq, Tirunelveli District of Tamil Nadu and lies between latitudes 8°25'N and 8°35'N and longitudes 77°25'E and 77°35'E. The hills are covered with dry deciduous forest on the lower slopes and evergreen (shola type) forests on the upper reaches, crossed by rivers and mountain streams. The highest peak is Kalakad Peak (1775 M) and the other noteworthy peaks are Velimalai (1011 M), Kakachi (1233 M), Netterikkal (1350 M), and Tiruvanamalai Peak (1387 M). Of the small but useful rivers springing from the hills, mention should be made of Pachayar, Kilmanimuthar, Nambiar, and Kodumudiar.

With an evolutionary lineage dating back to about 50 million years, the KWLS could boast of the richest and least disturbed patch of 100_2 km of shola forest found in Peninsular India today. It is, therefore, appropriate that the entire Kalakad Reseve Forest was converted into a Wildlife Sancutary in 1976.

ACCOUNTS OF SPECIES

Turtles and Tortoises
Family EMYDIDAE

Melanochelys trijuga trijuga (Schweigger) 1814
Madras Pond Tortoise
Found basking on the rocky edge of the streams. Three examples were taken. Common.

Family TESTUDINIDAE

Geochelone elegans (Schoepff) 1792
Indian Star Tortoise.
A juvenile and adult were picked up from the grassy slopes near Asthan Koil. The most common and most familiar of the land tortoises of India.

LIZARDS
Family GEKKONIDAE

Cnemaspis ornata (Beddome) 1870
Ornate Dwarf-Gecko
Two examples were taken from under stones in Kuliratti Estate. A forest species.

Dravidogecko anamallensis (Gunther) 1875
One example, found under stones in the Kuliratti Estate, was picked up. A rare gecko, restricted to the Anaimalais, Palnis and Tirunelveli Hills of the Western Ghats.

Hemidactylus leschenaulti Dum. & Bibr. 1835
Bark Gecko
One adult was chased out of its hideout under the bark of a giant tree in Sengeltheri and collected. Mainly a tree gecko but often enters human dwellings.

Family AGAMIDAE

Sitana ponticeriana Cuvier 1829
Fan-throated Lizard
One juvenile was picked up from the forest path in Sengeltheri. The Indian agamid with only four toes. Very common.

Calotes versicolor (Daudin) 1802
Indian Garden Lizard
Several samples from all the collecting stations were taken. A diurnal, arboreal lizard found throughout India.

Calotes grandisquamis Gunther 1875
Large-scaled Calotes
One specimen, a gravid female, was collected alongside Pachayar River. Recorded only from the Western Ghats. First record from Tirunelveli Hills.

Calotes calotes (Linn.) 1758
Green Calotes
One juvenile was picked up while it was crossing the forest path near Thalai Odai. Recorded from the hilly areas both in Eastern and Western Ghats. Also occurs in the Nicobar Islands and Sri Lanka. Though expected to be found in the sanctuary, the specimen under study constitutes the first authentic record.

Calotes elliotti Gunther 1864
Two examples were taken from the Sengeltheri forest. A hill species, recorded from the dense forests as well as the jungles at low elevations.

Psammophilus dorsalis (Gray) 1831
Peninsular Rock Agama
Two adults, basking on the rocky outcrops around Kombiar, were captured after a long chase. Found both in the plains and hills up to 2000 M. Very common in the Nilgiris and in Karnataka, especially around Bangalore.

Family CHAMAELEONIDAE

Chamaeleo zeylanicus Laurenti 1768
Indian Chameleon
One sub-adult was picked up from low bushes of Thekkadu Charagam. Common. Restricted to the wooded districts of the Gangetic plains, southern India, Pakistan and Sri Lanka.

Family SCINCIDAE

Mabuya macularia (Blyth) 1853
Bronze Grass Skink
Four examples were picked up from the leaf litter in the forest at Sengeltheri. A common skink, found throughout South India and Sri Lanka.

Mabuya beddomii (Jerdon) 1870
One example was picked up from under stones in Kuliratti Estate. Found only in South India, both in plains and hills.

SNAKES
Family COLUBRIDAE

Elaphe helena (Daudin) 1803
Trinket Snake
One example was picked up in Kuliratti Estate. Mainly a hill species, often found near the cultivated areas and human settlements. Common throughout India, Sri Lanka and Pakistan.

Liopeltis calamaria (Gunther) 1858
Striped-neck Snake
One specimen was taken from the leaf litter in Kavapatti Odai. A widely distributed hill species but is rarely seen.

Oligodon travancoricus (Beddome) 1877
One example was picked up in the Vallioor Reserve Forest Office Complex. Although expected to be found throughout the Western Ghats, it is, however, uncommon.

Xenochrophis piscator (Schneider) 1799
Checkered Keelback Water Snake
Several examples were seen swimming away in the streams and rivers of the sanctuary. One adult was picked up near Thalai Odai. The commonest water snake of India.

Amphiesma beddomei (Gunther) 1864
Three examples were caught from the water edge of Sengeltheri forest. A hill species, restricted to the Western Ghats.

Ahaetulla nasuta (Lacepede) 1789
Common Green Whip Snake
Two specimens were picked up from the Gooseberry Tree in the forest opposite Sengeltheri Rest House. Common Whip Snake of India, found both in plains and hills.

Ahaetulla dispar (Gunther) 1864
One juvenile was collected from the high grass on the edge of Keelamanimuthar River. Restricted to the Western Ghats. The specimen under study is an interesting record from the Tirunelveli Hills.

Ahaetulla pulverulenta (Dum. & Bibr.) 1854
Brown Whip Snake
Two examples were captured in the Sengeltheri Forest. A widespread species but not well represented in collections. First record for the Kalakad Sanctuary.

Family ELAPIDAE

Calliophis melanurus (Shaw) 1802
Slender Coral Snake
One specimen was collected from among stones in the Kodamadi Estate. Found throughout India but is rarely seen because of its nocturnal habits.

Family VIPERIDAE

Hypnale hypnale (Merrem)
Hump-nosed Pit Viper
Found in abundance in all situations of the sanctuary. Three examples were captured at different camps. Seems to prefer rocky areas situated near streams. Arboreal and terrestrial. Retricted to the Western Ghats (India) and Sri Lanka.

Trimeresurus macrolepis Beddome 1862
Large-scaled Pit Viper
An adult, resting on the branch of a small tree, in Majolai forest was captured. Found on the ground as well as among the bushes in other localities. Occurs in the hills of both Western and Eastern Ghats (India).

Trimeresurus malaburicus (Jerdon) 1854
Malabar Pit Viper
Commonly seen on the rocks and boulders situated on the banks of the rivers/streams throughout the sanctuary. Three examples were picked up from the evergreen forests of Sengeltheri, Kavapatti Odai and Nambi Kovil. A common hill snake of Western and Southern India.

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THE COMMON ASIATIC TREEFROG *(RHACOPHORUS LEUCOMYSTAX)*: CARE AND BREEDING IN CAPTIVITY

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INTRODUCTION

This robust frog is occasionally available from dealers under various English names. These include Golden Treefrog and Asian Flying Frog; this can be very confusing as the former name is more correctly applied to *Litoria (=Hyla) aurea* and the later to *Rhacophorus reinwardtii.* Despite this it must be said that this frog frequently displays a golden colouration and although it does not have the extensive webbing or skin folds normally associated with the flying frogs it is a prodigious leaper. This leaping ability certainly at times (particularly when trying to chase one around a room) seems at least as good as flying!

It is unfortunate that this frog does not appear to have achieved the popularity in captivity of many of the *Hylidae* as it offers many advantages. Amongst these are a tolerance (although not necessarily the enjoyment) of a wide temperature range, ease of maintenance and feeding, high resistance to the common amphibian diseases, and an attractive appearance. Additionally, although they are primarily nocturnal it is common for them to be active in daytime.

SPECIES DESCRIPTION

As adults the males are about 50-60mms in length whilst the females can be 1½ times this size and considerably bulkier – easily equal in size to if not exceeding a mature Common Frog *(Rana temporaria).* The "normal" colouration is a beige to creamy gold with darker markings on the back consisting of longitudinal stripes or an 'X' or 'Y' shape towards the front. There is a thin dark stripe running from the eye to just behind the foreleg and the backlegs display dark transverse bands on top and a lighter mottled or marbled effect beneath. Like most frogs the colouring can vary widely. An almost pure gold at one extreme can change to what can best be described as a blotchy brownish grey. (Photograph-*Zimmerman*, 1986).

These frogs are highly vocal. The males call frequently during the evenings with either a short clicking sound or a more prolonged trill. The female appears to be voiceless with the exception that on occasion she has when touched opened her mouth and emitted what can only be described as a human scream. It may be that this is an attempt to deter predators. It certainly deterred this herpetologist the first time it was experienced!

CARE AND BREEDING

A number of tadpoles of this species were reared on behalf of a colleague and the newly metamorphosed treefrogs were housed in an aquaterrarium measuring 60 cm. square and 90 cms. in height. About a third of the floor area was water to a depth of 15 cms. and the remainder filled with peat topped with bark chippings to a similar total depth. Within this were planted *Scindapsus, Dieffenbachia, Maranta* and *Vriesea* to provide climbing and hiding places with broad leaves overhanging the water for spawning purposes. The plants were supported by twigs and a moss covered branch. Daytime lighting was provided by an ordinary fluorescent tube with an external drive and heating by a thermostat controlled blue lightbulb within the range 22-30 deg. C. The water was filtered through a power filter and returned via a small waterfall in an attempt to increase humidity. An aquarium heater set at 22 deg. C. was fitted.

The froglets were fed initially on hatchling House Crickets *(Acheta domesticus),* Fruit fly *(Drosphila sp.),* Buffalo Worms *(Alphitobius diaperinus),* and small Mealworms *(Tenebrio molitor)* . Growth was rapid and was reflected in food size and type which included many a passing moth. After about four months it was possible to differentiate sexes by size alone. At this stage 2 males and a female were retained in the hope of successful breeding. Spasmodic calling from the males was already heard. This calling intensified gradually reaching a peak

as the frogs were approaching 9 months old in September. Attempts were made to encourage breeding by frequent spraying and although amplexus was frequently observed nothing came of it. It was noteable that even though the frogs were in a centrally heated house increases in calling and amplexus were most commonly associated with times of rainfall and low barometric pressure. Unfortunately it was beyond my capability to influence the latter so as a consequence the frogs were left very much to their own devices. In October we suffered a power cut while out of the house resulting in the filter motor burning out. This caused a reduction in humidity. Nevertheless calling and amplexus heightened and about a fortnight later the frogs spawned. As these frogs were foam nesters it was anticipated that the nest would be hanging from a leaf or branch over the water but it was in fact stuck in a corner of the aquaterrarium – fortunately still overhanging the water. After about 4 days the first tadpoles dropped from under the nest which was heavily sprayed thereafter until hatching was completed. The tadpoles, totalling about 200, were surprisingly small in size – less than 4 mms. in length – and still carried a considerable egg yolk.

REARING OF TADPOLES

About half the tadpoles were removed to be reared in an aquarium, also filtered and heated, whilst the remainder stayed in situ. The tadpoles were fed principally on rabbit pellets with occasional fish flakes and pieces of lettuce leaf. As I had a large number of other tadpoles, rearing accomodation was limited resulting in a degree of cannibalism – a frequent problem with overcrowding. Nevertheless the majority survived, some reaching lengths of 40mms overall within a month.

Metamorphosis commenced at this stage, the newly emerged frogs measuring between 10 and 15 mms. Froglets continued to metamorphose over a period of about 3 months. The froglets were reared as described above and growth was equally rapid, resulting in the anomalous situation of frogs from the same brood measuring anywhere between 15 mms and 75 mms. In all, well in excess of 130 frogs have metamorphosed successfully. The vast majority of these have thrived despite crowding. Some of the males have already started calling at the time of writing i.e. at 4 months of age and it is confidently expected that further generations can be bred.

SUMMARY

These frogs have proved extremely enjoyable to keep. Once the accomodation is set up there is very little difficulty in their upkeep. Whilst their appetites are considerable this is made more tolerable by their willingness to eat almost any insect. There have been no health problems apart from an intestinal protrusion in one of the males which readily responded to being gently but firmly pushed with oily cotton wool *(Zimmerman,* 1986). The frequent calling is fortunately a rather pleasurable sound and tends to lull one to sleep rather than cause insomnia. I would thoroughly recommend them as their ease of upkeep and lack of tendency to hide in the most impenetrable undergrowth more than compensates for their lack of the bright greens associated with the more commonly kept species.

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NOTES ON THE GENUS *BOMBINA* OKEN (Anura: Bombinatoridae): III. ANATOMY, SYSTEMATICS, HYBRIDIZATION FOSSIL RECORD AND BIOGEOGRAPHY

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INTRODUCTION

This paper represents the last portion in a three-part series of papers summarizing pertinent information available on *Bombina*. Overall the series synthesizes information on distribution and characteristics of recognized species of *Bombina*, together with aspects of external appearances, morphology, life history, systematics and taxonomy. This paper focusses on aspects of anatomy, systematics, hybridization, fossil record and biogeography of *Bombina*.

ANATOMY

Embryology

Ossification in *orientalis* commences as early as Gosner Stage 37 (hind limbs with all five toes distinct), but the full complement of adult bones is not attained until Stage 46 (metamorphosis complete) (Hanken and Hall, 1984). The number of bones present at intermediate stages is poorly correlated with external morphology. The modal ossification sequence as presented by Hanken and Hall (1984) is as follows: frontoparietal, exoccipital, parasphenoid, septomaxilla, premaxilla, vomer, nasal, maxilla, angulosplenial, dentary, squamosal, quadratojugal, pterygoid, prootic, (interfrontal), sphenethmoid and mentomeckelian.

Embryonic stages and timing of development of *orientalis* has been investigated by Sussman and Betz (1978). *Bombina orientalis* is the only species of this genus that has an interfrontal bone (Tschugunova, 1981).

Pedicellate teeth are present in *bombina* and *maxima*. In *B. variegata* there is no clear division crown and pedicel (Parsons and Williams, 1962; Viertel, 1986). Vomerine teeth are situated slightly posteriorly to the inner nasal openings and arranged in two short rows and are distinctly pedicellate (Viertel, 1986). Marginal and vomerine teeth are bicuspid (see Viertel, 1986 for illustration).

De Villiers (1922) investigated and described in detail the structure and development of the pectoral girdle of *Bombina variegata*. The episternum develops relatively late during postmetamorphosis. The cleithrum develops from the cutis bordering the suprascapular, and the clavicle develops between the epidermis and the procoracoid. The omosternum fails to develop.

Larval morphology

Larval mouthparts of European *Bombina* are illustrated by Engelmann *et al.* (1985). *Bombina bombina* has a triangular upper lip, with three rows of denticles on the lower lip that are sometimes interrupted at the midline. In *variegata* the upper lip is semicircular, and the lower lip has three rows of denticles rarely interrupted at the midline.

The dorsal tail fin in larvae may *(bombina)* or may not *(variegata)* reach the middle of the dorsum. Tadpoles have a black reticulation on the tail. The spiracle is situated more closely to the anus than the mouth. Additional detailed descriptions of the tadpoles of the European *Bombina* can be found in Michalowski (1966) and Lanza (1983).

The tadpoles of *Bombina* have six short gill-filaments developed on a single large fleshy base. The tail crest is strongly developed in the stream breeders and reaches the nuchal region.

Skeletal anatomy

The cranial anatomy of *Bombina variegata* has been described extensively by Slabbert (1945). Following is a summary of some of the findings. The olfactory capsule has a well-developed lateral wall; the medial nasal gland lies extra-capsular; the premaxilla lacks palatal squames; palatine entirely absent; frontoparietals are separated anteriorly by a wide stretch of connective tissue; the side walls of the cranial cavity in the orbital region are mainly membranous; three foramina acustica are present; the hyomandibular branch of the facial nerve passes through a narrow cranio-quadrate passage; the pseudobasal process articulates with a pointed ventral ledge of the otic capsule and the jaw suspension is autostylic; the sound conducting apparatus is reduced, with only the operculum being present (this perhaps in association with lack of vocal sacs); cornu hyale confluent with otic capsule; and the mentomeckelian is the only ossification of the Meckel's cartilage, which forms a synostosis with the dentary.

Böhme (1977) lists posteranial characteristics such as the presence of opisthocoelous vertebrae with free ribs; a slightly dilated sacrum, that can be quite variable (Madej, 1965); a free urostyle with lateral apophyses and a pars ascendens ilii that is less pronounced than the pars descendens ilii. The latter character is used to distinguish *Bombina* and European discoglossids *(Alytes & Discoglossus)* from other European Anurans (Böhme, 1977). A vexillum (= dorsal fin on pubic ala) is absent in *Bombina*. The sacrum of *Bombina* has a single condyle that articulates with the presacral vertebra.

Karotypes

Bombina bombina and *B. variegata* show a strictly corresponding diploid set of 12 chromosome pairs for both sexes (Moreschalchi, 1965, 1971; Ullerich, 1970; Popov, 1983). The diploid number of *orientalis* is also 24 (Sato, 1938). There are six large, one medium, and five small pairs of chromosomes. All chromosomes are metacentric, except the sixth pair which is submetacentric. A secondary constriction is observed on the long arm of the seventh and the short arm of the eighth chromosome. No heteromorphic chromosome was found (Jiang *et al.*, 1984).

SYSTEMATICS

The taxonomy and systematics of *Bombina* is quite confusing. Sokol (1975, 1977) erected the suborder Discoglossoidei as a clade for the Leiopelmatidae *(Ascaphus* and *Leiopelma)* and Discoglossidae *(Alytes, Barbourula, Bombina,* and *Discoglossus).* The fusion of the copula to the hypobranchials, and the partially adherent anterior filter valves are two derived features of the larvae (Type 3) in support of the monophyly of this taxon. The latter character is also present in pipoid and microhylid larvae (Sokol, 1975). Dubois (1983) resurrected the subfamily Bombinatorinae Gray within Discoglossidae to include *Alytes, Bombina* and *Bombinator.* Tian and Hu (1985) furthermore suggest the subdivision of *Bombina* into the subgenera *Bombina,* containing the Palaearctic *bombina, variegata* and *orientalis,* and the Oriental *Glandula* containing *maxima, microdeladigitora* and *fortinuptialis.* This division was based on the presence of small, regular and evenly spaced warts in the *Bombina*-group, whereas these dorsal warts are irregular and unevenly spaced in *Glandula*-group; the absence of a parotid gland in the *Bombina*-group; the presence of black spines on the chest of males in the *Glandula*-group; and the Palaearctic distribution of the *Bombina*-group versus the Oriental distribution of the *Bombina*-group.

Maxson and Szymura (1984) using micro-complement fixation showed that *Bombina* and *Discoglossus* shared a common lineage, separate from *Alytes* and *Baleaphryne.* These findings do not support Lanza *et al.*'s (1975, 1976) differentiation of Discoglossidae into two separate families: Discoglossidae *(Discoglossus)* and Bombinidae *(Bombina* and *Alytes).* The latter study was based on qualitative serological studies of serum proteins and *Barbourula* was not tested.

Olmo *et al.* (1982) could not resolve relationships within Discoglossidae because the karyotype and genome of *Discoglossus, Alytes* and *Bombina* are so heterogeneous and different from each other.

Cannatella (1985), showed the "Discoglossidae" to be paraphyletic, and correctly infers that the aforementioned biological estimates hinge on the underlying assumptions that the Discoglossidae (*sensu* Griffiths, 1963) was monophyletic. The possibility that some genera may be more closely related to other anurans was not tested. *Alytes* and *Discoglossus* are each

others' closest relatives and are more closely related to other frogs than they are to *Bombina* and *Barbourula*. Cannatella (1985) therefore established the family Bombinatoridae to include *Bombina* and *Barbourula*. The presence of an unusual flange on the quadratojugal and paired ossifications of the hyoid plate are unique derived characters in support of the monophyly of Bombinatoridae (Cannatella, 1985).

Bombina itself has two unique apomorphies that support its monophyly. In all species of *Bombina* the anterior ramus of the pterygoid extends forward, curving medially to invest the posterior margin of the planum antorbitale. The otic ramus of the squamosal is present and well-developed in all frogs except in *Bombina* in which it is greatly reduced (Cannatella, 1985).

Within *Bombina* the relationships have not been fully worked out. Mertens (1928) suggests that *orientalis* descended from *bombina* and *maxima* from *variegata*. Terent'ev (1949) in contrast using biometrical data indicated that *orientalis* was derived from *maxima*. Using colouration patterns Stugren (1966) opts for the notion that *orientalis* and *variegata* are more closely related to one another than either is to *bombina*. Maxson and Szymura (1979) compared *bombina*, *orientalis*, and *variegata* immunologically and discussed relationships between these three species, with *bombina* and *variegata* being each others' closest relatives. This is further supported by the genetic similarity of these two species (Szymura and Farana, 1978). Schneider *et al.* (1986) suggest that the mating call of *orientalis* is close to that of *variegata* and that the parameters of the mating call of *bombina* suggests no relationship to either *variegata* or *orientalis* further supporting Stugren's (1966) hypothesis. Tian and Wu (1981) in the original type description of *fortinuptialis* indicate that this species is related to *microdeladigitora*. This is in contrast to the original type description of *microdeladigitora* (Liu and Hu, 1961), in which the authors indicate a relationship with *maxima* [1].

HYBRIDIZATION

Natural hybrids of European *Bombina* have been known for quite some time (Mehely, 1905). Stable hybrid zones are identified in Poland (rather narrow zone through allopatric hybridization, Szymura, 1976; Szymura and Barton, 1986), in Czechoslovakia (Lac, 1961), in Lower Austria (zone of allopatric hybridization, Gollman, 1984) and in Yugoslavia (sympatric hybridization, Szymura, 1981; Gollman, 1986). Descriptions and characteristics of hybrids have been extensively investigated by Michalowski (1961, 1966), Michalowski and Madej (1969) and van den Elzen (1979). Characters for field identification of hybrids are provided by Gollman (1987).

Alleles from either species predominate clearly in each of the populations within this zone, but most of the individuals found there are from hybrid origin. Hödl and Gollman (1985) have furthermore investigated the bio-accoustics of these hybrid populations.

Raehmel (1974) reports on successful hybridization between *B. variegata* and *B. orientalis*.

FOSSIL RECORD

Fossil *Bombina* are known from the Lower Miocene of West Germany (Sanchiz and Schleich, 1986); the Middle Miocene of Poland (Mlynarski *et al.*, 1982); the Upper Pliocene of Central Poland (Mlynarski *et al.*, 1982; Sanchiz and Mlynarski, 1979); the Upper Pliocene-Lower Pleistocene of Czechoslovakia (Hodrova, 1981, 1985; Sanchiz and Szyndlar, 1984); and the Lower Pleistocene of Italy (Vergnaud-Grazziny, 1970).

BIOGEOGRAPHY

Stejneger (1907) indicated that *Bombina* originated from South Eastern Asia and dispersed northward and into Europe. Mertens (1928) proposes the late Tertiary as the timing of this European dispersal. This is in contrast to the European origin of *Bombina*, with subsequent dispersal into Asia as proposed by Friant (1960).

Mertens (1928) (further refined by Madej, 1964 and Arntzen, 1978) discuss the vicariant effect of one or more Pleistocene glaciations on the migration of *bombina* and *variegata* in Europe. Glaciation split the European stock into a western lineage *(variegata)* and an eastern lineage

[1] It should be noted that *fortinuptialis* was described later than *microdelagitora*.

(bombina). Bombina variegata sought refuge on mountain tops and differentiated, but was also pushed towards southern Europe, whereas *B. bombina* remained a lowland force. In the contact zone beween these two species (see above), enclaves of *variegata* are found on mountain tops. The mountain refugia are hypothesized to have arisen because of the northward postglacial advances of *bombina* that has superseded *variegata* in the surrounding lowlands in a process of hybridization and competition. Present day *bombina* is restricted to areas below 250m. Szymura (1983) using Nei's genetic distance between Polish *bombina* and *variegata*, suggests a Pliocene separation of these species. The Pliocene divergence proposed by Szymura (1983) is earlier than the Pleistocene separation as proposed by Mertens (1928) and Arntzen (1978).

Pracht (1987) furthermore indicates that the speciation between the two European *Bombina* is not complete as evidenced by the hybridization in the postglacial contact zones (see above).

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AMPHIBIAN CONSERVATION EFFORTS IN HUNGARY

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INTRODUCTION

In Hungary all the amphibians and reptiles are protected by a law which was issued by the head of the National Authority for Environmental Protection and Nature Conservation. (The Ministry of the Environment and Water Management was also formed in 1988 partly from this authority). In spite of this nobody has ever been sentenced for killing or torturing a native amphibian or reptile.

As Hungarian herpetofauna is declining there is an urgent need for research and conservation activities. The first organized "Hungarian toad rescue" occurred in 1987. In April twenty five people spent their spare time helping frogs and toads in the Börzsöny mountains in northern Hungary. Two sites were selected (Parassapuszta and Királyrét).

Parassapuszta is at the border between Czechoslovakia and Hungary, where an international road goes between the flood plain of the River Ipoly and the mountains. Unfortunately an increase in the number of cars (approximately 1,000 a day) crossing the border during the toad migration occurs because it coincides with the end of the skiing season in Hungary, but not that of Slovakia.

Three years ago efforts were made by the Ministry of Traffic to solve the problem in Parassapuszta by constructing fences and ditches. Unfortunately, however, in 1988 the fences, which directed the animals towards culverts, were neglected and the ditches along the road filled with rubbish, leaves and branches enabling amphibians to clamber up to the road.

The second site is at Királyrét, a popular tourist centre, where the main threat to the amphibian population is people. There are frequent sightings of people deliberately harming and killing amphibians (the author for example, found a common toad, *Bufo bufo*, female on a hook a metre above the ground this year on a sunny Saturday afternoon).

Our methods were the same at both sites. Frogs and toads were collected, measured and sexed, placed in buckets and taken to the other side of the road or to the breeding pond. At Parassapuszta they were helped during the night, the most active period being between 9 pm and 11 pm, while at Királyrét they were helped during the day. At this site we not only rescued and counted the animals but we also advised the tourists on how best to keep the disturbance to a minimum. Most of the people approached were found to be cooperative.

As a result, a total of nearly 2,500 frogs and toads were transported to breeding sites in the area. The species, in descending order of abundance were:

- Common Toad *(Bufo bufo)*
- Spade-Foot Toad *(Pelobates fuscus)*
- Agile Frog *(Rana dalmatina)*
- European Tree Frog *(Hyla arborea)*
- Fire-Bellied Toad *(Bombina bombina)*
- Green Toad *(Bufo viridis)*
- Edible Frog *(Rana esculenta)*

In spite of its relative abundance at Parassapuszta the occurrence of *Pelobates fuscus* was first recorded there by our group.

Most of the participants came together regularly and as it seemed to be a permanent company, we formed the Toad Action Group (in Hungarian, Varangy Akciósoport) within the Nature Conservation Club of University Eötvös in autumn, 1987.

Its objectives were three-fold. It aimed to be involved in amphibian conservation, to do scientific work and to conduct environmental education.

The arrangements for the second "Help toads across the road" Campaign began in October, 1987 with a lecture in a leisure centre. Later we held numerous lectures in schools, clubs and universities. The most important of these was a scientific meeting at the Hungarian Biological Society, Section of Zoology, where a paper on the scientific results of the first action was also accepted. Besides this we published four other articles and were also on the television and radio. Our greatest task was the organization of an "Amphibian and Reptile Day" with live specimens, films and lectures. This involved the largest number of people in the history of our club, 800-1,000, spending their time meeting these unpopular animals and getting to know them.

The second action aimed to save more amphibians, investigate other roads in the Börzsöny mountains and elsewhere and get international participation. It appears that the second action was also successful although only one of the new sites visited, Ócsa, a swamp 30 kms south to Budapest, will be visited again in 1989. At this site we found a herpetofauna which was naturally different from that of the Börzsöny mountains. It is a lowland area without a Common Toad predominance. The most abundant amphibians were the Spade-Foot Toad *(Pelobates fuscus)* and the Moor Frog *(Rana arvalis).*

In total, we helped more than 8,600 amphibians in 1988. The number of the participants increased to more than 250, with some people coming from Poland. These are quite good numbers especially if we take into consideration the fact that we got no financial support from any organisation in either 1987 or 1988.

After the second action the Toad Action Group has not stopped working because in 1988, when it was less than a year old, the Ministry of the Environment and Water Management offered it a three-year contract. The work was to investigate the building area of a planned motorway around the capital, MO. It will be at least 85 kms long; some of the plans have not yet been fixed, and it will probably cross some sites with herpetological interest. Twenty four members of the group worked on the project and the report on the first year was accepted by the Ministry. Even the recorders were surprised that during the survey eight amphibian species were found within the territory of Budapest. Although eight sites were selected for long term studies we will survey the whole system again in the spring. The whole picture is not so sunny, as most of the sites were agricultural deserts.

From the results of the more detailed survey of the second campaign, a thesis (third prize winner) was written for a student competition at the university Eötvös, Budapest, showing that research is important for us. Considerable differences were found between two populations indicating that the hypothesis that roads with heavy traffic can have great effects on local herpetofauna was valid.

The Toad Action Group has now organized its campaign for 1989. Although we realize that the final solution can only be the construction of fences, tunnels etc., we know that because of financial constraints this can only happen in the future. The research we do is also necessary so that we know how to conserve and protect our amphibians.

List of the species having been found so far in Hungary:

Urodela	Salamandridae	*Salamandra salamandra*		
		Triturus vulgaris		
		Triturus cristatus		
		Triturus alpestris		
Anura	Discoglossidae	*Bombina bombina*	Hylidae	*Hyla arborea*
		Bombina variegata	Ranidae	*Rana temporaria*
	Pelobatidae	*Pelobates fuscus*		*Rana arvalis*
	Bufonidae	*Bufo bufo*		*Rana dalmatina*
		Bufo viridis		*Rana lessonae*
				Rana ridibunda
				Rana esculenta

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