

# BRITISH JOURNAL OF HERPETOLOGY

Vol. 5 No. 7

December 1976

Published by  
THE BRITISH HERPETOLOGICAL SOCIETY  
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Contributions should be addressed to the Editor, Dr. Harold Fox, Department of Zoology, University College, Gower Street, London, W.C.1. Articles should be typed in double spacing on *one side* of the paper only. Figures should be drawn in Indian ink on plain white paper, or preferably Bristol Board and suitably lettered for publication.

## HEMIPENIAL MORPHOLOGY OF BRITISH SNAKES

By

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(Received 23/10/75)

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## INTRODUCTION

The male genitalia of snakes consist of paired, eversible structures, the hemipenes, lying in the base of the tail and opening onto the lateral margin of the posterior lip of the cloacal opening. Each hemipenis is tubular in structure, permeated with blood and lymph sinuses, and during copulation undergoes evagination such that structures lying previously on the inner surface of the organ are now externally placed. The surface of the everted organ may be smooth but is more frequently ornamented with a series of complex features consisting of spines, flounces, calyces or papillae. Regional differentiation is common. A prominent longitudinal groove, the sulcus spermaticus, along which sperm is transported during copulation, is always present although its form may vary considerably.

Hemipenial structure is remarkably constant in character and shows little intraspecific variation. Instances of intraspecific variability have been reported, however, in the Oriental genus *Calamaria* (Inger and Marx, 1962) and Neotropical genus *Rhadinaea* (Myers, 1974). Intraspecific variation in the length of the retracted hemipenis is usually restricted to 2-3 subcaudals. However, intrageneric variation is much greater and not correlated with tail length. Thus in southern African *Psammodphis sibilans* in which the subcaudals range from 88-110, the hemipenis reaches only as far as the third subcaudal, whilst in the mole snake, *Pseudaspis cana*, the subcaudals range from 58-70 with the hemipenis reaching the 32nd (FitzSimons, 1962).

Normally only the basal segment of the hemipenis is everted prior to actual insertion into the female cloaca, following which the shape of the fully everted organ is constrained by the urodaeum of the female. Thus as McDowell (1975) has noted; "although everted preparations are probably closer to the true form of the hemipenis than are dissections of inverted organs, they probably are not completely accurate indicators of the functional design of the hemipenis."

Cases of intersexuality in which snakes with functional ovaries or even well-developed embryos also possess hemipenes have been reported in *Bothrops insularis* (Hoge et al., 1959) and *B. moojeni* (Maclean, 1968). However, recently Hardy (1975) has reported the presence of small hemipenes and associated muscles in normal females of the North American hook-nosed snake, *Gyalopion canum*, and associated muscles but not hemipenes in *G. quadrangularis*.

## TAXONOMIC USE OF HEMIPENIAL CHARACTERS

The famous American herpetologist Edward Drinker Cope first employed the structural characteristics of the hemipenis in systematics, and in a comprehensive study (1895) yet to be equalled in size and scope described and illustrated the hemipenes of more than 200 species of snakes. Although Cope's hopes that the hemipenis would serve as an aid in the higher classification

of snakes were not realised, he was able to demonstrate that they were of general value in specific and generic analysis.

Dunn (1928) and Bogert (1940) attempted to use hemipenial characters in the analysis of American and African colubrid snakes, respectively, but with only qualified success, and Bogert concluded: "that penial characters, although extremely useful in gaining an understanding of generic relationships, are unsatisfactory as subfamilial characters." Underwood (1967), however, has distinguished the family Colubridae (in the restricted sense as understood by him) by the asymmetry of the hemipenis. Dowling (1974) gives this group of colubroid snakes subfamilial recognition based again in part on the asymmetrical condition of the hemipenis.

Hemipenial characters are often of value in generic and specific analysis. The two Asian pit vipers *Trimeresurus stejnegeri* and *T. popeorum* are indistinguishable on external morphology but readily separated by their spinose and non-spinose hemipenes, respectively (Loveridge, 1945). Similarly, the Southern African wolf snakes *Lycophidion capense* and *L. variegatum* often appear externally alike but have bilobed and trilobed hemipenes, respectively (Branch, 1976).

Older descriptions of snake hemipenes are often limited in their taxonomic usefulness being based on either retracted organs or misidentified snakes. In addition there is a confusion in terminology due to the absence of a standardised nomenclature of hemipenial morphology prior to the studies of Dowling and Savage (1960). Using the nomenclature suggested by these authors we present here standardised descriptions, based on everted organs, of the hemipenes of the British snakes, *Natrix natrix*, *Coronella austriaca* and *Vipera berus*. The taxonomic usefulness of this study is obviously limited, however, our main concern, besides the intrinsic value of the descriptions, is to attempt to stimulate further interest in the application of hemipenial characters in taxonomic studies.

#### TECHNIQUE FOR THE EVERTION OF HEMIPENES

The freshly-dead snake, which may be satisfactorily killed without exces-

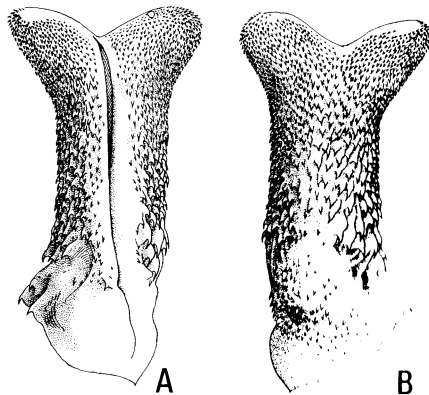


FIGURE 1:  
Right hemipenis of *Natrix natrix helvetica* (TM 43030) viewed from: (A) sulcate, and (B) asulcate sides. Scale = 5 mm.

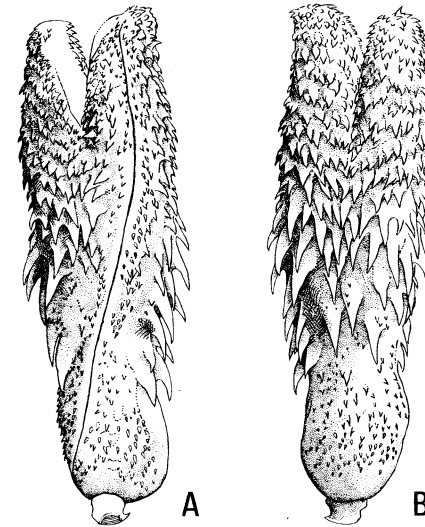


FIGURE 2:  
Right hemipenis of *Coronella austriaca austriaca* viewed from: (A) sulcate, and (B) asulcate sides. Scale = 5 mm.

sive muscular contraction by either Halothane-inhalation or an injection of dilute sodium pentobarbital or "Nembutal", is left for 1-2 hours to allow complete muscular relaxation. The tail is slit longitudinally to the left side of the mid-ventral line (for eversion of the right hemipenis) sufficiently far back to expose the *m retractor penis magnus*. This may be determined by trial dissection on the left hemipenis during which data for the retracted hemipenis, i.e. length of the hemipenis; point of bifurcation, if any, of the sulcus; point of division of the retractor muscle in bilobed hemipenes, can be recorded. The retractor muscle is severed a few mm behind its point of attachment to the hemipenis, and the tail gently squeezed in an anterior direction to evert the hemipenis. Alternatively the needle of a hypodermic syringe filled with water may be placed in the hemipenial cavity and the hemipenis everted by hydraulic pressure. Care should be taken at this stage to ensure that any terminal awns or papillae, such as found in the genera *Python* and *Bitis*, are completely everted.

When pressure is released the hemipenis will deflate, but not retract due to severance of the retractor muscle. This results in the loss or at best obscuring of the fine detail of ornamentation, and it is thus necessary to prevent deflation of the organ. A ligature placed at the base of the organ assists in maintaining inflation but often does not prevent partial collapse due to seepage of fluid through the interstitial spaces of the stretched tissue. We have found that the use of molten petroleum jelly, "Vaseline", prevents this problem.

It is easier to remove the hemipenis from the snake before final eversion with petroleum jelly. The everted but deflated organ is cut at its point of attachment to the cloaca and tied securely onto a hypodermic needle, the gauge of which is dependent upon the size of the hemipenis but which should be as large as feasible. A syringe filled with molten petroleum jelly (60-70°C) is attached to the needle, care being taken to prevent air bubbles, and the

hemipenis gently inflated. To prevent blockage of the needle by cooling petroleum jelly the hemipenis may be immersed during inflation in a beaker of warm water. Full eversion is maintained by syringe pressure and the hemipenis transferred to a beaker of ice cold water. The solidified petroleum jelly maintains full inflation and retains the fine detail of ornamentation. The hemipenis is then removed from the hypodermic needle, fixed in 10% formalin, and stored after washing in 70% alcohol.

DESCRIPTIONS OF EVERTED HEMIPENES  
*Natrix natrix helvetica* (Lacépède)

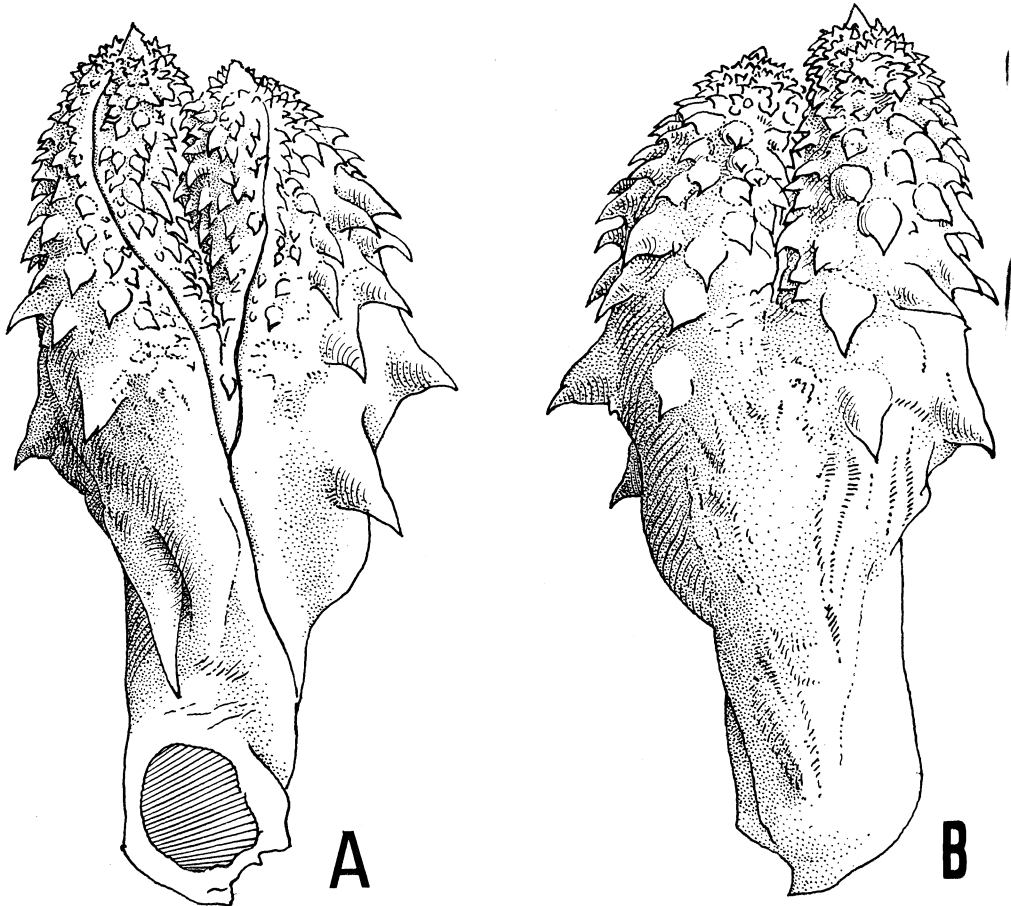


FIGURE 3:  
Right hemipenis of *Vipera berus berus* (TM 43026) viewed from: (A) sulcate, and (B) asulcate sides. Scale = 5 mm.

Voucher specimen, TM 43030 (TM = Transvaal Museum, South Africa), originally from Beaulieu, New Forest, Hampshire.

The subcylindrical organ is bilobed but only shallowly forked, and has a simple sulcus spermaticus running medially to end in the crotch between the lobes (Fig. 1A)—the “centripetal sulcus” of McDowell (1961). Ornamentation is composed of spines which reduce to spinules on the lobes and distal portion of the base of the hemipenis. The spines enlarge progressively proximally. Three enlarged spines occur on the base of the hemipenis figured; however, these are variable in number in the subspecies and may be absent. The extreme base of the asulcate surface (Fig. 1B) is sparsely covered in spinules, whilst the inner surface of the lobes is nude.

*Coronella austriaca austriaca* Laurenti

Voucher specimen (not preserved) from Dorset.

The bilobed organ is characterised by an asymmetrical sulcus spermaticus which extends in an oblique fashion to the lateral aspect (the “centrifugal sulcus” of McDowell, 1961) of the left-hand lobe (Fig. 2A) of the left and right hemipenes. Ornamentation is restricted to spines which are noticeably enlarged on the basal portion. The lobes, which are equal in length and approximately one third the length of the organ, bear spinules which reduce in size distally, and which may form 5-7 irregular transverse or oblique (pinnate) rows. The proximal region of the basal portion is covered with scattered spinules (Fig. 2B), whilst the inner faces of both lobes are nude.

*Vipera berus berus* (Linnaeus)

Voucher specimen (TM 43026) originally from Beaulieu, New Forest, Hampshire.

The organ is bilobed for approximately a third of its length and of much stouter habitus than that of the other two species. The sulcus spermaticus is divided for half the length of the organ and runs semicentrifugally up the medial aspect of the lobes to end just below the tips (Fig. 3A). Ornamentation consists of enlarged spines, those on the basal portion being particularly large. Reduction to spinules occurs distally and the lobes are apically differentiated with a small awn. The proximal portion of the basal segment is unadorned, but irregular in outline due to small longitudinal ridges (Fig. 3B).

DISCUSSION

The gross shape of the hemipenis is rarely of higher taxonomic importance although certain generalisations can be made. Thus the hemipenis of the Viperidae is always deeply forked and may even approach a divided condition, whilst that of the Typhlopidae is simple and almost unornamented. The hemipenes of the three British snakes are all bilobed but show a progression from shallowly forked (*Natrix natrix*) to deeply forked (*Vipera berus*). In addition they include representatives of the main types of sulcus condition, i.e. simple or divided, and centripetal or centrifugal.

The simple, centripetal sulcus of *Natrix* is an advanced state possibly derived by fusion from a primitive bifurcate sulcus found in the related genera *Macropophis*, *Fowlea* (= *Xenochrophis*), and *Rhabdophis* (Malnate, 1960). A stage in the possible evolution of the simple sulcus of *Natrix natrix* is shown in the closely related species *N. maura*, which has a simple hemipenis with a T-shaped sulcus.

The simple, asymmetrical sulcus, running centrifugally onto the left-hand lobe of the organ is characteristic of the subfamily Colubrinae (the classification of Dowling, 1974, has been adopted), and well illustrated in *Coronella austriaca*. This condition, which is also found in *Elaphe obsoleta* (Dowling

and Savage, 1960) and *Oxybelis fulgida* (Underwood, 1967) is considered primitive. In the more advanced condition, as shown in *Coronella girondica* (Domergue, 1962), the hemipenis is simple, the sulcus terminating on the left-hand side of the enlarged head.

Dowling (1974) states that the hemipenis of the Colubrinae is "usually spinose proximally and calyculate distally". This is true of *Lampropeltis*, *Sonora*, *Coluber*, *Oxybelis* and *Coronella girondica*, but not of *Coronella austriaca* in which the organ is spinose throughout. Similarly the hemipenis of the Viperidae usually has proximal spines and a distal area of calyces or frounces. That of *Vipera berus*, however, is spinose throughout although distal calyces are found in *V. aspis*, *V. ammodytes* and *V. lebetina*. (Domergue, 1962).

The snake fauna of the British Isles although depauperate in variety is nevertheless not without taxonomic interest. The hemipenes of these snakes show characteristic and uncharacteristic familial features, and in addition illustrate many of the basic types of hemipenial morphology.

#### ACKNOWLEDGEMENTS

We are indebted to Dr. I. Spellerberg, Department of Biology, University of Southampton, who allowed us to collect hemipenes from a smooth snake in his possession.

One of us (E.W.) expresses his gratitude to Dr. E. N. Arnold and Mr. A. F. Stimson, British Museum of Natural History, for permission to use stereo microscopes in their care.

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## ASPECTS OF BEHAVIOUR OF THE GROUND DWELLING AGAMID LIZARD, *SITANA PONTICERIANA*

By

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(Received 30/10/74)

#### INTRODUCTION

Temperature relations are of particular interest because homeotherms are evolved from primitive reptiles. Also, temperature is one factor in the control of both growth and metabolism (Prosser and Brown, 1971). Since the most important temperature adaptations of reptiles are behavioural, investigations were carried out on the ground dwelling agamid lizard, *Sitana ponticeriana* to obtain information on its behaviour at high temperature.

There would appear to be little information in the literature on the behaviour, activity and thermal characteristics of the tropical ground dwelling agamid lizard, *Sitana ponticeriana*.

#### MATERIAL AND METHODS

Critical thermal maximum (CTM) is reached when locomotor activity becomes disorganised and the animal loses its ability to escape from conditions that will lead to its death (Lowe and Vance, 1955), Lethal temperature (LT) is the temperature when respiration, that is movement of abdominal muscles, ceases and will not later be resumed (Hirth, 1963).

In order to investigate CTM and LT 6 males and 6 females lizards of known weights were maintained in different battery jars and tested for 24 hours at different thermostatically regulated oven temperatures of 30, 35, 40, 45, 46, 46.5 and 47°C respectively.

#### RESULTS

*S. ponticeriana* is diurnal and active in the morning when the sky is clear. During summer on clear days lizards were found on rocks during the 0600 hr counts (Table 1) and in winter on clear days during the 0700 hr counts (Table 1). However, active phases are influenced by light and rain. During bright, warm weather most lizards rest in the shade beneath stems or rocks. During rainy or stormy weather lizards shelter under bushes of *Barleria noctiflora* and *Randia dumetorum*.

In winter and summer from 1800 to 0600 hrs adult and juvenile *S. ponticeriana* are inactive at night irrespective of weather conditions.

At night *S. ponticeriana* sleeps at the base of bushes; they also rest in fields. The lizards plough the earth to a depth of 0.5 cm their bellies remaining close to the soil in the furrow. During this time their eyelids opened and closed frequently. Occasionally during the day, *S. ponticeriana* rested in the shade on tree trunks in a vertical position (Fig. 1).

Adults and juveniles displayed themselves on rocks (Fig. 2) and occasionally on stems (basking temperature range: 25.6-34.0°C). During basking; thermoregulatory posture, sleeping on extreme positive orientation, or vertical stance may occur.

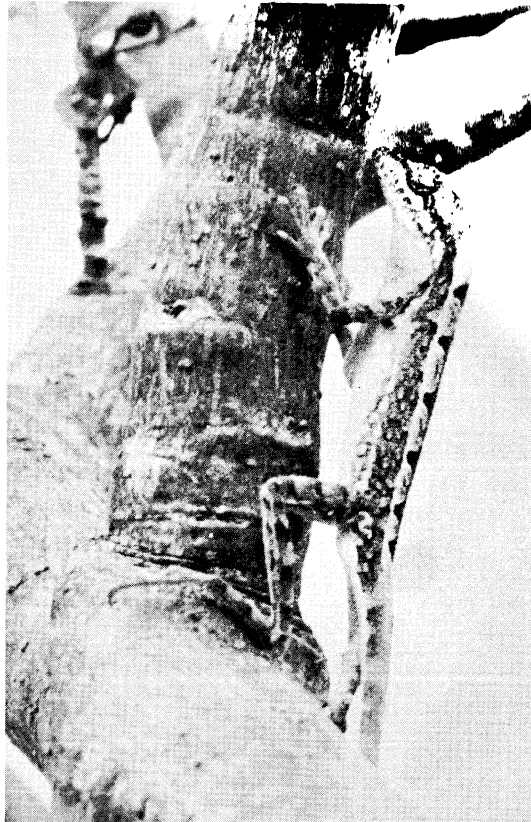


FIG. 1. Shade rest or shade basking type of behaviour in *Sitana ponticeriana*.

The body temperature of these lizards was slightly lower than their habitat temperature (Table 2). At night body temperature was also lower than that of the environment (Table 3).

The thermal thresholds of this species are: maximum voluntary tolerance:— 37.6-39.0°C; minimum voluntary tolerance:— 22.0-25.5°C. The normal activity range is 34.1-37.5°C. The preferred temperature, critical thermal maximum and lethal temperatures are 35.5°C; 46.5°C and 47.0°C respectively (Table 4).

#### SUMMARY

*Sitana ponticeriana* is a diurnal ground dwelling agamid lizard with the most active phases being from 0900 to 1200 hr and 1500 to 1700 hr on clear sunny days.

The lizard selects the base of bushes to sleep but occasionally slept on tree trunks.

The activity cycle is controlled by marked behavioural thermoregulation, influenced by ambient temperature.

Various thermal categories were determined on the basis of temperature

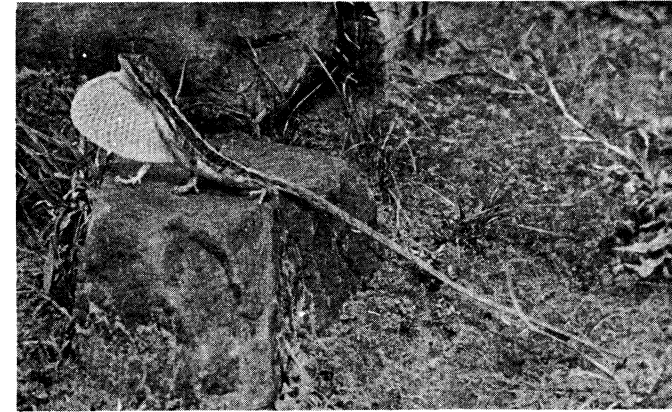


FIG. 2. Displaying male *Sitana ponticeriana* (observe the gular pouch extension; absent in case of female).

#### ACKNOWLEDGEMENTS

Dr. M. V. Subba Rao received funds from the University Grants commission of New-Delhi.

Dr. H. R. Bustard of the Australian National University and Dr. Harold Fox of University college London read the manuscript and offered helpful suggestions.

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TABLE 1. Estimates of active lizards, *Sitana ponticeriana* (June to November, 1964-1966) in the field. No = total number for all years.

Time (Hours)	Clear Sun		Cloudy Sun	
	Summer No	Winter No	Summer No	Winter No
0600	30	—	—	—
0700	45	30	30	—
0800	90	45	60	30
0900	180	90	90	60
1000	240	150	180	90
1100	210	195	270	150
1200	120	225	150	210
1300	60	135	75	120
1400	90	105	90	105
1500	210	210	210	210
1600	210	225	180	180
1700	180	165	150	135
1800	135	105	120	90

TABLE 2. Relation between body air and substratum temperature ( $^{\circ}\text{C}$ ) of *Sitana ponticeriana* between 0600 and 1200 hr. (June-November, 1965). (S.D. Standard Deviation)

Air temperature Mean $\pm$ S.D.	Substratum temperature Mean $\pm$ S.D.	Body temperature Mean $\pm$ S.D.		Number lizards observed
		Males	Females	
28.5 $\pm$ 0.5	27.5 $\pm$ 0.7	28.0 $\pm$ 0.7	28.0 $\pm$ 0.7	12
28.5 $\pm$ 0.7	28.5 $\pm$ 0.7	27.5 $\pm$ 0.5	28.0 $\pm$ 0.5	30
30.0 $\pm$ 0.5	29.5 $\pm$ 0.5	29.0 $\pm$ 0.5	29.5 $\pm$ 0.5	20
31.0 $\pm$ 0.5	30.5 $\pm$ 0.7	30.0 $\pm$ 0.5	30.5 $\pm$ 0.5	16
32.5 $\pm$ 0.7	32.5 $\pm$ 0.5	32.0 $\pm$ 0.7	32.0 $\pm$ 0.5	40
33.5 $\pm$ 0.7	33.0 $\pm$ 0.5	32.5 $\pm$ 0.7	32.0 $\pm$ 0.7	24
33.5 $\pm$ 0.7	33.5 $\pm$ 0.7	33.0 $\pm$ 0.5	32.5 $\pm$ 0.7	36
34.5 $\pm$ 0.5	34.0 $\pm$ 0.7	33.5 $\pm$ 0.2	33.0 $\pm$ 0.2	48
34.5 $\pm$ 0.7	34.0 $\pm$ 0.7	35.5 $\pm$ 0.5	33.5 $\pm$ 0.5	16
36.5 $\pm$ 0.5	36.5 $\pm$ 0.5	35.5 $\pm$ 0.5	35.0 $\pm$ 0.5	6
37.0 $\pm$ 0.5	37.0 $\pm$ 0.5	36.5 $\pm$ 0.5	36.0 $\pm$ 0.7	12
38.5 $\pm$ 0.5	38.0 $\pm$ 0.7	37.5 $\pm$ 0.7	37.0 $\pm$ 0.7	12

TABLE 3. Relation between air and body temperatures of *Sitana ponticeriana* captured between 1800 and 2000 hr.

Number of lizards observed in each case--24  
S.D.—Standard Deviation.

Date	Mean $\pm$ S.D. Body temperature ( $^{\circ}\text{C}$ )	Mean $\pm$ S.D. Air temperature ( $^{\circ}\text{C}$ )
5 Oct 1965	24.5 $\pm$ 0.5	25.0 $\pm$ 0.5
25 Oct 1965	25.5 $\pm$ 0.5	26.0 $\pm$ 0.5
5 Sep 1965	26.5 $\pm$ 0.5	27.0 $\pm$ 0.5
25 Sep 1965	27.0 $\pm$ 0.5	28.0 $\pm$ 0.5
5 Aug 1965	28.5 $\pm$ 0.5	29.0 $\pm$ 0.5
25 Aug 1965	29.0 $\pm$ 0.5	30.0 $\pm$ 0.5

TABLE 4. Mortality during critical thermal maximum (CTM) and lethal temperature (LT) ( $^{\circ}\text{C}$ ) tests in *Sitana ponticeriana*.

- Lizards were not acclimated.
- Photoperiod was not observed.

Temperatures $^{\circ}\text{C}$	Number of lizards observed		Mortality		
	Males	Females	Males	Females	% of total mortality
30.0	6	6	—	—	—
35.0	6	6	—	—	—
40.0	6	6	—	—	—
45.0	6	6	2	2	33.33
46.0	6	6	3	3	50.00
46.5*	6	6	4	5	75.00
47.0**	6	6	5	6	91.67

\* Critical thermal maximum

\*\* Lethal temperature

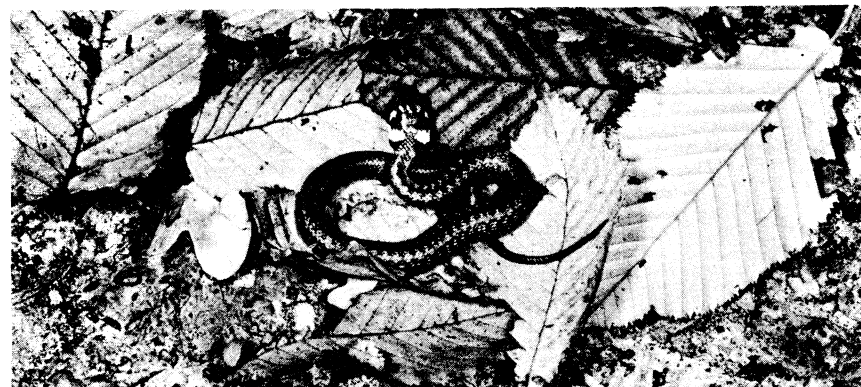


FIG. 1. Young *Natrix natrix persa*, found near Slavonski Brod, Nr. Jugoslavia. Photograph E. Hosking.



FIG. 2. Male *Lacerta agilis bosnica*, found near Slavonski Brod. Photograph E. Hosking.

BRIEF REPORT ON SOME REPTILES FOUND  
IN THE SAVA VALLEY (JUGOSLAVIA)

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(Received 23/6/75)

In the late summer of 1974 a short visit was made to the Sava valley in northern Yugoslavia, a region which has received little attention from herpetologists, compared with the Adriatic zone of that country. Reference to this area has however been made by Karaman (1939), Radovanović (1941 & 1964) and Pozzi (1966) in papers dealing generally with the herpetofauna of Yugoslavia. The area investigated was that of the northern (Slavonian) side of the river, to the west of Slavonski Brod, a flat, low-lying and often watery region interspersed with occasional woodland. The Sava, a tributary of the Danube, forms the northern boundary of Bosnia in this part of its course.

The most frequently observed reptile was the striped grass snake (*Natrix natrix persa*). A remarkable feature of the young specimens found there was their possession of a blackish zigzag stripe on top of the back (Fig. 1), a marking which is very similar in appearance to the dorsal pattern of the adder (*Vipera berus*), and also to that of certain specimens of the viperine snake (*Natrix maura*). A 44 cm long grass snake with a similar black zigzag pattern has been recorded from Tiszahát in north-eastern Hungary (Janisch, 1973). This individual had a dark, bluish-black belly, and the snout was markedly shorter than that of a typical *Natrix natrix*. The specimens found near Slavovski Brod were, however, apart from their dorsal markings, quite normal in appearance. Most of them possessed a pair of pale yellow or whitish dorso-lateral stripes. In the adult specimens examined the zigzag pattern was either indistinct or absent.

The other species occurring reasonably commonly in the wooded regions was the sand lizard (*Lacerta agilis*). These lizards were often large in size, several of those observed exceeding a length of 20 cm. Pozzi (1966) mentions the Sava valley as being inhabited by the typical form *Lacerta agilis agilis*. Those specimens found west of Slavovski Brod however appeared to be characteristic of the subspecies *Lacerta agilis bosnica* (Fig. 2), possessing a more or less continuous white vertebral stripe, a single *postnasal* and a single anterior *loreal* shield. There were 12 or 13 femoral pores on each thigh. Those captured behaved more docilely than is usual with newly caught sand lizards, showing less inclination to bite. Being well represented in Bosnia, the occurrence of this subspecies a little north of the river Sava is not really surprising.

In the hilly region north of the river Sava the following reptiles were found to occur: the wall lizard (*Lacerta muralis muralis*), the green lizard (*Lacerta viridis viridis*), the western subspecies of slow worm (*Anguis fragilis fragilis*), the Aesculapian snake (*Elaphe longissima longissima*), a specimen of which was found coiled up inside the lining of a discarded anorak(!), and the smooth snake (*Coronella austriaca*).

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SOME ECOLOGICAL NOTES ON XENOCHROPHIS PISCATOR  
(SERPENTES: COLUBRIDAE) IN THE POONCH VALLEY, JAMMU AND  
KASHMIR, INDIA

By

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Studies on the snake *Xenochrophis piscator* were made during 1971-1973, under natural conditions in the Poonch Valley, and in the laboratory of the Zoology department of the Government Degree College, Poonch. Occurrence of naticine snakes in the Himalayas of northwest India is recorded by Smith (1943); *X. piscator* is reported in the Poonch Valley by Murthy and Sharma (1975).

The Poonch Valley (alt. 3200 ft) is a sub-temperate region of Jammu province situated along the western boundary of the state between the Pir Panchal range (8500 ft) and the lower Himalayas. Continuity with the Valley of Kashmir is made through the Hazipir pass (18500 ft.). Highpeaks surrounding the valley are snow-capped for more than six months of the year. The Poonch Valley river originates in the high mountains of the Pir Panchal approximately 40 km east of Poonch.

*Xenochrophis piscator* is especially common along the tributaries of the Poonch river. Many examples were captured by hand with traps and with the aid of fish nets. Captured specimens were transferred to the laboratory to study their food and feeding behaviour. Some were anaesthetised to study ectoparasites, endoparasites and gut contents.

Individuals of *X. piscator*, irrespective of age and sex were found under stones, in and near large stone ledges, in bushes at the river side, and in and about irrigated rice fields (Fig. 1). Males were smaller and seemed more agile than females.

These snakes feed voraciously on fish and anurans. The analysis of the gut revealed the fish *Barilius bendlisis*, *Puntius ticto* and *Schizothorax* spp. and the amphibians *Rana cyanophlyctis* (juveniles and uncommonly adults) and *R. tigrina*. Insects identified were the ant *Componotus compressus* and the nymphs and larvae of *Odonates*. It may be assumed that the insects were present within the frogs eaten. Parasites present included the endoparasitic nematodes *Tanqua anomala* (intestines) and *Ascaridia* (stomach and intestines), the cestode *Raillientina* spp. (lungs) and the trematode *Proalaroides tropidonotus* (intestine). Ectoparasites were not observed.

Known predators upon *X. piscator* in the Poonch Valley are *Naja naja oxiana*, *Milvus migrans*, *Falco* spp., *Herpestes edwardsii* and *Suncus murinus murinus*.

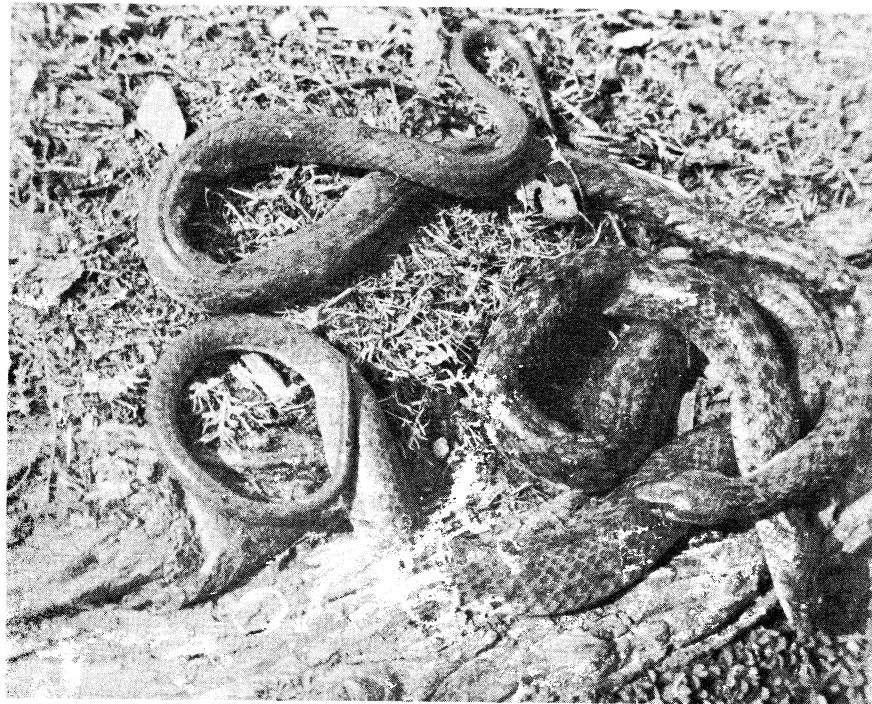


FIG. 1. Two *Xenochrophis piscator* in a rice field in Poonch Valley, in J & K State.

#### ACKNOWLEDGEMENT

Sincere thanks are extended to Dr. Edmond V. Malnate, Academy of Natural Sciences, Philadelphia, U.S.A. for valuable comments and relevant literature.

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### ASPECTS OF REPRODUCTION AND GROWTH OF THE INDIAN PYTHON, *PYTHON MOLURUS MOLURUS*, IN CAPTIVITY

By

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(Received 5/8/1975)

The 3 Indian pythons described have lived in Nandankanan Biological Park, Orissa, India for 3 to 5 years. They are housed with 4 others in an outdoor enclosure (area 5.25 x 4.50 metres; height 1.45 metres). The floor is sandy; there are a few bushes and a spacious water tank. The top is partially covered by a thatched roof and a chainlink mesh. The sides include a chainlink mesh wall and a rough wall embedded with stone pieces.

Despite maintaining a collection of *Python molurus molurus* for 13 years no previous matings or egg laying occurred. The Indian python periodically lays eggs in zoos but this has seldom been recorded in India—the natural habitat. In the present case actual mating, the gestation period and incubation and the growth of 11 to 14 of the young were followed in the natural environment; for the park is within range of the species and locally caught individuals are kept here for a full year.

**Mating:** Mating was observed on 4 and 5 February, 1974. The matings, seen once a day in the morning, each lasted for about an hour. The female was 435 cm long; the circumference at the thickest part was 45.5 cm and she weighed 33.5 Kg. The male was much smaller; 288 cm long; the circumference at the thickest part was 28 cm and he weighed 10.6 Kg.

**Gestation Period:** The female of the previous pair laid 53 eggs on 28 April 1974. The gestation period was 82-83 days.

**Egg-Laying:** Egg-laying was not observed; presumably eggs were laid in the early morning. Eggs were white and leathery and adhered to one another in a gum-like mass. Four of the 48 normal eggs were 8.0-8.6 cm long x 5.4-5.5 cm broad and each averaged 150-172 grams in weight. There were also 5 small abnormal eggs, of light brown colour and one of them measured 6.6 x 4.4 cm and weighed 60 grams.

Another female (smaller than the first), whose mating was not seen, laid 19 eggs on 2 May 1974, of similar colour and texture. 13 white eggs measured 7.9-9.9 cm x 4.9-6.8 cm and weighed 150-178 grams; 6 abnormal light brown coloured eggs measured 2.4-7.5 cm x 2.1-4.5 cm and weighed 10-75 grams.

**Incubation:** Pythons brood their eggs and remain coiled round them till they hatch (Smith, 1943).

The female remained coiled round the eggs, its head at the top kept in such a way that no egg was visible. She resented the approach of any one. The frequent jerking body movements at this time may be a muscular function raising body temperature to facilitate egg incubation (Bustard, *Pers. comm.*).

On 22 June 1974 the python exposed her eggs in the middle and coiled all around the eggs. Eggs began to crack and some newly hatched python heads appeared through the openings. The mother moved her head in the direction of the keeper when approached. The first young hatched on 23 June 1974 and the last ones on 25 June 1974. The incubation period was 56-58 days.

The second python unfortunately discontinued incubation during the fourth week; all the eggs died.

Before final hatching at frequent intervals some young pythons poked their heads and anterior part of their bodies out of the egg for distances of up to 10-30 cm. They retreated into the shell at the slightest disturbance. Complete emergence of a hatchling took about 10 minutes. 38 young hatched from 53 eggs laid (71.7%). Examination on 26 June 1974 of the rest of the eggs revealed that 4 embryos had died at various stages of development; 5 eggs showed no signs of development and were assumed to be infertile and 6 fully formed dead embryos, with unabsorbed yolk failed to emerge.

*Behaviour of the Brooding Female:* Throughout the incubation period the mother refused food though this was frequently offered. After the incubation period on 30 June 1974 she accepted her usual food of live fowl. Only once was she seen near the water tank. She resented removal of the empty egg shells and spoiled eggs, even at the termination of hatch on 26 June 1974. She sloughed on 4 April 1974 3 weeks before laying and on 30 June 1974, 5 days after completion of incubation. No sloughing occurred during the entire period of incubation. The inter-sloughing period of this female (May, 1973 to August, 1973, when not incubating eggs) was 40-41 days.

*Hatchlings:* Soon after emerging from the egg the young moved over the mother's body and adjacent areas. She showed no interest in the newly

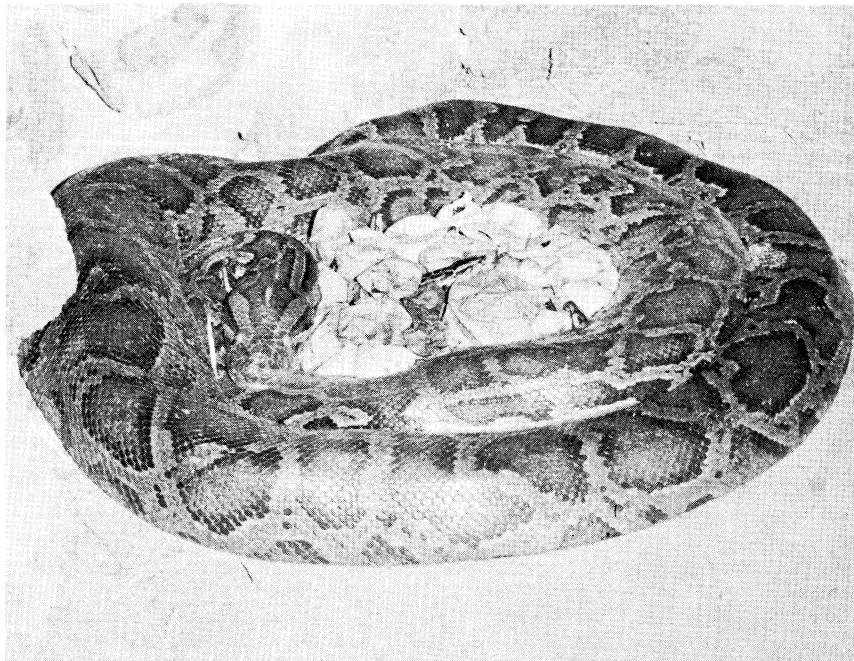


FIG. 1. A mother Indian python in an advanced stage of incubation (24 June 1974). Some empty shells and heads of young pythons are seen poking out of the egg shells.



FIG. 2. A young Indian python seen in the process of swallowing its bird prey.

hatched young. After hatching the young were 58.5-66.5 cm long and weighed 77-103 grams.

One newly hatched python took a small live bird on 26 June 1974 constricting it exactly as in the adult. First sloughing by the newly hatched pythons occurred from 5 July 1974 to 8 July 1974 when they were about two weeks old. They were separated from the adults and fed with small live birds e.g. house sparrows, munia etc, and albino rats though freshly killed ones are also readily taken.

*Growth:* There is great variation in size and weight, which probably relates to the quantity and frequency of ingested food (Table 1).

TABLE 1. Quarterly growth rate of young pythons to 1 year old.

Dates	Age in months	Sample size	Mean length (Range) cm.	Mean weight (Range) grams
23 June 1974				
to				
25 June 1974	—	38	61.71	90.29
(Date of hatching)			(58.5-66.5)	(77-103)
25 Sept. 1974	3	14	78.25	187.43
			(65.5-85)	(82-265)
25 Dec. 1974	6	11	82.55	307.64
			(72-90)	(215-395)
25 Mar. 1975	9	11	98.73	388.91
			(83-109)	(232-535)
4 July 1975	12	11	136.41	942.91
			(126.5-153)	(720-1535)

Within three and half months of hatching out of 38 young 17 died by (accidental) cannibalism through attacking each other; one died by asphyxiation while trying to escape; 3 escaped and 6 died mainly from starvation for they refused to accept food.

## DISCUSSION

In northern India mating of *Python molurus molurus* occurs during hibernation (during the cooler months in northern India little activity occurs; Smith, 1943). Eggs vary slightly in size, some laid in a Berlin Aquarium averaged 120 x 60 mm. Up to 107 eggs can be laid and hatchlings average 73 cm long. In reptiles clutch size increases with increasing size of the female (Bustard, 1970, 1972).

The incubation period recorded (56.58 days) is about the same as that described by Deoras (1965), about 60 days.

The period of 1 to 2 days when young remain in the egg during hatching probably permits final absorption of the yolk sac. A similar phenomenon has been noted in crocodiles and gharials (Bustard, *Pers. comm.*).

An Indian Python at the Zoological gardens at Jaipur laid 48 eggs from which 23 young survived (Anon, 1965). Cannibalism is common in snakes; Russell's viper may eat its own young and two young vipers swallowed each other to death. In the laboratory an Indian python of unknown age grew 6.8 inches (15.20 cm) per year (Deoras, 1965). According to Street (??) there are many cases of snakes which do not normally feed on other snakes yet nevertheless eat their cage mates. Usually both snakes seize opposite ends of the same prey and as they approach one another, one engulfs the other.

In view of our hatchling losses it is important to ensure good husbandry and only a small number of young should be kept together. They should be fed simultaneously and a close watch kept during feeding, particularly during the first 4 to 6 months. However, even when one year old several pythons are often attracted to the same prey and constrict around each other. This does not occur with adults.

It is intended to rear a batch of these hatchlings to sexual maturity.

## SUMMARY

Mating, gestation, egg-laying, incubation and behaviour of the brooding female, hatchlings and growth up to one year of the Indian python (*Python molurus molurus*) were observed in a natural environment at Nandankanan Biological Park, Orissa, India.

Mating occurred in the first week of February, the gestation period was 82-83 days; 53 eggs and 19 eggs were laid by 2 Indian pythons in the last week of April and first week of May respectively, 38 young hatched (from 53 eggs laid) in the first python in the fourth week of June, after an incubation period of 56-58 days. Soon after emergence hatchlings were 58.5-66.5 cm long and weighed 77-103 grams. The mother refused to feed though frequently offered food and did not slough during the period of incubation. 11 one year old hatchlings measured 126.5-153 cm and weighed 720-1535 grams.

## ACKNOWLEDGEMENT

The authors are grateful to Dr. H. R. Bustard, F.A.O./U.N.D.P. Consultant on Crocodiles in India for reading the manuscript and offering valuable advice.

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## THE REPTILE FAUNA IN THE LOWER ALPINE ZONE OF ABERDARE AND MT. KENYA

By

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(Received 23/6/75)

## INTRODUCTION

From the 25th of January to the 4th of February 1974 an ecological field survey was performed in the lower alpine zone of Aberdare and Mt. Kenya, situated on the equator in central Kenya. Aberdare is 4000 M high and lacks glaciers. Mt. Kenya, 5200 M high, has a central rocky peak area with glaciers and snowfields. Attention was given to the environmental conditions at high altitudes.

## ALTITUDINAL ZONATION

Different altitudinal zones of vegetation reflect different temperatures distribution of rainfall, soil structure, and frequency of fires.

*Forest zone* (about 2000 to 3000 M)

On the lower slopes the forest vegetation spreads around the mountains. This zone is comparatively thin on the western and northern sides, but is broader and typically mountain rain forest occurs in the rain shadow of the south western mountains. Extensive areas of the lower regions have been damaged by tree-felling. Dominant species are *Juniperus procera*, *Podocarpus milanjianus*, *P. gracilior*, *Olea chrysophylla* and *O. hochstetteri* (Coe, 1967). In the upper forest region there is a more or less well developed bamboo zone and *Arundinaria alpina* dominates, often in groves or spinnies. The extent of the forest (3000 M in height) correlates with the distribution of rainfall.

*Lower alpine zone* (about 3000 to 4000 M)

Field investigations were restricted to this zone. Its borders are irregular, against the forest zone and the upper alpine zone. The lower alpine zone is variable in its vegetation, the dominant vegetation is high tussocked grasses, often characterized as moorland. It forms the upper part of Aberdare (fig. 1) and is the area between the forest and the upper alpine zone of Mt. Kenya. Along the lower border and in small valleys *Hagenia abyssinica* and *Hypericum leucoptychodes* occurs in groves. The tussocked grass vegetation on Aberdare includes *Festuca p. pilgeri*, *Koeleria gracilis var. convoluta* and *Andropogon amethystinus* and on Mt. Kenya *Festuca p. pilgeri*, *Carex monostachya* and *Agrostis trachyphylla*. There are also species of *Poa*, *Myostis*, *Valeriana*, *Lobelia* and *Senecio*. Mosses of *Brachythesium*, *Bryum* and *Didymodon* form the lower layer between the tussocks (Hedberg, 1964). On moraine ground shrub vegetation includes *Alchemilla*, *Adenocarpus*, *Athospermum*, *Euryops*, *Helichrysum*, *Phillipia*, *Protea* and *Struthiola* (Coe, 1967 and Hedberg, 1964), which is less dominant on Aberdare compared with Mt. Kenya. The soil in the moorland is black with a high content of humus underlaid by dark clay (Coe, 1967).

*Upper alpine zone* (about 4000 to 4500 M)

This zone is present only on Mt. Kenya. The vegetation, characterized by a unique *Senecio* woodland, has special edaphic requirements and reaches to about 4500 M. The dominant species are *Senecio brassica* and *Senecio*

*keniodendron*. The field layer is formed by *Alchemilla* shrub and grasses (*Festuca*, *Poa*, *Deschampsia* and *Anthoxantum*) (Hedberg, 1964).

#### CLIMATE OF THE LOWER ALPINE ZONE

In the afro-alpine zone climatic seasonal changes are not significant. The marked diurnal temperature variation is probably the most important environmental factor influencing the flora and fauna.

#### TEMPERATURE

In clear weather ground and air temperatures are equal during the morning. In daytime ground temperature is higher than that of the air, a difference of 30°C is not unusual (Coe, 1967). By sunset temperatures are the same but during the night ground temperature falls below air temperature and on clear nights freezing may occur. Surface temperature depends to a high degree on the density of ground cover. When the weather is variable the variation between ground and air temperature can fluctuate several times per day.

#### PRECIPITATION AND HUMIDITY

There are two more or less marked rainy seasons, a longer one from March to May and a shorter one from October to December. In the lower alpine zone the level of rainfall is relatively low but morning frost and dew are an important source.

Relative humidity near the ground changes considerably. Recordings of relative humidity in the alpine zone (1963) in dull and cloudy weather and 6 and 26 cm above ground level, ranged between 58 and 71%. In clear weather it falls below 20% (Coe, 1967).

#### REPTILES OF THE LOWER ALPINE ZONE

Five species were recorded at Aberdare and Mt. Kenya. Some are restricted to these mountain zones. Special attention is given to those species which are only briefly described in the literature. Coloration is given from living specimens.

Field observations were made from 07.00 to 17.00 hours and all reptilian species were documented and photographed. A few specimens of each of the reptile species found are preserved at the Natural History Museum of Gothenburg (G.N.M.) and given a Reptilia exotica (Re. ex.) number. Specimens described are adults, except for occasional semiadults and juveniles (marked). Specimens preserved are referred as SP; those observed as SO.

#### *Chamaeleo bitaeniatus schubotzi* (Sternfeld (fig. 4)

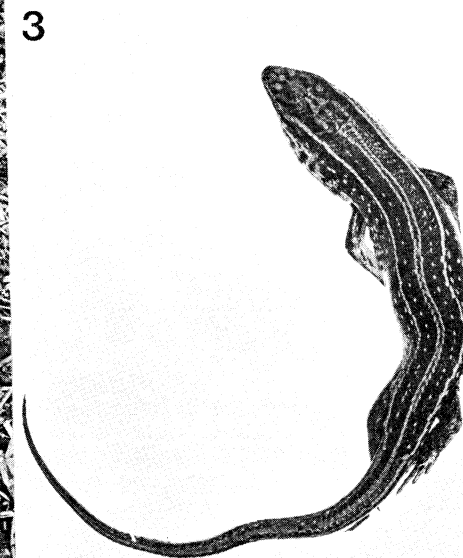
SP. Mawe mbili, Chebuswa, N. Aberdare. 31.I.1974 (G.N.M. Re. ex. 4339, 1 male).

Total length 137 mm (tail 73 mm); clearly marked, 5 mm high and 8 mm long, red coloured casque; 3 mm long rostral horn; well marked, 2-3 mm high gular crest scaling heterogeneous, with two well developed rows of enlarged scales on each flank, the lower larger.

Ontulili, N.W. Mt. Kenya. 2.II.1974 (G.N.M. Re. ex 4340, 1 female),

Total length 123 mm (tail 53 mm); clearly marked, 2 mm high and 5 mm long, casque; no rostral horn; 1-2 mm high gular crest; scaling as the male.

SO. Kiandongoro gate, central Aberdare. 26.I.1974 (1 female). Ontulili, N.W. Mt. Kenya. 2.II.1974 (2 females).



1. The biotop of Mawe mbili, Chebuswa in N. Aberdare. All reptile species mentioned were found in this area.
2. *Vipera hindii*, Boulenger, semiadult male (G.N.M. Re. ex. 4353).
3. *Mabuya irregularis*, Lönnberg, adult (G.N.M. Re. ex. 4326).

## COMMENTS

Specimens from Aberdare found near the ground in *Alchemilla* shrub; those from Mt. Kenya 1.2 M above ground level in *Hagenia* and *Hypericum* groves. All specimens active at noon. One gravid female from Mt. Kenya (G.N.M. Re. ex. 4340) possessed large eggs. During cold nights reptiles require shelter above lethal temperatures and the microclimate beneath dense bushes which they use presumably provides favourable conditions. According to the National Park rangers the chamaeleon is rather common and often seen in the localities mentioned. The high altitudes of Mt. Kenya and Mt. Kilimanjaro are reported as the geographical range by Sternfeld (1912) for this subspecies.

*Mabuya irregularis* Lönnberg (fig. 3).

SP. Mawe mbili, Chebuswa, N. Aberdare. 1.II.1974 (G.N.M. Re. ex. 4326 (a), 1 and G.N.M. Re. ex. 4326 (b), 1 juvenile).

Ontulili, N.W. Mt. Kenya. 3.II.1974 (G.N.M. Re. ex. 4325 (a), 1 and G.N.M. Re. ex. 4325 (b), 1 semiadult).

## PHOLIDOSES

**Head:** Snout short. Lower eyelid with large undivided transparent disk. Nostril just above the vertical of the suture between rostral and first labial; one postnasal; anterior loreal in contact with second labial (first and second labial in one specimen); anterior internasals in contact behind the rostral; posterior internasals large, in contact with anterior internasals, first loreal, prefrontals and frontonasal; frontonasal as broad as long, in contact with frontal; latter a little shorter than the frontoparietals and interparietal together, in contact with the second and third supraoculars; 4 supraoculars, first small, second very large; 4 supraciliars, second largest; frontoparietals distinct, as large as the interparietal; parietals do not meet behind interparietal; 2 nuchals (3 in one specimen); 4 labials anterior to the subocular, which is feebly but distinctly narrowed inferiorly; 4 lower labials anterior to the subocular. Ear-opening oval, oblique, smaller than the transparent palpebral disk, with 3 short pointed lobulus anteriorly.

**Trunk:** Nuchals, dorsal and lateral scales strongly carinated; nuchals with 3-18 carinates; dorsolateral scales with 4-5 carinates anteriorly and 2-3 carinates posteriorly; vertebral and lateral scales with 2-3 carinates; ventral scales smooth; 31-32 scales round the middle of the body.

**Limbs and digits:** The hind limb reaches the elbow of the adpressed fore limb. Scales on dorsal and ventral sides of limbs with 2-3 carinates; scales on soles sharply tricarinate, spinose; subdigital lamellae sharply keeled, spinose; subdigital lamellae 19-21 on hind limbs, 15-17 on front limbs; first digit shorter than fifth, fifth digit shorter than second, second digit shorter than fourth on hind limbs; on front limbs similar except that fourth digit is shorter than third.

**Tail:** Vertebral scales with 3-6 carinates, sharp on basal part and weak on tip; dorsolateral and lateral scales on basal third of tail with 2-3 carinates, scales on the rest of the tail smooth; ventral scales smooth.

**Colour:** Dorsal and dorsolateral side of head, trunk, limbs and tail black; dorsally a light brown double and partly single line from nuchals to end of tail; dorsolaterally a light brown line from anterior supraciliar, along body and throughout tail; between dorsal and dorsolateral light brown lines a single row of similarly coloured dots or stripes laterally on body and dorsal parts of limbs; dorsal and lateral sides of head with brown irregular spots; ventral and ventro-lateral sides of head, trunk, limbs and tail light blue with more

or less distinct irregular rows of black stripes, most frequent on throat; soles and anal plate light pink. (Table 1).

## COMMENTS

Specimens of this skink from Aberdare were collected under stones on rocky, morainous ground, barely covered with short grasses and *Helichrysum* shrub. Specimens from Mt. Kenya found in the ecocline between *Hagenia* groves and *Helichrysum* scrub. Specimens from Aberdare (2 observations), inactive between 08.00 to 10.00 hours, under rocks used for nightshelters. Specimens from Mt. Kenya (2 observations), active at noon. This species seems to be rather uncommon and is unknown to the National Park rangers, who have worked in the area for several years.

*Mabuya varia varia* Peters (fig. 6)

SP. Kiandongoro gate—Queens falls, central Aberdare. 25.I-28.I.1974 (G.N.M. Re. ex. 4328, 4 and 1 semiadult).

Mawe mbili, Chebuswa, N. Aberdare, 31.I-1.II.1974 (G.N.M. Re. ex. 4329, 1).

A wide variation in colour and marking occurs. Dorsal colour grey, brown or black; ventral side light blue or white. In some specimens markings are lacking, in others there are two lateral white lines, one dorso-ventral white or light brown line and one vertebral light brown line. Lines are usually bordered with a thin black line. In some specimens there are rows of black dots between the light lines, continuing vertebally throughout the tail. In others there are small white dots on the ventral scales, especially on the throat. (Table 2).

SO. Kiandongoro gate—Queens falls, central Aberdare. 25.I-28.I.1974 (about 75).

Fort Jerusalem, S. Aberdare. 28.I-29.I.1974 (15).

Mawe mbili, Chebuswa, N. Aberdare. 31.I-1.II.1974 (about 40).

Ontulili, N.W. Mt. Kenya. 2.II-4.II.1974 (10).

## COMMENTS

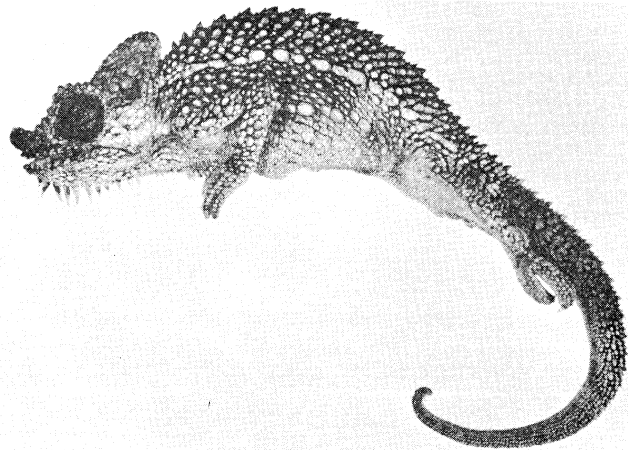
Specimens were found in high tussocked grasses and in low scrub of *Alchemilla* or *Helichrysum*. During the morning (07.00-09.00) specimens in central Aberdare and N.W. Mt. Kenya hide in the basal parts of grass tussocks, in N. Aberdare mainly under rocks. During daytime most specimens were fully active in the upper parts of grass tussocks, on the ground or in scrub vegetation. *Mabuya varia varia* seems the most common reptilian species in the moorland of Aberdare and Mt. Kenya. It is active in clear weather from 09.30 to 17.00 hours. At night it is found in the basal parts of tussocks or under rocks (18 observations). Temperature on Aberdare just after sunrise (07.00) beneath 5 rocks used as night shelters was  $-1$  to  $0^{\circ}\text{C}$ . When ground temperature was  $+7^{\circ}\text{C}$  (about 09.30, in clear weather) the lizards left their night shelters and at about 17.00 hours (ground temperature  $+8^{\circ}\text{C}$ ) they returned to them. 12 eggs of *Mabuya varia varia*, ready to hatch, were found under a rock at Mawe mbili, Chebuswa, N. Aberdare (1.II.1974; time 07.00; temperature  $-1^{\circ}\text{C}$ ).

*Algyroides alleni* Barbour (fig. 5)

SP. Kiandongoro gate—Queens falls, central Aberdare. 25.I-28.I.1974 (G.N.M. Re. ex. 4320, 2).

Mawe mbili, Chebuswa, N. Aberdare. 31.I-1.II.1974 (G.N.M. Re. ex. 4321-4323, 7).

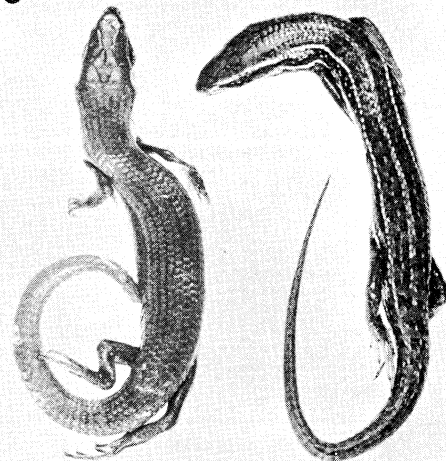
4



5



6



4. *Chamaeleo bitaeniatus schubotzi*, Sternfeld, adult male (G.N.M. Re. ex. 4339).  
 5. *Algyroides alleni*, Barbour, adult (G.N.M. Re. ex. 4322).  
 6. *Mabuya varia varia*, (Peters), adults (G.N.M. Re. ex. 4328). Note the different markings in the two specimens.

Ontulili, N.W. Mt. Kenya. 2.II.-4.II.1974 (G.N.M. Re. ex. 4324, 2).

Dorsal and lateral sides of head, body, tail and limbs grey or brown; ventral side blue, throat darker blue. All specimens with a thin vertebral black line, part of which can be a row of stripes; one blue longitudinal dorsolateral line (missing in one specimen). In 4 specimens a blue lateral line, in 5 specimens small black spots bordering the dorso-lateral line. Head, lateral side of body, tail and limbs with small black dots. Some specimens with red anal plate, others with white. (Table 3).

SO. Kiandongoro gate—Queens falls, central Aberdare. 26.I.-28.I.1974 (14).

Fort Jerusalem, S. Aberdare. 28.I.-29.I.1974 (2).

Chebuswa, N. Aberdare. 31.I.-1.II.1974 (6 and 2 semiadults).

Ontulili, N.W. Mt. Kenya. 2.II.-4.II.1974 (14).

#### COMMENTS

The habitat of this lacertid is similar to that of *Mabuya varia varia*; high tussocked grasses and low *Alchemilla* or *Helichrysum* scrub. Except for a higher preference by *Algyroides alleni* for scrub vegetation in daytime and the use of rocks as night shelters. In the moorland on Mt. Kenya this species was seen as frequently as *Mabuya varia varia*. *Algyroides alleni* is active from 09.30 to 17.00 hours. A few records were made of semi-adult specimens. According to Coe (1967) *Algyroides* occurs at higher altitudes on Mt. Kenya more than any other reptile and in cold weather was found under stones "in an almost moribund state. Stomach contents indicate that they feed largely on beetles and their larvae".

*Vipera hindii* Boulenger (fig. 1)

SP. Queens falls, central Aberdare. 26.I.1974 G.N.M. Re. ex. 4354, 1 female).

Total length 290 mm (tail 36 mm). Ventralia 2 + 127. Anal 1. Squamation 23, 25, 21. Subcaudalia 26/26 + 1. Colour of dorsal and ventral sides of head, body and tail brown; two dorsal longitudinal rows of white-edged triangular black spots, transformed into two black lines on the tail; a U-shaped black-edged dark brown marking covering a major part of dorsal side of head; ventral side of head and body with black spots; ventral side of tail reddish yellow.

Kiandongoro gate, central Aberdare. 27.I.1974 (G.N.M. Re. ex. 4352 (a), 1 male).

Total length 281 mm (tail 35 mm). Ventralia 2 + 133. Anal 1. Squamation 23, 25, 21. Subcaudalia 33/33 + 1.

Kiandongoro gate, central Aberdare. 28.I.1974 (G.N.M. Re. ex. 4352 (b), 1 male).

Total length 240 mm (tail 32 mm). Ventralia 1 + 130. Anal 1. Squamation 23, 25, 21. Subcaudalia 34/35 + 1.

Mawe mbili, Chebuswa, N. Aberdare. 1.II.1974 (G.N.M. Re. ex. 4353, 1 semiadult male).

Total length 181 mm (tail 21 mm). Ventralia 2 + 129. Anal 1. Squamation 23, 25, 21. Subcaudalia 32/31 + 1.

Markings and colours in the males similar to those of the female, except that in males the ground colour is almost grey instead of brown. Probably there is a distinct sexual dichromatism in this species.

SO. Kiandongoro gate, central Aberdare. 25.I.1974 (2 males). Mawe mbili, Chebuswa, N. Aberdare. 1.II.1974 (2 semiadult males).

## COMMENTS

The Queens falls specimen was found in high tussocked grass vegetation; Kiandongoro specimens in similar vegetation and in low *Alchemilla* scrub. All Mawe mbili specimens were found early in the morning under rocks on morainous ground scarcely covered with low *Alchemilla* scrub. 8 specimens recorded, however, the population size is not as small as supposed by the few observations. The number noticed depend to a high degree on the weather. During two visits to the same area in 1961 and 1962 Ionides collected 74 specimens in 14 days (Ionides & Pitman, 1965). The number of collectors used was not reported.

All 5 adults were noticed at noon in clear weather. 3 semiadults were found under rocks 07.30 to 09.30 hours (ground temperature  $-1^{\circ}\text{C}$ ).

The gravid female (G.N.M. Re. ex. 4354) from Queens falls gave birth to 3 juveniles 8.V.1974 in captivity.

According to Ionides and Pitman (1965) very small juveniles were found in February and all specimens taken in August were of good size. Ionides believes that this viper becomes adult in one year. This suggestion may well be erroneous (table 4). Adult specimens feed on lizards and frogs and an adult female *Vipera hindii* had swallowed a fair sized *Chamaeleo bitaeniatus schubotzi* (Ionides & Pitman, 1965).

Probably *Vipera hindii* uses high tussocked grasses as shelter during unfavourable weather. Hedberg (1964) made temperature measurements in a tussock of *Festuca p. pilgeri* at 4200 M in Teleki Valley on Mt. Kenya. When the temperature among the outermost leaves of the tussock was  $-5^{\circ}\text{C}$ , it proved to be  $+2.5^{\circ}\text{C}$  among the inovation shoots in the central part of the tussock.

The factors that control breeding in these equatorial mountains, lacking seasonal variation in temperature and photo period is not understood. If a distinct breeding season exists it may be related to the two rainy periods, the only obvious environmental factor with a regular biannual periodicity. The small number of offspring from *Vipera hindii* (G.N.M. Re. ex. 4354) is possibly a normal occurrence. Birds and mammals in the alpine zone also have small clutch sizes (Coe, 1967).

## SUMMARY

During 25th January to February 4th, 1974 an ecological field survey which included reptilian fauna, was made on Aberdare and Mt. Kenya, East Africa. Altitudinal vegetation zonation and important climatological factors were denoted. The investigation, restricted to the lower alpine zone (altitude about 3000 to 4000 M), includes 5 reptilian species, which are active between 09.30 and 17.00 hours. *Mabuya varia varia* was the most frequently observed lizard on Aberdare and is as frequent as *Algyroides alleni* on Mt. Kenya. *Chamaeleo bitaeniatus schubotzi* is rather common in scrub and bush vegetation in both areas. *Mabuya irregularis* seems to be the least common lizard. *Vipera hindii* occurred in central and N. Aberdare.

## ACKNOWLEDGEMENTS

I thank the Warden of the Mountain National Parks Mr. Bill Woodley and his staff for their assistance and Dr. Ake Norberg and Mr. Göran Nilsson for reading the manuscript.

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Size (mm):				
G.N.M. Re. ex.	4326 (a)	4326 (b)	4325 (a)	4325 (b)
Total	121	99	87	37
Head	12	15	9	8
Width of head	9	12	6	5
Snout-vent	52	69	37	29
Front limbs	15	20	16	13
Hind limbs	20	27	16	13
Tail	69	30	50	8

TABLE 1. Measurements of *Mabuya irregularis*.

Size (mm):			
G.N.M. Re. ex. 4328		G.N.M. Re. ex. 4329	
Total	Tail	Total	Tail
141	84	85	31
110	60		
90	43 (broken)		
50	31		
51	5 (broken)		

TABLE 2. Measurements of *Mabuya varia varia*.

Size (mm):					
G.N.M. Re. ex. 4320		G.N.M. Re. ex. 4321-4323		G.N.M. Re. ex. 4324	
Total	Tail	Total	Tail	Total	Tail
87	47	136	90	103	52 (regene- rated)
53	11 (broken)	121	78	121	75
		96	58		
		79	36 (broken)		
		56	9 (broken)		
		71	39		
		167	110		

TABLE 3. Measurements of *Algyroides alleni*.

G.N.M. Re. ex.	Weight (gram)	Total length (mm) 8.V.1974	Total length (mm) 10.IX.1974
4355 (a)	1,49	102	121
4355 (b)	1,50	105	124
4355 (c)	1,64	109	126

TABLE 4. Measurements made on juvenile *Vipera hindii* born in captivity and fed on small frogs and fish during the first 4 months.

## OBSERVATIONS ON THE HERPETOFAUNA OF TURKEY IN 1968-1973

By  
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(Received 1/5/75)

## INTRODUCTION

The data are based on field observations in the european part of Turkey, Thrace, and the western parts of asiatic Turkey, Anatolia, made during five different excursions in 1968-1973. All specimens were caught and examined in the field. All species were documented with colour photos. A minor part of the collection is preserved in the Natural History Museum of Gothenburg (G.N.M.) and in the Department of Zoology, University of Gothenburg (D.Z.G.). A major part of the 1968 collection of reptiles and amphibians returned to Sweden by air, unfortunately disappeared on the way and was never found.

Periods of observation	Areas of observation
28/05-25/06 1968	Western Anatolia and Thrace
17/06-23/07 1970	Western Anatolia and Thrace
26/12-02/01 1971-72	Province Mugla
08/04-20/04 1972	Provinces Mugla and Anatalya
01/08-03/08 1973	Trace (Belgrad Forest)

## VEGETATION OF THE AREA

Northern Thrace, situated north of the Marmara Lake, is an offshoot from the european broad-leaved forest. The vegetation is montane summer-green forest. Southern Thrace and western Anatolia are a part of the mediterranean sclerofyll-vegetation area. The lowland formerly embraced forest dominated by *Quercus coccifera* and *Pinus halipensis*, but after repeated treefelling the ecology of the forest has changed dramatically, resulting in the loss of forest, and only shrub vegetation remains. In slightly damp areas the dense shrub forest includes *Quercus coccifera*, *Erica arborea*, *Myrtus communis* intertwined by trailing plants. This vegetation, the maccia, is replaced by the phrygana in dryer areas, which is characterized by low, thorny bushes (especially species of Leguminosae), grasses and many aromatic herbs (*Lavendula*, *Stureja*, *Salvia*, *Aspholedus*, *Myrtus* and *Stachys*). In the southern and central parts of Anatolia, there are smaller areas of semi desert and desert steppe. In ground depressions, which are influenced by saline groundwater, there is salt steppe vegetation characterized by *Artemisia* and the family Chenopodiaceae (*Chenopodium*, *Salsola*). The dominating type of soil is the red, ferruginous terra rossa. The entire area has dry, warm summers and mild rainy winters.

## HERPETOFAUNA OF THE AREAS VISITED

All specimens mentioned were adults, except for the occasional juveniles (remarked).

## SALENTIA

- Bufo bufo spinosus* Daudin  
Belgrad Forest, north of Istanbul. 14.VII.1970 (1).  
Boz Dagh, east of Izmir near Odemis. 27.VI.1972 (3).  
*Bufo viridis viridis* Laurenti (fig. 1).  
Urla near Izmir. 7.VI.1968 (1).  
Boz Dagh, east of Izmir near Odemis. 2.VI.1968 (1).  
Bafa Lake, Province Aydin. 25.VI.1970 (7).  
Boz Dagh, east of Izmir near Odemis. 27.VI.1970 (1).  
Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatalya. 11.IV.1972 (15).  
Rather common in the lowland areas and in the mountains. Most specimens in the Ciglicara Forest in amplexus at the bottom of a pond, about 20 cm deep.  
*Hyla arborea arborea* Linnaeus  
Efesus, south of Izmir. 26.VI.1970 (2).  
Manyas Lake. Prov. Balikisir. 10.VII.1970 (14).  
Marmaris. Prov. Mugla. 18.IV.1972 (8).  
Specimens seen in April in Marmaris, sitting on the ground, at the borders of small ponds, calling. Those seen in July in the Manyas Lake area sitting on reeds (*Phragmites communis*) one metre above ground.  
*Rana dalmatina* Bonaparte  
Belgrad Forest, north of Istanbul. 13.VII.1970 (1).  
Single specimen found in area characterized by montane summergreen forest.  
*Rana ridibunda ridibunda* Pallas  
Belgrad Forest, north of Istanbul. 13.VII.1968 (1).  
Manyas Lake. Prov. Balikisir. 10.VII.1970 (2).  
Belgrad Forest, north of Istanbul. 20.VII.1970 (10).  
Marmaris. Prov. Mugla. 1.I.1970 (14).  
Finike. Prov. Anatalya. 10.IV.1972 (5 specimens).  
Marmaris. Prov. Mugla. 17.IV.1972 (24 specimens).  
An extremely common species, noticed in almost every pond, lake and stream; often in great numbers.

## CHELONIA

- Clemmys caspica rivulata* Valenciennes  
Halkali near Istanbul. 30.V.1968 (10 specimens).  
Kepsut. Prov. Balikisir. 1.VI.1968 (1).  
Belgrad Forest, north of Istanbul. 20.VII.1970 (7).  
Finike. Prov. Anatalya. 10.IV.1972 (1).  
Marmaris. Prov. Mugla. 17.IV.1972 (1).  
*Testudo graeca iberica* Pallas (fig. 2)  
Halkali near Istanbul. 30.V.1968 (1).  
Kepsut. Prov. Balikisir. 1.VI.1968 (1).  
Foca near Izmir. 3.VI.1968 (1).  
Boz Dagh, east of Izmir near Odemis. June 1968 and June 1970 (15).  
Efesus, south of Izmir. 2.VII.1970 (10).  
Belgrad Forest, north of Istanbul. 20.VII.1970 (10).  
Xanthos (Kinik). Prov. Mugla. 24.XII.1971 (1).  
Finike. Prov. Anatalya. 15.IV.1972 (15).

A female *Testudo graeca ibera* was observed at noon during egg-laying on the 13.VI.1968 a few kilometres north of the village Boz Dagh near Odemis. The female began to dig a pit with its front legs. The ground was stony, sparsely covered with grasses and herbs. The soil was pushed away with the hind legs. After 20 minutes of such activity the pit was 15-20 cm deep, 20 cm in diameter at earth level and 5 cm at the bottom. The female laid 3 eggs at 4-5 minutes intervals and afterwards soil was pushed backwards by the hind legs to cover the eggs partially. 10 minutes later 2 more eggs were laid at 5 minutes intervals into the same pit, which was then completely covered, mainly by help from the hind legs. The entire programme was completed in about 70 minutes.

## SAURIA

*Hemidactylus turcicus turcicus* Linnaeus

Bafa Lake. Prov. Aydin. 17.VI.1968 (1).

Bafa Lake. Prov. Aydin. 23.VI.1970 (2).

*Agama stellio stellio* Linnaeus

Kepsut. Prov. Balıksir. 1.VI.1968 (1).

Bornova near Izmir. 4.VI.1968 (4 and 2 juveniles).

Efesus, south of Izmir. 8.VI.1968 (3 and 1 juvenile).

Birgi near Odemis. 12.VI.1968 (1).

Boz Dagh, east of Izmir near Odemis. 14.VI.1968 (1).

Bafa Lake. Prov. Aydin. 17.VI.1968 (2).

Efesus, south of Izmir. 25.VI.1970 (5).

Efesus, south of Izmir. 1.VII.1970 (G.N.M. Re. ex. 3282) (1).

Efesus, south of Izmir. 2.VII.1970 (1).

Xanthos (Kinik). Prov. Mugla. 29.XII.1971 (2).

Marmaris. Prov. Mugla. 1.I.1972 (4).

Kalkan. Prov. Anatolya. 9.IV.1972 (1).

Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatolya. 14.IV.1972 (6).

Finike. Prov. Anatolya. 15.IV.1972 (1).

Marmaris. Prov. Mugla. 18.IV.1972 (6).

Common in most dry areas in the southern part of Anatolia; seems well adapted to the many ancient and ruined towns in southern Turkey.

*Anguis fragilis colchicus* Nordman

Belgrad Forest, north of Istanbul. 29.V.1968 (5).

Belgrad Forest, north of Istanbul. 22.VI.1968 (D.Z.G.) (1).

Belgrad Forest, north of Istanbul. 13.VII.1970 (G.N.M. Re. ex. 3283) (1).

*Ophisaurus apodus* Pallas

Halkali near Istanbul. 30.V.1968 (2).

Efesus, south of Izmir. 9.VI.1968 (2).

Birgi near Odemis. 12.VI.1968 (1).

Efesus, south of Izmir. 20.VI.-2.VII.1970 (G.N.M. Re. ex. 3284) (6).

Troya. Prov. Canakale. 7.VII.1970 (2).

*Lacerta danfordi danfordi* Günter

Xanthos (Kinik). Prov. Mugla. 28.XII.1971 (1).

Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatolya. 12.IV.1972 (2).

*Lacerta danfordi anatolica* Werner

Boz Dagh, east of Izmir near Odemis. 20.VI.1968 (4).

Boz Dagh, east of Izmir near Odemis. 30.VI.1970 (2).

*Lacerta taurica taurica* Pallas

Belgrad Forest, north of Istanbul. 29.V.1968 (D.Z.G.) (3).

Halkali near Istanbul. 30.V.1968 (D.Z.G.) (3).

Belgrad Forest, north of Istanbul. 2.VIII.1973 (1).

*Lacerta trilineata cariensis* Peters

Bornova near Izmir. 4.VI.1968 (1).

Boz Dagh, east of Izmir near Odemis. 12.VI.1968 (4).

Boz Dagh, east of Izmir near Odemis. 29.VI.1970 (1).

*Lacerta viridis meridionalis* Cyrén

Belgrad Forest, north of Istanbul. 29.V.1968 (2).

Efesus, south of Izmir. 8.VI.1968 (1).

Belgrad Forest, north of Istanbul. 16.VII.1970 (3).

Belgrad Forest, north of Istanbul. 2.VIII.1973 (1).

*Ophisops elegans ehrenbergi* Wiegmann

Belgrad Forest, north of Istanbul. 26.V.1968 (3).

Kepsut. Prov. Balıksir. 1.VI.1968 (3).

Foca near Izmir. 3.VI.1968 (2).

Bornova near Izmir. 19.VI.1970 (5).

Troya. Prov. Canakale. 7.VII.1970 (2).

Xanthos (Kinik). Prov. Mugla. 29.VII.1971 (1).

Marmaris. Prov. Mugla. 1.I.1972 (1).

Marmaris. Prov. Mugla. 19.IV.1972 (1).

*Ablepharus kitaibelii kitaibelii* Bibron & Bory

Belgrad Forest, north of Istanbul. 29.V.1968 (D.Z.G.) (5).

Boz Dagh, east of Izmir near Odemis. 13.VI.1968 (2).

Belgrad Forest, north of Istanbul. 23.VI.1968 (1).

Efesus, south of Izmir. 20.VI.1970 (1).

Belgrad Forest, north of Istanbul. 13.VII.1970 (1).

Xanthos (Kinik). Prov. Mugla. 29.XII.1971 (1).

Marmaris. Prov. Mugla. 31.XII.1971 (1).

Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatolya. 13.IV.1972. (8).

*Bianus strauchii* Bedriaga

Efesus, south of Izmir. 9.VI.1968 (9).

Birgi, east of Izmir near Odemis. 12.VI.1968 (4).

Efesus, south of Izmir. 20.VI.1970 (1).

Xanthos (Kinik). Prov. Mugla. 28.XII.1971 (1).

All specimens of this amphisbaenian were found under stones. The

Xanthos specimen was identified by a sloughed skin.

*Chamaeleo chamaeleon chamaeleon* Linnaeus

Xanthos (Kinik). Prov. Mugla. 29.XII.1971 (G.N.M. Re. ex. 3317) (1).

## SERPENTES

*Typhlops vermicularis* Merrem

Urla near Izmir. 6.VI.1968 (1).

Efesus, south of Izmir. 8.VI.1968 (4).

Efesus, south of Izmir. 19.VI.1970 (D.Z.G.) (3).

Digging species, was found only under stones.

*Eryx jaculus turcicus* Oliver

Efesus, south of Izmir. 9.VI.1968 (3).

Digging species, was only found in the early morning, under stones.

*Coluber jugularis jugularis* Linnaeus

Ciglicara Ormani, 20 km SSW of Elmali. Prov. Anatolya. 12.IV.1972 (4).

*Coluber jugularis caspius* Gmelin

Efesus, south of Izmir. 18.VI.1968 (2).

Efesus, south of Izmir. 25.VI.1970 (G.N.M. Re. ex. 3320) (1).

Boz Dagh, east of Izmir, by Odemis. 28.VI.1970 (D.Z.G.) (1).

Belgrad Forest, north of Istanbul. 13.VII.1970 (1).

Two melanotic specimens of *Coluber jugularis* found dead in Efesus 1968; one melanotic specimen collected in 1970. All three completely black-violet, except the throat, which was deep red. The 1970 specimen had the following characteristics; length 1620 mm, ventralia 2+ 199+ 1 and subcaudalia 111/111 + 1. According to Wettstein (1953) only *C.j. jugularis* has been found showing a melanotic variety. From the melanotic specimen preserved, the locality and number of ventralia suggests it to be *C.j. caspius*; its appearance and number of subcaudalia indicates *C.j. jugularis*.

Pholidoses scale characters concerning *C.j. jugularis* and *C.j. caspius* from the whole geographical range (except Creta and Phodos) (Wettstein, 1953).

	Ventralia	Subcaudalia
<i>C.j. jugularis</i>	199-214 (mean 206)	100-132 (mean 113)
<i>C.j. caspius</i>	192-209 (mean 199)	84-111 (mean 100)

A normal coloured *Coluber jugularis* found in Boz Dagh, near Odemis, NE of Efesus, had 3 + 198 + 2 ventralia and 110/110 + 1 subcaudalia, and in this area *C.j. caspius* is present (Mertens, 1952). We have not been able to find reliable information concerning the geographical range of *C.j. jugularis* and *C.j. caspius* in Anatolia. However, according to distribution maps (Steward, 1971), *C.j. caspius* occurs in the Efesus region.

*Coluber ravergieri nummifer* Reuss  
Efesus, south of Izmir. 21.VI.1970 (1).

This large specimen (1.5 M), unfortunately lost, had one subocular plate and one supralabialia and cataracts on both eyes. Another snake found at the same place and date (believed to be the same species), almost immediately disappeared behind a stone wall. Both snakes had the same markings, a zig-zag band which led into straight parallel lines on the tail.

*Coluber najadum dahlii* Schinz  
Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatalya. 14.IV.1972 (5) (G.N.M. Re. ex. 3321 (1)).

*Elaphe longissima longissima* Laurenti  
Belgrad Forest, north of Istanbul 23.VI.1968 (1).  
Belgrad Forest, north of Istanbul. 12.VII.1970 (2).

*Elaphe situla* Linnaeus  
Efesus, south of Izmir. 20.VII.1970 (1).

Specimen of spotted variety, collected at the time of sloughing.

*Coronella austriaca austriaca* Laurenti  
Belgrad Forest, north of Istanbul. 22.VI.1968 (1).  
Belgrad Forest, north of Istanbul. 20.VII.1970 (2).

Specimen from Belgrad Forest (22.VI.1968) was an adult female. It gave birth to 8 juveniles in captivity (20.VIII.1968).

	Length (mm)	Ventralia	Anal	Subcaudalia
Female	700	(2 +) 166	3	48/48 + 1
Juvenile	150	(2 +) 171	3	47/47 + 1
"	156	(2 +) 160	2	47/47 + 1
"	170	(1 +) 202	2	52/52 + 1
"	161	(2 +) 178	2	45/45 + 1
"	168	(3 +) 163	2	4/5 + 7 + 42/42 + 2
"	165	(2 +) 162	2	57/57 + 1
"	171	(3 +) 178	2	20/20 + 8 + 2/2 + 1 + 14/14 + 2
"	175	(2 +) 179	2	50/50 + 2



FIG. 1. *Bufo v. viridis* Laurenti in amplexus at the bottom of a small pond in Ciglicara forest. 11.IV.1972.



FIG. 2. *Testudo graeca ibera* Pallas during egg-laying, in Boz Dagh. 13.VI.1968.

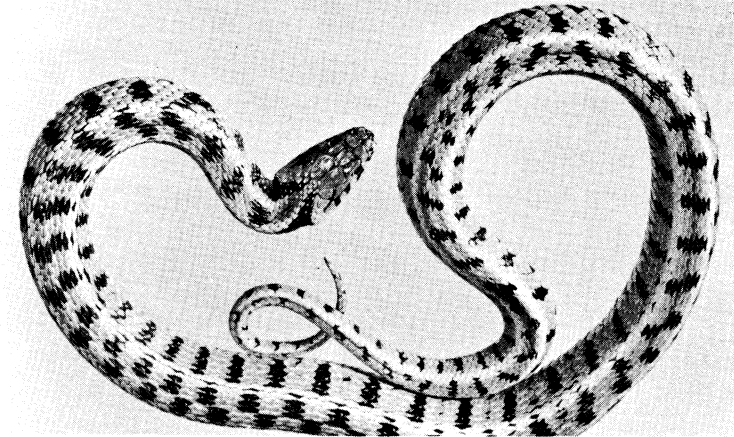


FIG. 3. *Natrix natrix persa* (Pallas) found in Ciglicara forest.



FIG. 4. Hibernating area for *Coluber j. jugularis* Linnaeus, *Coluber najadum dahlii* Schinz, *Natrix natrix persa* (Pallas) and *Vipera x. xanthina* (Gray) in Kuhu Dag Mountains, Province Anatalya.

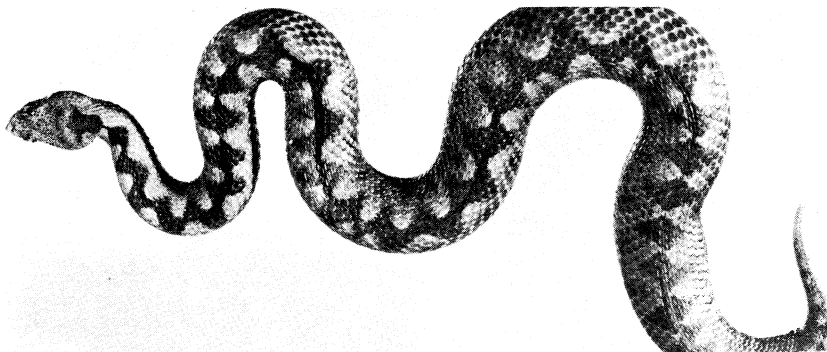


FIG. 5. A female *Vipera ammodytes montandoni* Boulenger, from Belgrad Forest, north of Istanbul.



FIG. 6. The habitat of *Vipera ammodytes montandoni*, in Belgrad Forest, characterized by open sclerophyllous vegetation on sandy ground.

*Eirenis modestus modestus* Martin

Foca near Izmir. 3.VI.1968 (1).

Urla near Izmir. 6.VI.1968 (4).

Efesus, south of Izmir. 8.VI.1968 (2).

Efesus, south of Izmir. 2.VII.1970 (G.N.M. Re. ex. 3285) (1).

Ayvalik. Prov. Balikisir. 6.VII.1970 (G.N.M. Re. ex. 3286) (1).

Finike. Prov. Anatalya. 15.IV.1972 (1).

One *Eirenis* specimen collected in Urla near Izmir (6.VI.1968) showed characteristics more similar to *Eirenis decemlineata* than to *E.modestus* (Nikolskii, 1964). Unfortunately the specimen was lost and only field notices and colour photos are still available. The 10 *Eirenis* specimens collected (4 from Urla) all showed typical *E.modestus* characteristics; length 20-40 cm, dorsal surface without pattern, neck with a transverse black or dark brown band with a yellow margin anteriorly and posteriorly, and a yellow ventral surface. The aberrant specimen was about 60 cm in length, dorsal surface pale brown with double dark brown longitudinal lines, neck without pattern and a white ventral surface. As scale characteristics are missing, it is not possible to give an exact classification of this aberrant specimen.

*Natrix natrix persa* Pallas (fig. 3)

Belgrad Forest, north of Istanbul. 29.V.1968 (1 juvenile).

Efesus, south of Izmir. 8.VI.1968 (2).

Belgrad Forest, north of Istanbul. 26.VII.1970 (G.N.M. Re. ex. 3287) (2).

Ciglicara Forest, 20 km SSW of Elmali. Prov. Anatalya. 13.IV.1972. (1).

In the two adult specimens from the Belgrad Forest the two light lines along the body (normally found on this subspecies), were missing.

*Natrix tessellata* Laurenti

Halkali by Istanbul. 30.V.1968 (2).

Kepsut. Province Balikisir. 1.VI.1968 (6).

Bafa Lake. Province Aydin. 30.VI.1970 (7).

Manyas Lake. Province Balikisir. 9.VII.1970 (G.N.M. Re. ex. 3288) (2).

Belgrad Forest, north of Istanbul. 15.VII.1970 (G.N.M. Re. ex. 3289) (2).

Marmaris. Province Mugla. 18.IV.1972 (2).

It is probable that specimens in areas which feed on fish, grow larger than those in areas where frogs are the only prey.

*Malpolon monspessulanus insignitus* Geoffroy

Belgrad Forest, north of Istanbul. 13.VII.1970 (2).

*Vipera ammodytes montandoni* Boulenger (fig. 5)

Belgrad Forest, north of Istanbul. 18.VII.1970 (1 female, alive).

Belgrad Forest, north of Istanbul. 18.VII.1970 (1 female, alive).

655 = 597 + 58 mm; Sq. 21, V. (1+) 146, A.1, Sc.32/32 + 1.

The pregnant female gave birth to 11 young (15.IX.1970). 3 were preserved: 2 juveniles were preserved at their birth;

Female, 179 = 158 + 21 mm; Sq. 21, V. (2+) 140, A.1, Sc.32/32 + 1 (D.Z.G.)

Male, 194 = 168 + 26 mm; Sq. 21, V. (1+) 146, A.1, Sc. 35/35 + 1 (D.Z.G.)

The 3rd, a male, preserved as adult (16.VI.1973);

566 = 502 + 64 mm; Sq. 21, V. (1+) 150, A.1, Sc. 35/35 + 1 (G.N.M. Re. ex. 3319).

In the two adults the shape of the rostral plate (max. height/breadth) is 1.40 (female) and 1.54 (male). The horn is 2-3 scales high above the rostral plate, and formed of 8-12 scales. The ground-colour is light brown (female), grey-beige (male), both with dark brown markings. The vertebral markings are unbroken zigzag bands, which are dark bordered on the male. Laterally, there is a horizontal row of dark-brown diffuse blotches, which are darker than the ground-colour. The underside is light-brown, with a diffuse dark-

brown pattern of tiny spots. The posterior third of the unmarked ventral side of the tail is green-gray in colour, with a green-yellow tip.

According to Eiselt & Baran (1970), the asiatic populations of *Vipera ammodytes* at the Bosphorus belong to *V.a. meridionalis*, for the number of ventral plates was within the limits of that subspecies. However, they pointed out that the shape of the rostral plate (higher than broad), of these northern Anatolian populations, agreed with the rostral plate of *V.a. montandoni*. In *V.a. meridionalis* the height and breadth of the rostral plate are equal (Boulenger, 1913). They did not study specimens from the European side of the Bosphorus, and did not discuss the taxonomic status of the populations of that area. The shape of the rostral plates of our 4 specimens from the Belgrad Forest, north of Istanbul, is characteristic of *V.a. montandoni*. They also have other characteristics, which taxonomically should place these populations of north-eastern Thrace, contrary to Bodenheimer (1944), into the subspecies *V.a. montandoni*. According to Eiselt & Baran (1970), the reduced snout, extension of the rostral plate and increase in the number of ventral plates are characteristic of *V.a. montandoni*.

Pholidoses of *V.a. meridionalis* and *V.a. montandoni*; geographical range (Boulenger, 1913), and *V. ammodytes* from the Belgrad Forest.

	Rostral height to breadth	Number of ventrals	Total number of hornscales
<i>V.a. meridionalis</i>	same	133-147	14-20
<i>V.a. montandoni</i>	higher than broad	149-158	10-14
<i>V. ammodytes</i> (Belgrad Forest)	higher than broad	140-150	8-12

The number of ventral plates on our specimens, 140-150, is within the range of both subspecies. The snout-horn (8-10 scales) and the shape of the rostral plate suggest *V.a. montandoni*. The length of the adults and the position of the snout-horn, in the two adult specimens, perpendicular to the head are more typical of *V.a. montandoni* than *V.a. meridionalis* (Clark, 1965). In the two juvenile specimens the snout-horn is pressed backwards along the head.

In Roumania, *V.a. montandoni* occurs in a lowland zone along the coast of the Black Sea (Fuhn & Vancea, 1961). In Bulgaria it occurs along the coast to the Turkish border (Buresch & Zonkow, 1934). Eiselt & Baran (1970) reported specimens from the coastal area of northern Thrace, province Kirk-lareli, which belong to *V.a. montandoni*. Bodenheimer (1944) wrote, "it is common in the whole of Thrace". The range is obviously continuous for *Vipera ammodytes* along the western and south-western coasts of the Black Sea and should allow inter-breeding between this populations. Along the coastal area, the species occurs in a lowland biotope. The choice of biotope in the Belgrad Forest is open sclerophyllous, vegetation areas on sandy grounds. The area lacks rocky or stony habitats, which normally characterize the biotope of *Vipera ammodytes*.

*Vipera xanthina xanthina* Gray

Efesus, south of Izmir. 9.VI.1968 (1 juvenile).

Efesus, south of Izmir. 26.VI.1970 (1).

Ciglicara, 20 km SSW of Elmali. Province Anatolya. 14.IV.1972 (4).

The adult gravid female from Efesus had 10 embryos in her uterus. The 4 specimens from Ciglicara Forest (3 males, 1 female), seemed just to have emerged from hibernation. The skins of these vipers, including that over the eye, were quite grey. They were probably undergoing their first shedding for

the year. The juvenile specimen from Efesus, was recognized by its skin, found under a stone.

#### DISCUSSION

Five species of amphibians and thirty species and subspecies of reptiles were observed in western Turkey. The dominating species were *Rana r. ridibunda*, *Testudo graeca iberica*, *Ophisops elegans ehrenbergi*, *Ablepharus k. kitaibelli* and *Natrix t. tessellata*. *Clemmys caspica rivulata* was also regularly observed in the area, in ponds and river-systems. *Bufo b. spinosus*, *Ophisaurus apodus*, *Lacerta viridis meridionalis*, *Coluber jugularis* and *Natrix n. persa* were less frequently found. Some species were more common in certain regions. *Bufo v. viridis* was often seen in Anatolia in aquatic areas. *Agama stellio* was abundant in dryer areas of south-western Anatolia. It was also seen in the north up to the area of Balikesir.

Further local observations in southwestern Anatolia were made on *Hyla a. arborea*, *Lacerta danfordi*, *Lacerta trilineata cariensis*, *Blanus strauchii*, *Typhlops vermicularis*, *Eirenis m. modestus* and *Vipera x. xanthina*. Isolated observations in southwestern Anatolia were made on *Hemidactylus t. turcicus*, *Chamaeleo c. chamaeleon*, *Eryx jaculus turcicus*, *Coluber ravergieri nummifer*, *Coluber najadum dahlii* and *Elaphe situla*. In the Belgrad Forest and adjacent areas of Thrace, an area which is partially covered with montane summergreen forest, *Rana dalmatina*, *Anguis fragilis colchicus*, *Lacerta t. taurica*, *Elaphe l. longissima*, *Coronella austriaca*, *Malopon monspessulanus insignitus* and *Vipera ammodytes montandoni* were found.

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SPAWNING DATES OF THE FROG (*RANA TEMPORARIA*) AND  
THE TOAD (*BUFO BUFO*) IN BRITAIN

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(Received 14/11/74)

INTRODUCTION

Frazer (1953a, b, 1955, 1956) tabulated breeding details for the frog (*Rana temporaria*) and the toad (*Bufo bufo*) in Britain for the period 1952-1955, including information on when the first spawn was seen. Savage's book on the frog (1961) contains a map of the British Isles indicating when in the year spawning begins. This map was constructed from the Phenological Reports of the Royal Meteorological Society and represents an immense amount of work done both by the field observers and by Savage. Unfortunately the map is difficult to interpret because of the ambiguous nature of the key to the shaded areas and because the time scale is divided into ten day periods rather than months or weeks. Apart from papers covering specific localities or books on amphibia containing vague generalisations, these remain the only publications on frog and toad spawning dates.

DETERMINATION OF SPAWNING DATES

When I began to abstract Frazer's material, my main objective was to determine when the toad begins to breed in different parts of Britain. Although Dr. Frazer kindly supplied me with previously unpublished breeding details covering the period 1956-1959, it was soon apparent that there was insufficient information to construct a map for the toad similar to Savage's map for the frog. Instead I decided to prepare a new frog map using the information gathered by both authors, and then determine whether the spawning dates for the toad were related to those for the frog in areas covered by Frazer's observers. If there was any relationship, then information on toad spawning dates for areas not covered by observers could be obtained indirectly. This method has the added benefit of providing an improved version of Savage's frog map (Figure 1). The map is only intended to be a guide to the usual spawning dates of the frog. Abnormal weather might alter the date by as much as a month. Savage (1961) discussed at some length the external factors controlling the spawn date of the frog.

For 12 English counties, Frazer collected at least two spawn dates for both the frog and the toad during the period 1952-1959. Mean toad spawning date is plotted against mean frog spawning date for each of these counties in Figure 2. As can be seen, those counties where the frogs spawn early in the year tend to be the counties where toad spawn is first recorded, and vice versa (Spearman's rank correlation coefficient = 0.76,  $t_{10} = 3.16$ ,  $P = 0.01$ ). The interval of time between the two species beginning to spawn in an area is related to the date when the frogs begin to spawn; the interval being greater where the frogs breed earlier (Figure 3). For only one locality have I managed to find spawn date details for both species over a period of several years. H. J. Moore sent Dr Frazer such information from Iwerne Minster in Dorset for the period 1950-1957. This information is consistent with that plotted on a county basis (Figures 2 and 3). Thus we can tentatively conclude that (i) where the frog begins to breed in early February the toad spawns about a month later; and (ii) the interval between the species is reduced in

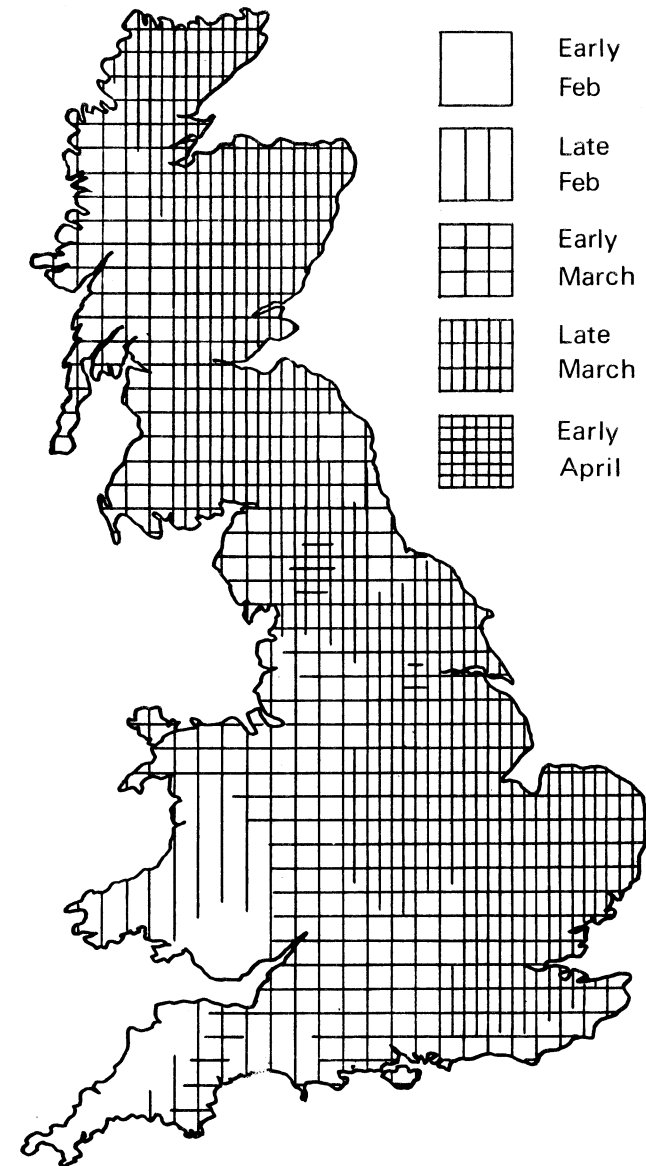


FIG. 1. The periods during which frog spawn is usually first recorded in different parts of Britain. The map is a simplified version of that presented by Savage (1961). Spawning date information collected by Frazer (1953a, 1953b, 1955, 1956 and unpublished) has also been taken into account.

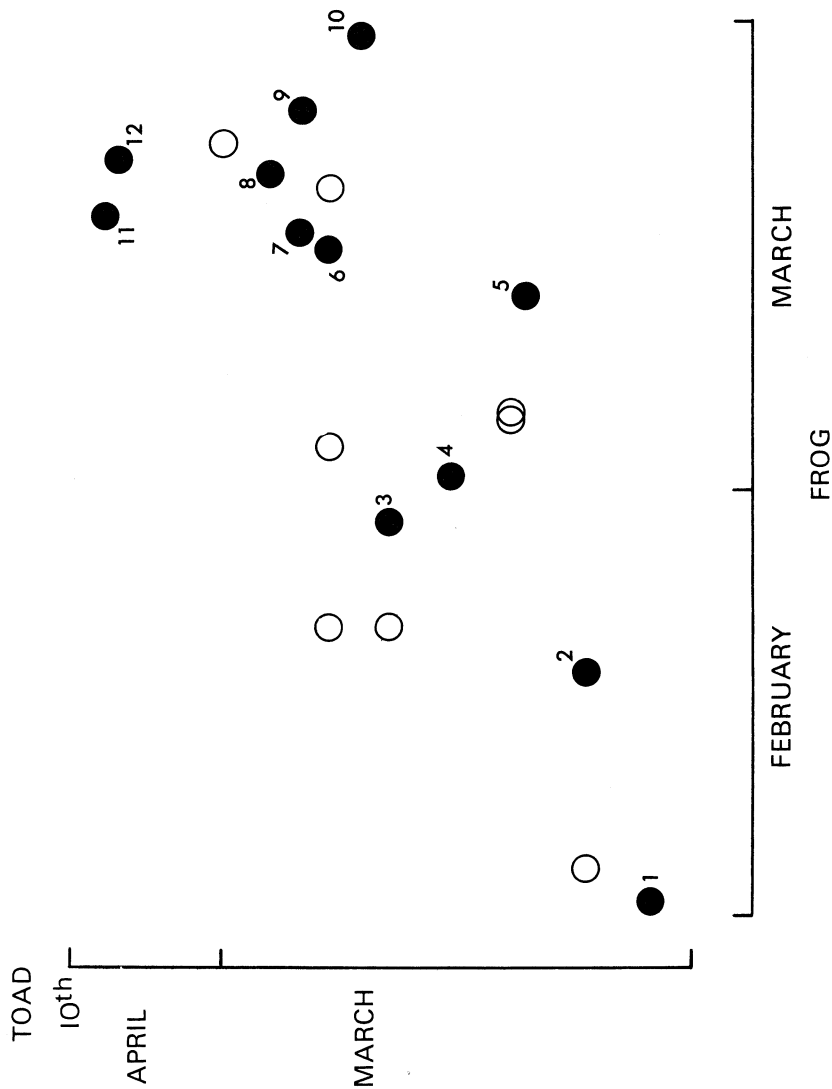


FIG. 2. Mean date when toad spawn was first recorded against the mean date for the frog on a county basis (●). Information was collected by Frazer (1953a, 1953b, 1955, 1956 and unpublished). Key to points: 1, Cornwall (2 frog records, 2 toad records); 2, Devon (8, 10); 3, Dorset (7, 6); 4, Somerset (5, 4); 5, Hants (7, 3); 6, Yorks (26, 4); 7, Surrey (26, 12); 8, Essex (4, 4); 9, Hunts (3, 4); 10, Sussex (3, 9); 11, Herts (3, 2); 12, Kent (9, 3). Data collected in Iwerne Minster, Dorset by H. J. Moore from 1950 until 1957 are plotted on an annual basis (○).

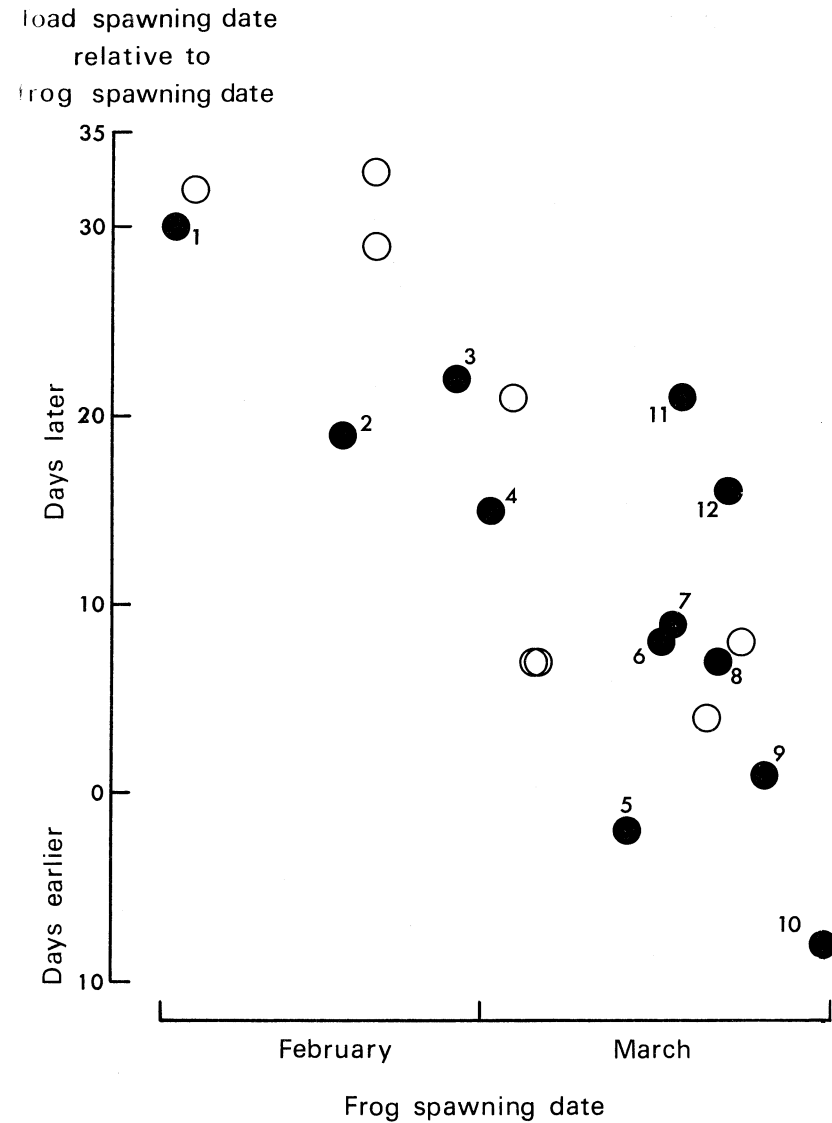


FIG. 3. The interval between the mean dates when spawning was first recorded for the frog and the toad, plotted on a county basis (●). Information was collected by Frazer (1953a, 1953b, 1955, 1956 and unpublished). Key to points: 1, Cornwall; 2, Devon; 3, Dorset; 4, Somerset; 5, Hants; 6, Yorks; 7, Surrey; 8, Essex; 9, Hunts; 10, Sussex; 11, Herts; 12, Kent. Numbers of records are given in the legend to Figure 2. Data collected in Iwerne Minster by H. J. Moore from 1950 until 1957 are plotted on an annual basis (○).

places where the frog breeds later, until in those areas where frogs spawn in late March or early April, toads spawn at about the same time. The Iwerne Minster data suggest that although for a locality there can be much variation in spawn date from year to year (particularly for the frog), if the frog spawning date for any year is known, then the date when the toads will spawn can usually be predicted to within a week or so.

For England, at least, the time range of the beginning of the frog spawning period (early February to early April) is about twice that for the toad (early March to early April). Over most of England, toads tend to begin to spawn in late March, or, to a lesser extent, early April. Only in the extreme south and south-west and perhaps in southern Lancashire are toads likely to be frequently encountered breeding before mid March. Frazer's English information gives the mean date for the toad as 22 March (S.E. = 1.4 days, n = 63). There is virtually no information for toads in Scotland or Wales, but from Figures 1, 2 and 3, toads might be expected to start to spawn in early March in South Wales, in late March in North Wales and over most of Scotland, and in early April in the rest of Scotland.

Finally it is worth stressing that this paper summarises when spawn has first been recorded in different parts of Britain. Sometimes a breeding season can continue for several months. Also since strings of toad spawn are more easily overlooked than clumps of frog spawn, the bias towards late recording may be rather worse for the toad than for the frog.

## ACKNOWLEDGEMENTS

I thank Dr. J. F. D. Frazer and Dr. R. M. Savage for their help during the preparation of this paper. Dr. J. P. Dempster also kindly commented on the manuscript.

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## LETTERS TO THE EDITOR

THE FUTURE OF THE INDIAN GHARIAL, *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA, CROCODILIA)

The gharial, perhaps the world's largest crocodile, and the sole surviving member of the family Gavialidae, is an inhabitant of rivers rising in the Himalayan region. It has been brought to the verge of extinction, its survival depending on the rapid creation of special sanctuary areas combined with active management<sup>1</sup>. The Government of Orissa, having considered expert reports, started a programme to save this rare crocodilian. Wild laid eggs are being collected for captive incubation and rearing of young for subsequent transfer into the sanctuary which incorporates thirty km of Mahanadi River including Satkosha Gorge, which is considered by Dr. H. R. Bustard the best remaining gharial habitat in the entire country. The scheme, with financial assistance from the Government of India and the United Nations Development Programme, has technical assistance from the Food and Agriculture Organisation of the United Nations. We have already raised 44 young gharials against only 10 definitely known to occur in the wild in Orissa<sup>2</sup>.

<sup>1</sup> FAO. India: A Preliminary Survey of the Prospects for Crocodile Farming 1974 (based on work of H. R. Bustard). FAO Rome (FO:IND/71/033), October 1974.

<sup>2</sup> FAO. India: Gharial and Crocodile Conservation Management in Orissa 1975 (based on work of H. R. Bustard). FAO Rome (FO:IND/71/033), December 1975.

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## INTERGENERIC HYBRIDIZATION IN CAPTIVITY: A CORRECTION

A recent perusal of the late Professor Dr. Robert Mertens' "Über Reptilienbastarde, V" (*Senckenbergiana Biologica*, 53:1-19) prompts me to make a correction that probably should have been published long ago. This concerns presumed hybridization between *Elaphe obsoleta quadrivittata* and *Natrix aequifasciata* as reported in the "Chester Zoo News" for February, 1969.

As soon as I learned about this and because of my long-standing interest in the naticine snakes, I wrote to G. S. Mottershead, O.B.E., M.Sc., Director-Secretary of the North of England Zoological Society. He and Roger Ainsley, Curator of Reptiles of the Chester Zoo, very kindly supplied me with pertinent details as well as colour photographs of the adult snakes and black-and-white prints of their offspring. From these it is evident that the female parent is an undoubted *Elaphe obsoleta quadrivittata* which had been living at the Chester Zoo for more than three years prior to the mating. The male parent I would identify as another member of the *Elaphe obsoleta* complex. Although the specimen has not been available for detailed examination, the coloration and pattern, which show clearly in the series of photographs sent to me, is well within the range of variation exhibited by the subspecies *lindheimeri*. Mating was observed twice during July, 1968, and nine eggs were laid by the female on 10 September 1968 of which four hatched between 7 November and 10 November 1968. The young, as is normally the case among juveniles of the species, were well patterned with blotches on a paler ground color; there were also strong suggestions of dark longitudinal striping, which is

characteristic of the subspecies *quadrivittata*.

Crosses between races of *E. obsoleta* are well known, and most North American zoos that maintain large reptile collections have had young hatched from similar matings. At the Philadelphia Zoological Garden, with which I was affiliated for 38 years, we had innumerable viable crosses within the complex in a large "swamp cage" where we occasionally exhibited as many as four races (*obsoleta*, *quadrivittata*, *rossalleni*, and *lindheimeri*) at the same time.

The origin of the male parent is of interest. It was donated to the Chester Zoo by an officer of a British freighter on the China run, and the snake was given to him in Shanghai. It was assumed, of course, that it had originated in Asia. A description was sent to the British Museum (Natural History) where it was suggested that the snake might be a member of any one of three species. It appeared to fit *Natrix aequifasciata* most closely, and was so labelled. One of the photographs shows clearly that the rostral region is scarred and deformed, a condition often resulting from a snake's being kept in a wire or rough-sided cage where the snout becomes abraded as the reptile struggles to escape. Inasmuch as it arrived at the Chester Zoo in that condition, it probably had been held in captivity, possibly for a considerable length of time. Because of the world wide traffic in reptiles and amphibians for the pet trade, it is not difficult to conclude that this American snake was somehow transported to the Orient where it eventually reached the hands of the ship's officer.

In any event, Merten's doubts have been justified. He wrote (*op. cit.*, p. 1), "Hingegen stehe ich dem angeblichen Hybriden *Elaphe obsoleta quadrivittata* X *Natrix "aequifasciata"* im Zoologischen Garten Chester Anonymus 1969) sehr skeptische gegenüber," which may be translated as "On the other hand I am skeptical about the alleged hybrid *Elaphe obsoleta quadrivittata* X *Natrix aequifasciata* in the Chester Zoological Garden."

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23/2/1976

## BOOK REVIEWS

G. M. Hughes (editor) 1976. *Respiration of amphibious vertebrates*. Academic Press: London, New York, San Francisco. pp. xix + 402. £12.00, \$29.75.

In many ways, water provides a more hospitable environment than land; its temperature is more equable, it provides protection against excessive ultraviolet radiation, and contains biological necessities readily available. Fresh water is not so advantageous in these respects as the sea, but animals which can solve the problems of salt and water balance posed by a migration to fresh water can enjoy a habitat relatively free of competition. A difficulty can arise in warm still waters, such as tropical swamps shaded by luxuriant vegetation, where the oxygen content of the water, except in the surface layer, falls very low. In such conditions, which occur in many places in South America, Africa and India, fishes of diverse groups have taken to getting their oxygen supply above the surface of the water. A similar problem presumably caused our own remote ancestors to develop lungs as well as gills; air-breathing enabled them to live in water which would otherwise have been unsuitable, and they probably first emerged to land only to pass to other bodies of water. Some fish still use lungs as their main or accessory respiratory organs, others have modified a variety of other structures, from the gills to parts of the intestine, to act as respiratory surfaces. This has happened independently a number of times in different groups of teleost fishes. Some use aerial breathing all the time, like the electric eel or the arapaima, which drown if prevented from surfacing, some use it only as an alternative to aquatic breathing, like the pond loach, or smaller specimens of the climbing perch, or the American gars in warm weather. Nearly all air-breathing fish however still use their gills to eliminate about three quarters of all the carbon dioxide respired, and even in amphibians the greater part of the carbon dioxide is passed out through the skin rather than through the lungs. Secondly aquatic amphibians have a physiology which resembles that of fish in many respects, whether they depend on lungs or on gills; in both cases the ambient temperature is an important factor.

These topics were among those discussed at a Symposium held at Bhagalpur University, Bihar, India, late in 1974. The proceedings are published as a series of papers which bring together research results on ecology, morphology and fine structure, as well as on the respiratory physiology, of diverse vertebrates which live in water but breathe air. The title of the book is slightly misleading as the majority of the contributions are concerned with fishes and by no means all the animals discussed ever set foot, or fin, on land. Mammals and birds are not included except in so far as they provide some comparative data. Much previously published work in this field is scattered in learned journals or is contained in texts which deal with the physiology of different systematic groups separately, so that a synthesis is very much to be welcomed.

Looking at vertebrate evolution through the eyes of respiratory physiologists, it appears that the crucial stage in the evolution of the tetrapods was not the development of a lung as such, but the utilisation of a breathing mechanism which would allow carbon dioxide to be exhaled efficiently from the lungs; it was then possible to function with a dry skin which would allow more efficient water conservation and eventually the acquisition of the fur or feathers associated with homiothermy. It can't be quite as simple as that, but it is salutary to remember that a number of different factors are involved in complete adaptation to terrestrial life. Water relations and embryology have been more frequently considered in the past. However, it is not apt to compare (as Rahn & Howell do) the horny scales of reptiles with the bony,

demal scales of fish and even of the apodan amphibians, which form part of a moist and mucigenic skin.

Fresh water air-breathing fishes take a wide variety of diets, and when a few species occasionally come out of water, it is not in search of food. Even though aerial breathing has been evolved repeatedly, it is unlikely that these fish will effect a new colonisation of land, if only because of the number of competitors already there. The case of certain marine fishes is somewhat different. Oxygen is seldom a limiting factor in the sea, but littoral fishes may find air-breathing advantageous as it enables them to stay on the shore even when the tide is down. The mud skippers, *Periophthalmidae*, are the best known fish with this habit, and some species spend most of their time out of the water. The mud skippers inhabit mud flats and mangrove swamps, but members of other typically littoral families, the blennies and the cling-fishes, are associated with rocky shores or, in some cases, with coral reefs. Shore living amphibious fish usually show little obvious morphological adaptation, often using the skin and gills as respiratory surfaces, but they appear to be relatively efficient at excreting carbon dioxide when in air, and are able to switch from aerial to aquatic respiration, and back again, when necessary. Most avoid drying out by behavioural modifications.

Not only certain amphibians, but also many reptiles, have become secondarily aquatic. Turtles and crocodilians which habitually live in water use different mechanisms to ventilate their lungs when in the water. Sea snakes show physiological adaptations to a diving habit. Only two of the seventeen papers in the volume are about reptiles. The three papers which are exclusively on amphibians deal with North American salamanders. Nevertheless the other contributions contain a great deal of matter which is of interest even to those who are not primarily concerned with fish.

MARY WHITEAR

HANDBOOK OF COMMON NEW GUINEA FROGS. By J. I. Menzies, XI + 77 pp. Wau Ecology Institute Handbook No. 1. 1976. £2-20 Australia; \$3-20 U.S.A.

The Wau Institute is dedicated to the study of the ecology and conservation of the flora and fauna of Papua New Guinea. Its location is at Wau (alt. 1200 metres) in the mountains of E. Papua. Accommodation is available for those requiring modest facilities for reading, research and exploration. This volume is the first published by the Institute, on the anuran fauna of the New Guinea mainland. Its interest and importance are emphasised in the Foreword by no less a person than Mr. A. Maori Kiki, the Minister of Defences, International Relations and Trade of Papua New Guinea.

As Menzies writes in the Introduction, "there are more than 200 different species of anurans on the New Guinea mainland", but strangely there are no urodeles and perhaps less strangely, no apodans either. It is of interest that probably because of the high atmospheric humidity many frogs do not have a larval stage in their life history, especially microhylids and some ranids. (*Platymantis*). A systematic account is given of members of the four main families, which comprise the *Leptodactylidae*, *Hylidae*, *Ranidae* and *Microhylidae* and also the *Bufo* spp. which includes only the introduced spp. *Bufo marinus*. The family *Rhacophoridae* of 2 specimens only, which were introduced in 1926, is not considered. There are 12 colour plates, each including 6 different specimens which demonstrate the beautiful range of form and colouration of these anurans. About 50 spp. (or groups of spp.), of the most widespread and commonest anurans are described; indeed some closely related forms are only distinguishable by their voices. This short volume provides much interesting information about New Guinea frogs and herpeto-

logical libraries should welcome the book, which must have few companions on the subject.

H. Fox

FROM EGG TO ADOLESCENT. *XENOPUS*—A MODEL FOR DEVELOPMENT. By Hamilton, Louie (1976). Pp. X + 78. The English Universities Press. £3.45.

Dr. Hamilton has written a fascinating book on *Xenopus laevis*, mainly aimed at trainee school teachers, sixth formers and university students, though anyone interested in vertebrate embryology would find the contents rewarding. Gametogenesis, initial embryogeny including gastrulation and neurulation and then the later differentiation of the neural, mesodermal and endodermal tissues are described. Other chapters deal with metamorphosis, regeneration of tissues and thence nuclear transplantation, especially where such work helps us to understand nucleo-cytoplasmic relationships during cellular differentiation. Further reading on each subject is provided at the end of each chapter. An Appendix describes some experimental procedures which may be followed by those readers wishing to examine first hand, embryological processes of *Xenopus* embryos and larvae in the laboratory.

The account of different developmental features seems to explain some of the complexities as though they are simpler than is really the case. This is doubtless due to the skill of the author, who manages to handle this difficult subject in a manner which is both readable and informative. A stimulating Foreword by Sir Peter Medawar is included.

The book should provide a firm basis for those who are interested in how living animals which begin life as tiny fertilised eggs can finish up as humans or elephants or snakes, or, of course, *Xenopus*.

H. Fox

THE ANATOMY OF THE GARDEN LIZARD (*Calotes versicolor*, Bouln.). By S. Y. Paranjape. Zoological Monograph, University of Poona, 1974. Pp. 173. Illustr.

A useful work, dealing with both gross and microscopic anatomy of an Indian agamid.